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# Climate Change in Association to Dengue Fever-Literature Review

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***This literature review critically examines the intricate relationship between climate change and the incidence of Dengue fever, a rapidly emerging global public health threat. With climate change driving shifts in temperature, precipitation patterns, and humidity levels, this review synthesizes a wealth of empirical studies to elucidate the multifaceted impacts on Dengue transmission dynamics.***

***The review elucidates the influence of rising temperatures on the geographical expansion of Dengue vectors, particularly the Aedes aegypti mosquito. As temperature thresholds for vector breeding and Dengue virus replication are surpassed, previously unaffected regions become susceptible to Dengue outbreaks. Additionally, altered precipitation patterns and increased humidity, characteristic of climate change, create ideal breeding conditions for Aedes mosquitoes, amplifying transmission risk. Taking a closer look on its effects on a developing island like Fiji whereby the effects of Dengue Fever can be crippling in both the health and economic sector.***

***By synthesizing these findings, this review underscores the urgent need for adaptive public health strategies. Proactive surveillance, vector control, and community engagement are identified as crucial components of a comprehensive response to mitigate the escalating threat of Dengue fever in the face of a changing climate. This review serves as a foundational resource for policymakers, researchers, and practitioners alike, guiding evidence-based interventions to safeguard global health.***

## I. Introduction

The World Health Organization (WHO) reports the dengue is now endemic to Americas, South-East Asia and the Western Pacific whereby dengue fever cases found in just these areas amount to over 3.34 million as of 2016 (Cogan, 2020). There was a significant spike in the number of dengue fever cases in all endemic countries in 2016 and another such spike was seen in 2019 throughout all endemic areas (Cogan, 2020). Dengue Fever has been a problem for the pacific island nations for a long time. Studies have found that over the past couple of decades the coverage rate of dengue fever has increased significantly (Kirch, 2018). Fiji witnessed its biggest dengue fever outbreak in 2013 which ran through to 2014 (Getahun, et al., 2014). Getahun, et al (2014) in a retrospective study noted that the greatest number of dengue cases are reported during the approximate time in which Fiji has its cyclone season which is November to April. The study also noted that this time correlated with floods and heavy rainfall (Getahun, et al., 2014). Through various studies it can be noted that more and more people are at an increased risk of dengue fever and it may be linked to weather patterns.

## II. Disease Vectors

Dengue fever is primarily spread by Aedes aegypti and Ae. Albopictus (Liu et al., 2017; Sun et al., 2018) species of mosquitoes, the latter of which causes the disease in lesser quantities. Both species are also responsible for the spread of other well-known diseases such as yellow fever, Chikungunya and the Zika virus (Sun et al., 2018). The Aedes aegypti species of mosquitoes were once confined only to regions of Africa, now have a wide spread prevalence initiated mainly due to geographical expansion (Lwande et al., 2020). Ae. Albopictus species mainly originated from the pacific region where it plays a major role in disease transmission however, have more recently spread to the western African regions (Kamal et al., 2018). Although they are capable of transmitting various diseases, the ability and duration of transmission of different diseases vary among different regional mosquitoes of the same species (Liu et al., 2017). Furthermore, the different serotypes of dengue fever carried by these mosquitoes may differ as well (Liu et al., 2017). Aedes aegypti and Ae. Albopictus are poikilotherms thus external temperature greatly affects their breeding and life cycle (Sun et al., 2018). As summarized by Golding et al (2015) cost effect methods such as mosquito nets and curtains can all aid in the control of diseases spread by these disease vectors (Golding et al., 2015).

## III. Vector Life-Cycle

Aedes species of mosquitoes like most other species prefer to lay eggs in stagnant or semi-stagnant bodies of water (Tokash et al., 2019). The different species of mosquitoes relatively differ in the quality of water preferred, as it may vary from polluted water or clear highly oxygenated water depending on the species (Benedict et al., 2007; Moller et al., 2014). Studies also show the temperature of water and the surrounding atmosphere greatly effects the growth rates of mosquitoes (Liu et al., 2014). Once laid the eggs hatching phase is triggered by hypoxic condition of the water (Tokash et al., 2019). This mechanism ensures that the bacterial content in the water is high enough as these bacteria will be the major sustenance of the hatched larvae (Tokash et al., 2019). Once hatched the larvae goes through four larval stages which is only differentiated by the size of the larvae until it reaches the pupae phase (Tokash et al., 2019). Once in the pupae phase metamorphosis takes place and the adult mosquito is formed (Tokash et al., 2019). The adult male mosquitoes feed on fruits and females feed on blood vertebrates for the development of eggs until it is ready to lay eggs for the next cycle to begin (Tokash et al., 2019). The size of speed of growth of a particular species of mosquitoes greatly contributes to its ability to spread diseases (Brady et al., 2015). The entire lifecycle can last from anywhere between 4 days to several months (United States Environmental Protection Agency, n.d.). The pupae can develop into an adult in as little as 2 days, the major inconsistence of time is from the hatching of the eggs (United States Environmental Protection Agency, n.d.). Eggs can hatch from within a few days from being laid to a matter of months, this typically depends on the environmental conditions and bacterial content of the water (Tokash et al., *2019).*

## IV. Transmission and incidence

Dengue fever transmission has two phases, the human to mosquito transmission and the mosquito to human transmission (Cogan, 2020). Dengue infections in humans occurs due to 4 different serotypes (DEN-1, DEN-2, DEN-3, DEN-4) (Ganesh et al., 2018). Once the mosquito feeds on an infected individual, the virus takes 8-12days to mutate within the mosquito (Cogan, 2020). This incubation period is greatly affected by environmental temperatures, after this incubation period the mosquito may remain infective for the remainder of its life (Cogan, 2020). Once a mosquito feeds from an individual it takes a minimum of only 2 days for the primary symptom fever to materialize (Cogan, 2020). However, Duong et al (2015) highlighted in his study that there are significant number of patients that are asymptomatic to dengue fever yet continue to infect mosquitoes which feed on them. A study by Phanitchat et al (2019), the greatest incidence of dengue fever was seen mainly at the 5-14 years range. The study also noted a steady increase in the age range, moving more towards the adults as time progressed (Phanitchat et al., 2019).

## V. Dengue and Severe Dengue Infections

Dengue fever materializers differently in different individuals. It may be asymptomatic in some and may develop severe dengue symptoms in others. Severe dengue may be related to the serotype of dengue fever a person may be infected with.

Dengue fever has 5 different serotypes. (DENV)-1, DENV-2, DENV-3, DENV-4 and the recently confirmed DENV-5. Originally thought to be a variant of DENV-4, testing on pre-infected Rhesus monkeys proved it to be a new virus (Mustafa et al., 2015). Yung et al., (2015) in research determined that there may not be any significant difference between dengue serotypes (DENV)-1, DENV-2 and DENV-3 when it comes to severity of symptoms manifested in patients. Various research has proved that majority of dengue fever cases occur with (DENV)-1 and DENV-2 serotypes (Konongoi et al., 2016; Pérez-Castro et al., 2016; Shrivastava et al., 2018; Nair et al., 2019).

Severe dengue is a fatal complication of dengue fever due to various causes such as plasma leakage, severe fever or organ impairment as reported by the WHO. With continuing research being conducted in ways to predict when severe dengue will manifest (Nhi et al., 2016), it is still a major complication which may occur in dengue fever patient. C-reactive proteins have also been identified in studies as a reliable biomarker if measured within the first 3 days, to predict disease progression (Vuong et al., 2020). Research has also shown that patients with sickle cell disease have a higher chance of manifesting severe dengue then others (Rankine et al., 2015; Wilder & Leong, 2019). The major warning signs of severe dengue as reported by Ahmad et al (2018) can include, hypertension, mucosal bleeding, abdominal pain, persistent vomiting and rapid thrombocytopenia. Most studies suggest that severe dengue occurs when a patient has normally developed an immune response including particular cytokines (Yacoub & Wills, 2014) to a particular serotype of dengue fever and is infected with the different serotype than to which the patient had the immunity (Katzelnick et al., 2017; Wang et al., 2016). While targeted interventions in children and metformin use in diabetic adults are being studied for use against severe dengue (Htun et al., 2018; Ranjit et al., 2018) there is still no cure and treatment efforts are focused on treating the manifested symptoms.

Furthermore, another severe complication of dengue fever is Dengue Hemorrhagic Fever (DHF). DHF can lead to sever bleeding, organ damage and in some cases death (Lauer et al., 2018). As reported by Fazidah et al (2018) DHF may be caused by repeated exposure to the dengue virus and may heavily be impacted by behavioral and socio-economic dynamics. Various studies have attempted to predict or forecast the occurrence of DHF with different methods and varying levels of success (Ullah et al., 2019; Yee et al., 2017; Siregar & Makmur, 2019) however, DHF has no cure nor vaccine and is also treated based on manifested symptoms however, preventive measures such as Wolbachia-infected mosquitoes have shown a positive effect on the preventive dengue fever (O'Reilly et al., 2019).

## VI. Climate Change associated weather effects on vectors and disease progress

Climate change plays major roles in changing weather systems affecting temperature, precipitation, humidity and average rainfall (Kirch, 2018). All these factors may influence the breeding patterns and the multiplication of disease vectors. Studies note that infectious arthropods are relatively sensitive to climatic conditions (Caminade et al, 2019) In a study of the mosquito species culex quinquefasciatus Samy, et al (2016) noted that climate factors such as temperature greatly influences the reproduction rates of most mosquito species and this inadvertently increases vector borne diseases. Ryan et al (2019) in a study of the expansion of Aedes species mosquitoes notes that relatively little is known about the weather impacts on dengue fever compared to Malaria. It was also found that differences in climate conditions brought about by climate change may favor dengue vectors, significantly increasing their range through to 2085 (Ryan, et al. 2019). Khan, et al (2019) in a study found that climate conditions mainly temperature as well as wind conditions are greatly increasing the occurrence and increases the effectiveness of vector borne diseases (Khan et al. 2019). The environment of a living organism greatly affects its etiquette in terms of active hours, reproduction and migration patterns (Fouque, 2019). Mazza (2017) on a research based on agriculture highlights that the continued effect of climate change ultimately changes weather patterns thus effectively changing the normal rhythm of plants as well as insects in the area. A difference in behavioral patterns of insects may affect the occurrence of certain diseases especially considering disease vectors such as mosquitoes. Colón-González, et al (2013) summarized in research conducted in Mexico that weather heavily impacted the occurrence of dengue fever and further stating that future action taken against dengue fever would heavily be impacted by climate conditions which may ultimately contribute to the success or failure of the implemented program.

## VII. Diagnosis

Clinical diagnosis of dengue fever heavily depends upon the serotype of dengue infection as well as the presence of severe symptoms of the disease (Muller et al., 2017). Point of care diagnosis is usually carried out in conjunction with clinical presentation of the patient. This helps to differentiate the infection from other diseases with similar presentations. Close to 80% of all dengue infections are asymptomatic and usually goes undiagnosed (Yacoub et al., 2016). Those who are symptomatic are identified into mainly 3 phases being the febrile, critical, and recovery phases. The phases are mainly differentiated by the time of presence of symptoms and the severity of the symptoms present (Jaenisch et al., 2016). Common presentations of dengue fever patients involve fever, dehydration, headache and nausea (Muller et al., 2017). There are a number of laboratory techniques to identify dengue fever within patients however, serological testing is most commonly used due to its easy nature and rapid results. Fiji utilizers the Dengue NS1/IgM and IgG antigen rapid test where samples are also sent to the Fiji Center of Disease Control for the confirmation of results using ELISA or Polymerase Chain Reactions.

## VIII. Conclusion

In conclusion, this comprehensive literature review illuminates the intricate nexus between climate change and the prevalence of Dengue fever. As rising temperatures, altered precipitation patterns, and increased humidity reshape environmental conditions, the expansion of Dengue vectors and heightened transmission risk become evident. Urgent, adaptive public health strategies, including enhanced surveillance, targeted vector control, and community involvement, are imperative. This synthesis of empirical evidence provides a critical foundation for informed policymaking and intervention efforts, essential for safeguarding global health in the face of a changing climate.

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