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ENVIRONMENT CLIMATE CHANGES AND DENGUE FEVER

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ABSTRACT

Dengue is transmitted to humans by mosquitoes. The intensity of the disease has increased an estimated 30-fold over the past 50 years. Globalization, trade, urbanization, travel, demographic change, inadequate domestic water supplies and warming temperatures are associated with the spread of the main vectors *Aedes aegypti and Aedes albopictus*. *aegypti*, originally from Africa, and *Ae. albopictus*, from Asia, rapidly expanded their range over the past 50 years, transported among continents and spread overland by the global shipping industry, in Worldwide, dengue is the most important vector-borne viral disease that is rubber tires or other containers in which eggs had been laid. Dengue virus also spreads rapidly via infected travelers [whose numbers have increased over recent decades] . Climate change may lead to changes in these determinants of dengue transmission by multiple, inter-related mechanisms. Dengue is the world's most important arboviral disease in terms of number of people affected. Over the past 50 years, incidence increased 30-fold: there were approximately 390 million infections in 2010. New geographic areas along the fringe of current geographic ranges for *Aedes* will become environmentally suitable for the mosquito's lifecycle, and for dengue transmission. Many endemic countries where dengue is likely to spread further have underdeveloped health systems, increasing the substantial challenges of disease prevention and control. Control focuses on management of *Aedes*, although these efforts have typically had limited effectiveness in preventing outbreaks. New prevention and control efforts are needed to counter the potential consequences of climate change on the geographic range and incidence of dengue, including novel methods of vector control and dengue vaccines.

Keywords; Climate Change, Dengue, Aedes Aegypti, Aedes Albopictus, Vector Control, Dengue Vaccine.

I INTRODUCTION

Dengue viruses are transmitted by *Aedes* mosquitoes, which are highly sensitive to environmental conditions. Temperature, precipitation, and humidity are critical to mosquito survival, reproduction, and development and can influence mosquito presence and abundance. Additionally, higher temperatures reduce the time required for the virus to replicate and disseminate in the mosquito. This process, referred to as the "extrinsic incubation period", mostly occur before the virus can reach the mosquitoes salivary glands and be transmitted to humans. If the mosquito becomes infectious faster because temperatures are warmer, it has a greater chance of infecting a human before it dies.

Epidemiology

Dengue is transmitted between people through mosquitoes *Aedes aegypti* and *Aedes* albopictus, which are found throughout the world. Insects that transmit disease are vectors. Symptoms of infection usually begin 4 – 7 days after the mosquito bite and typically last 3 – 10 days. In order to transmission to occur, the mosquito must feed on a person during a 5- day period when large amounts of virus are in the blood; this period usually begins a little before the person become symptomatic. Some people never have significant symptoms but can still infect mosquitoes. After entering the mosquito in the blood meal, the virus will require an additional 8-12 days incubation before it can then be transmitted to another human. The mosquito remains infected for the remainder of its life, which might be days or a few weeks.

In rare cases dengue can be transmitted in organ transplants or blood transfusions from infected donors, and there is evidence of transmission from an infected pregnant mother to her fetus. But in the vast majority of infections, a mosquito bite is responsible. In many parts of the tropics and subtropics, dengue is endemic, that is, it occurs every year, usually during a season when *Aedes* mosquito populations are high, often when rainfall is optimal for breeding. These areas are, however, additionally at periodic risk for epidemic dengue, when large numbers of people become infected during a short period. Dengue epidemics require a coincidence of large numbers of vector mosquitoes, large numbers of people with no immunity to one of the four virus types (DENV 1, DENV 2, DENV 3, DENV 4), and the opportunity for contact between the two. Although *Aedes* are common in the southern U. S., dengue is endemic in northern Mexico, and the U.S. population has no immunity, the lack of dengue transmission in the continental U.S. is primarily because contact between people and the vectors is not frequent to sustain transmission.

Globally, the reported incidence of dengue has been increasing. Although climate may play a role in changing dengue incidence and distribution, it is one of many factors; given its poor correlation with historical changes in incidence, its role may be minor. Other important factors potentially contributing to global changes in dengue

incidence and distribution include population growth, urbanization, lack of sanitation, increased long-distance travel, ineffective mosquito control, and increased reporting capacity.

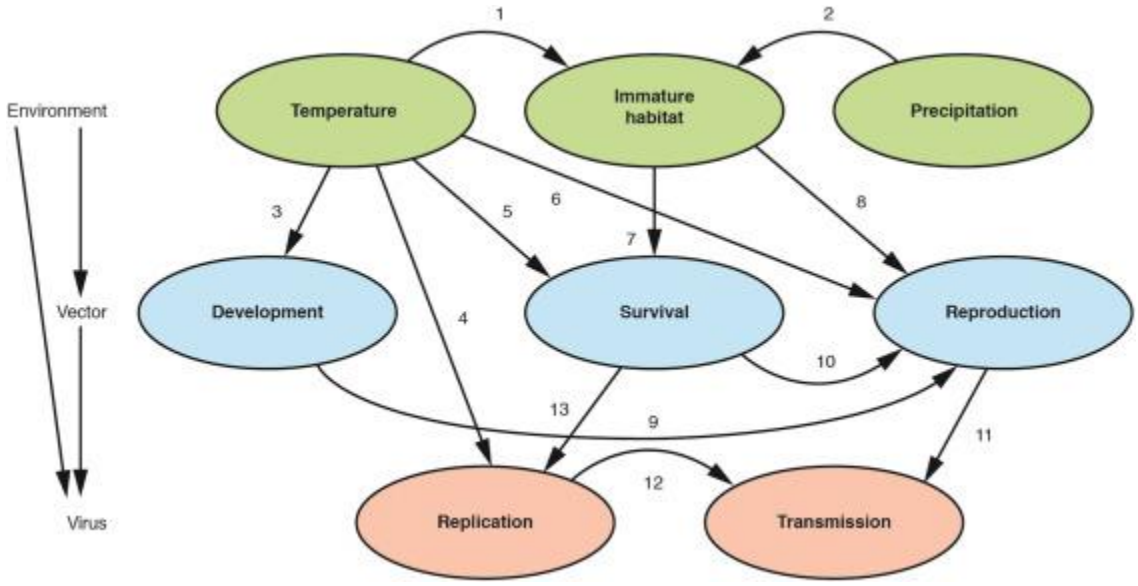
The primary carrier is the mosquito *Aedes aegypti* which originated in Africa but now resides in tropical and subtropical regions throughout the world. Sadly, no vaccines or drugs to date are able to combat the dengue virus. When outbreaks of the dengue virus start in urban areas, it may affect as much as 80% of the population. Currently, an estimated 2.5 billion people are at risk of contacting this virus but with global warming, the number will rise drastically. Consequently, this could overwhelm public health services in many regions worldwide during epidemics.

EFFECT OF CLIMATE

Diurnal temperature range is also important for dengue transmission by *Ae. Aegypti* (Lambrechts et al., 2011). Thermodynamic modeling predicts that at low mean temperatures (<18 °C), increases in diurnal temperature ranges led to increased DENV transmission, whereas at mean temperatures >18 °C, the effect was reversed. Indeed, at 26 °C, mosquitoes were susceptible to infection and survived for a shorter period under larger diurnal temperature ranges (Lambrechts et al., 2011). Carrington et al. found that a small diurnal temperature range had no effect on vector competence at a high mean temperature (30 °C), but a large diurnal temperature range at a low temperature (20 °C) increased the proportion of infected mosquitoes that could disseminate infection by 60% (Carrington et al., 2013). In line with these findings, Liu-Helmersson et al. showed that a higher diurnal temperature range was associated with increased dengue epidemic potential in both cold-to-temperate and extremely hot climates (Liu-Helmersson et al., 2014). The model suggested that small increases in dengue epidemic potential occurred over the past 100 years. Since 1950, diurnal temperature range increased and magnitudes of annual temperature cycles

increased by 0.4 °C in temperate regions (Vasseur et al., 2014), which means possible impacts on dengue outbreak risk if this trend continues.

These temperature-dependent relationships differ depending on the *Aedes* species. Brady et al. created survival models for *Ae. Aegypti* and *Ae. Albopictus* across their range of viable temperatures, showing that *Ae. Albopictus* has higher survival rates and thus may become a more important vector in some regions (Brady et al., 2014). *Ae. Aegypti* can tolerate a wider range of temperatures, presumably by exploiting habitatat in urban areas with favorable temperatures.



Biophysical influences on dengue ecology showing the interactions between climate variables, vectors, and the virus. The numbers in the figure identify relationships between variables supported by research in the field and under controlled laboratory conditions:

Habitat availability for mosquito larvae is influenced by (1) temperature through evaporation and transpiration, (2) incoming precipitation, Temperature is a major regulator of (3) mosquito development, (4) viral replication within infected mosquitoes, (5) mosquito survival, (6) the reproductive behavior of mosquitoes, Habitat availability is required for (7) survival, (8) egg-laying, Mosquito reproduction is accelerated by (9) faster mosquito development, (10) increased survival, Increased mosquito reproduction (11) enhances the likelihood of transmission by increasing the number of blood feedings, Faster viral replication (12) increases transmission by shortening the time for the virus to develop in the mosquito, Increased survival of the adult mosquito (13) increases the amount of viral replication. Source: Morin et al. (2013).

It is established that climate change is happening and it is likely to expand the geographical distribution of several mosquito-borne diseases [26]. The mounting evidence around climate-disease relationships raises many important issues about the potential effects of global climate changes on the transmission of infectious diseases, particularly dengue [5,27-29]. There is evidence indicating that dengue epidemics have been associated with temperature [30-32], rainfall [33,34] and relative humidity [35-37]. Few studies have included spatial data in climate-based predictive models [33,38]

Aedesaegypti	**Aedesalbopictus**
"Yellow fever" mosquito	"Asian tiger" mosquito
Bright silvery lyre-shaped dorsal pattern and white banded legs	Single longitudinal silvery dorsal stripes and white banded legs
Occupies urban areas with or without vegetation	Associated with thickets and arboreal vegetation
Bites, rests, and lays eggs indoors and outdoors	Mostly an outdoor (garden) mosquito
Sneaky biter	Aggressive biter
High preference for taking blood meals from humans and to a lesser extent from domestic mammals	Bites humans but also a variety of available domestic and wild vertebrates that do not carry the dengue virus, which lowers its capacity to transmit them
Main dengue vector worldwide	Main dengue vector in some areas, but is mostly a secondary vector
Major production places are man-made containers, tree holes, and bamboo internodes holding water	Preference for tree holes and bamboo internodes with water but can also utilize man-made containers for its immature development
Most containers with water used for immature development are within or in close proximity to households	Utilizes water-filled containers around or further away from households
Maximum survival 22 days	Maximum survival 65 days
Biting and movement impaired below 14°C	Biting and movement impaired below 13°C

II DISCUSSION

Climatic factors play a significant role in the mosquito biology, the viruses they transmit, and more broadly, dengue transmission cycles. Higher temperatures increase the rate of larval development and shorten the emergence of adult

mosquitoes, increase the biting rate of mosquito and reduce the time required for virus replication within the mosquito. Extreme higher temperatures may reduce mosquito survival time, which could offset the positive effect on mosquito abundance [69]. Evidence had accrued to show the link between temperature and dengue incidence rates [9,34,36,47]. These studies have used a range of statistical approaches considering different temperature parameters (e.g. mean, maximum and minimum temperatures), and the results are generally consistent, indicating that the epidemics of dengue are driven by climate to some extent.

Relative humidity is another key factor that influences mosquitoes' life cycle at different stages. The combined effect of temperature and humidity significantly influences the number of blood meals and can also affect the survival rate of the vector, and the probability that it will become infected and able to transmit dengue [70]. In the literature, relative humidity and temperature are the two most important variables with potential impact on dengue transmission. Vapour pressure or relative humidity is affected by a combination of rainfall and temperature and influences the mosquito lifespan and thus the potential for transmission of the virus. Hales et al. found that annual average vapour pressure was the most important climatic predictor of global dengue occurrence [33]. Therefore, temperature, rainfall and relative humidity are important determinants of the geographic limits within which dengue transmission can be expected to continue, primarily through their effects on the *Aedes* vector. Furthermore, within areas where minimum thresholds of these climate parameters are sufficient to maintain dengue transmission, seasonal fluctuations in these parameters will be important determinants of the duration and potentially the intensity of transmission.

III CONCLUSION

There is no vaccine available against dengue, and there are no specific medications to treat a dengue infection. This makes prevention the most important step, and prevention means avoiding mosquito bites.

The best way to reduce mosquitoes is to eliminate the places where the mosquito lays her eggs, like artificial containers that hold water in and around the home. Outdoors, clean water containers like pet and animal watering containers, flower planter dishes or cover water storage barrels. Look for standing water indoors such as in vases with fresh flowers and clean at least once a week.

The adult mosquitoes like to bite inside as well as around homes, during the day and at night when the lights are on. To protect yourself, use repellent on your skin while indoors or out. When possible, wear long sleeves and pants for additional protection. Also, make sure window and door screens are secure and without holes. If available, use air-conditioners. If someone in your house is ill with dengue, take extra precautions to prevent mosquitoes from biting the patient and going on to bite others in the household. Sleep under a mosquito bed net, eliminate mosquitoes with repellents

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