ISSN: 2474-3658

Irma et al. J Infect Dis Epidemiol 2019, 5:097
DOI: 10.23937/2474-3658/1510097
Volume 5 | Issue 6
Open Access

Journal of
Infectious Diseases and Epidemiology

RESEARCH ARTICLE

Climate Variability and Its Impact on the Incidence by Dengue in Six Endemic States of the Mexican Republic

Pérez Contreras Irma[1*], Alvarado Bravo Krystel Mariel[2], Barragán Gonzáles Alin[2] and Velasco Pérez Daniel Alejandro[3]

[1]Research Professor, Faculty of Medicine, Meritorious Autonomous University of Puebla, México

[2]Medical Student, Meritorious Autonomous University of Puebla, México

[3]Graduate Student, Universidad Mesoamericana de Puebla, México

***Corresponding authors:** *Pérez Contreras Irma, Research Professor, Faculty of Medicine, Meritorious Autonomous University of Puebla, 13 sur 2702, Colonia Volcanes, 72 410, Puebla, Mexico, Tel: 01-22-2229-5500, Ext 6304, 6315*

Abstract

Introduction: Climate variables are one of the main drivers of dengue epidemics and the proliferation of their vectors. Significant relationships have been found between fluctuations in temperature, rainfall, and the incidence of dengue. The interaction between high levels of these variables significantly influences the increase in the incidence after at least one month of this event.

Methods: The confirmed cases of dengue reported in the epidemiological bulletins of the Epidemiology General Directorate were collected. Seven states with the highest incidence in the Mexican Republic during the years 2016-2018 through week 14 were selected. The environmental temperature and precipitation data reported by official organisms of each state during the indicated period were obtained. Incidence data were plotted for each month. The analysis of climatic variability behaviors, the degree of precipitation, and the incidence of dengue cases were made.

Results: The states analyzed were Jalisco, Michoacán, Guerrero, Nuevo León, Chiapas, Guanajuato, and Veracruz. The state of Guerrero reported cases of dengue throughout the entire study period. This state is characterized by maintaining high environmental temperatures with minimal variation and variable volume of precipitation. It was observed as a preamble of the rise in cases, high environmental temperatures, and a high degree of precipitation. Chiapas and Veracruz have the same environmental characteristics as Guerrero, as well as case reports during the entire study period; the rise of cases in the year 2017 in Chiapas was associated with a high degree of rainfall. In Veracruz, two outbreaks occurred in 2016 and another one in 2017, both preceding high environmental temperatures and high precipitation volume. Michoacán, Nuevo León, Jalisco, and Guanajuato showed more significant variability in environmental temperature and degree of precipitation; Guanajuato reported cases in minimum quantity in October and November 2016 and 2017 there was an outbreak of dengue preceded by high environmental temperature and slight increase in the degree of precipitation. Michoacán presented an outbreak in 2016, preceded by high environmental temperatures and a high degree of precipitation. Nuevo León presented two outbreaks preceded by high environmental temperatures and low rainfall. Jalisco presented two outbreaks, one in 2016 and the other in 2017, preceded by high temperatures and a high precipitation volume.

Conclusion: High environmental temperatures in six of the seven states studied were observed as predictors of high incidence of dengue cases.

Keywords

Dengue, Climate, Precipitation, Incidence

Introduction

In the last decades, the incidence of dengue in the world has increased enormously. The actual number of cases is underreported, and many cases are misclassified. According to a recent estimate, 390 million dengue infections occur each year (credible range of 95%: 284 to 528 million), of which 96 million (67 to 136 million) are clinically manifested (regardless of the severity of the disease) [1-3].

Another study regarding the prevalence of dengue

Citation: Irma PC, Mariel ABK, Alin BG, Alejandro VPD (2019) Climate Variability and Its Impact on the Incidence by Dengue in Six Endemic States of the Mexican Republic. J Infect Dis Epidemiol 5:097. doi.org/10.23937/2474-3658/1510097

Accepted: November 02, 2019: **Published:** November 04, 2019

reported it is estimated that 3900 million people, from 128 countries, are at risk of infection by this virus [4].

Numerous mechanisms have influenced this expansion, such as population growth, unplanned urbanization, increased travel, transportation of goods, lack of political will and limited resources to implement effective control measures [5,6].

Four conditions have at least been mentioned for an increase in transmission, human susceptibility, the presence of the vector, the introduction of the virus, and an enabling environment. There is scientific evidence that climate is one of the main drivers of dengue epidemics and the proliferation of its vector [7-11].

The most likely mechanisms include extreme weather events and the increasing of mosquito breeding sites as a result of the collapse of water supplies, of sanitation services, and a shorter extrinsic incubation period of the virus inside the mosquito [4]. The transmission of dengue is sensitive to climate, to climate change and is associated with trade or global transportation, facilitating the spread of the virus and the vectors of dengue [12-14].

Rain is an element that affects the incubation period of mosquitoes, which can only complete their life cycle in standing water [15].

On the contrary, the unusual climatic conditions of drought and above the normal temperature, like in the "El Niño" phenomenon, adversely affect the number of mosquito breeding habitats and, therefore, the populations of mosquitoes. However, this can be significantly compensated with the human practice of storing or accumulating water for consumption, making available many filled with water containers, providing a good place for mosquito life and breeding. Also, global warming is affecting the breeding cycles of mosquitoes that generally hibernate during the cold. Global warming also allows the spread of insects such as mosquitoes by extending their geographic range [15,16].

Many researchers are working on measures to prevent and control the spread. One research pathway is the collaboration between informatics and epidemiology researchers in the development of methods to predict possible outbreaks of dengue infection. An important objective of the research is the development of models that allow or improve the outbreak forecast, allowing health professionals to develop plans towards this goal [17,18].

In Mexico, the initial dengue reports were registered in 1941 with 6,955 cases, and since then, only a few cases were reported until its disappearance in 1963, thanks to the Aedes eradication campaign, which kept dengue absent for 12 years. However, in 1978 it revived in Mexico, with increasing cases in 1980, turning dengue in one of the most important public health problems in the country [1,19,20]. Most recent data, from 2018, reported 12,706 confirmed dengue cases (higher than in 2017) [21].

The strategy and coverage differences in the dengue control programs in Mexico have not been able to avoid a trend in the increase of the number of cases and distribution for local transmission, with different intensity in 30 of the 32 federal entities of the country. In the country, the states of Chiapas, Veracruz, Jalisco, Nuevo León, and San Luis Potosí accounted for 82% of the confirmed cases and where 73% of the total of deaths occurred in the state of Chiapas.

The problems facing prevention and control of dengue are multiple, ranging from general aspects such as global warming to the dependence of the states on the federation for the control of emerging situations in natural disasters and outbreaks [18,21]. As well as the rain forest climatic conditions of states such as Chiapas, Guerrero, and Veracruz where the mosquito cycle is active year long. Central region states such as Jalisco, Michoacán, Guanajuato.

Materials and Methods

We conducted a research study based on information on dengue of new cases confirmed from 7 states with the highest number of cases published in the Epidemiological Bulletins of the Epidemiology Department for the years 2016, 2017, and 2018 until week no. 14.

We obtained the average values per month and by state of environmental temperature (maximum, average, and minimum values) of precipitations from information of official organisms of each state during the indicated period. We graphed the confirmed cases of dengue reported by month, temperature values, rainfall, and, finally, we analyzed the information by each state.

Results

In the state of Veracruz, cases of dengue were reported though out every month of the years studied. The months with the most significant number of cases were September, October, and November of the year 2016 and 2017 having as a preamble at least one to two months before high figures of environmental temperature and high rainfall (Figure 1).

In the state of Michoacán, dengue cases were reported every month during the studied years except for January and March of 2018. In September, October, and November of the year 2016, a rebound of dengue cases was observed, having as a preamble high environmental temperatures and the presence of rainfall. During the same months in 2017, there was an increase in cases but fewer quantity than the previous year, with a preamble of high environmental temperatures and the presence of rainfall (Figure 2).

DOI: 10.23937/2474-3658/1510097 ISSN: 2474-3658

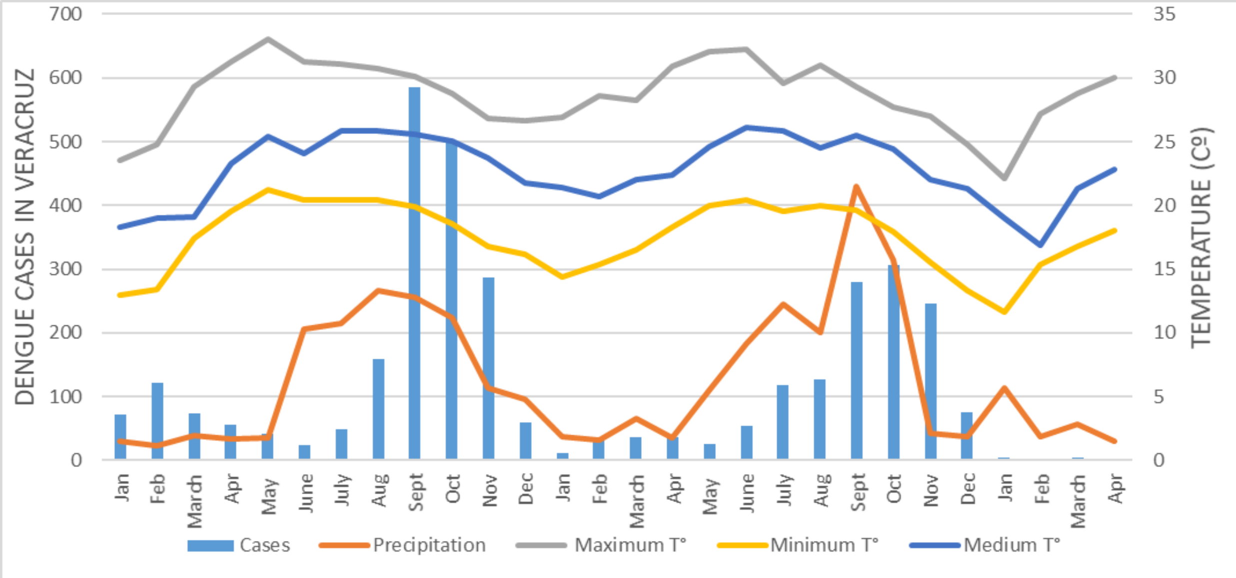

Figure 1: Monthly cases of dengue, minimum, average and maximum temperature and precipitation in Veracruz 2016-2018 (Until week 14).

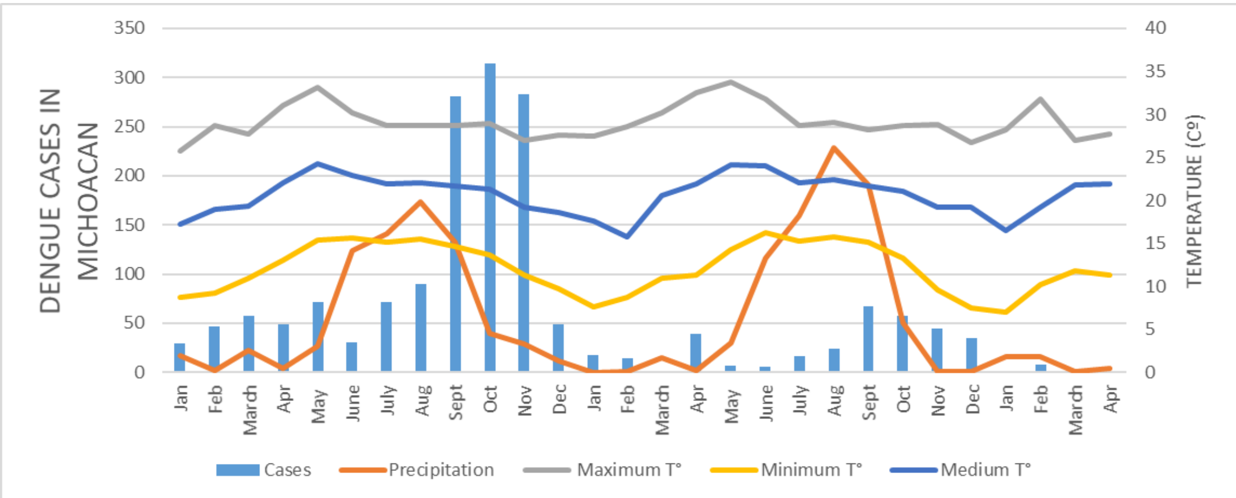

Figure 2: Monthly cases of dengue, minimum, average and maximum temperature and precipitation in Michoacán 2016-2018 (Until week 14).

During 2016, the state of Guerrero presented a high number of dengue cases throughout the year, with the highest number of cases being reported in February, July, and September; variations in the environmental temperature in this state were minimal and generally high, for the year 2017 the incidence of cases decreased significantly despite the high rainfall during June to October. In the first months of the year 2018, no cases were reported (Figure 3).

The state of Nuevo Leon reported cases of dengue during the months of the years under study except in January of 2016. October to December were the months with the highest number of cases reported in the year 2016 and September to December in the year 2017, having in both cases as a preamble high environmental temperatures and average precipitation (Figure 4).

Chiapas is a state considered to have a high incidence of dengue cases due to its high environmental temperature with little variation. Chiapas reported cases of dengue continuously during the months of the years under study, maintaining this pattern until the first weeks of 2018. In 2017 there was an increase in case reports (Figure 5).

The state of Jalisco maintains the lowest environmental temperatures in January and February. During these months in 2016, cases of dengue were reported. While for 2017 and 2018, there were no reported cases. In the months of September to November of 2016, there was a significant increase in cases preceded by high environmental temperatures and high precipitation. September to December 2017, there was an increase in cases, although lower than in 2016, with the highest incidence in December. This event preceded by high environmental temperatures and high precipita-

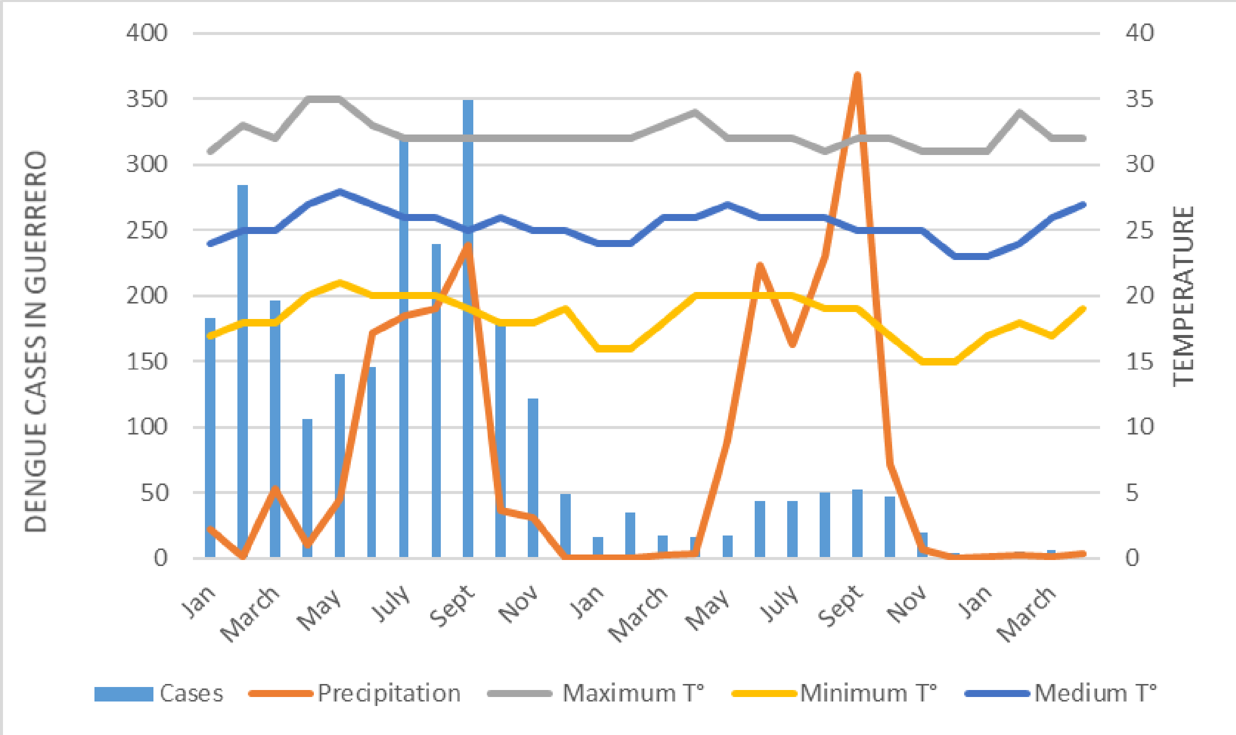

Figure 3: Monthly cases of dengue, minimum, average and maximum temperature and precipitation in Guerrero 2016-2018 (Until week 14).

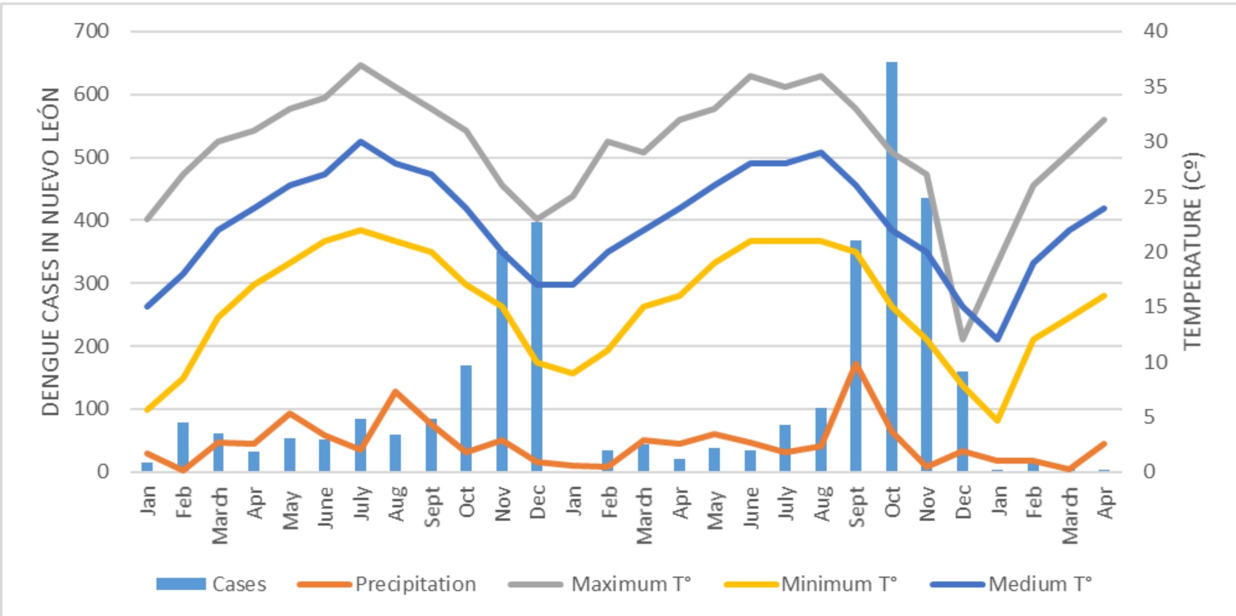

Figure 4: Monthly cases of dengue, minimum, maximum, average and precipitation temperature in Nuevo León 2016-2018 (Until week 14).

tion (Figure 6).

Guanajuato is a state located in the center of the Mexican Republic. Cases of dengue were not reported in 2016, but for 2017 a spike of cases was observed through September to November and a preamble of average precipitation with decreasing pattern and relatively high environmental temperatures (Figure 7).

Discussion

The transmission of dengue fever is the result of complex interactions between the virus, human hosts, and vectors (mosquitoes), all of which are influenced by environmental factors [17].

Climatic variables support the dynamics of dengue transmission, to the capture of the progression essence of that disease in the population, to predict the effects of different strategies to prevent or eradicate this disease [22].

Chan TC, et al. in their study "Daily forecast of den-

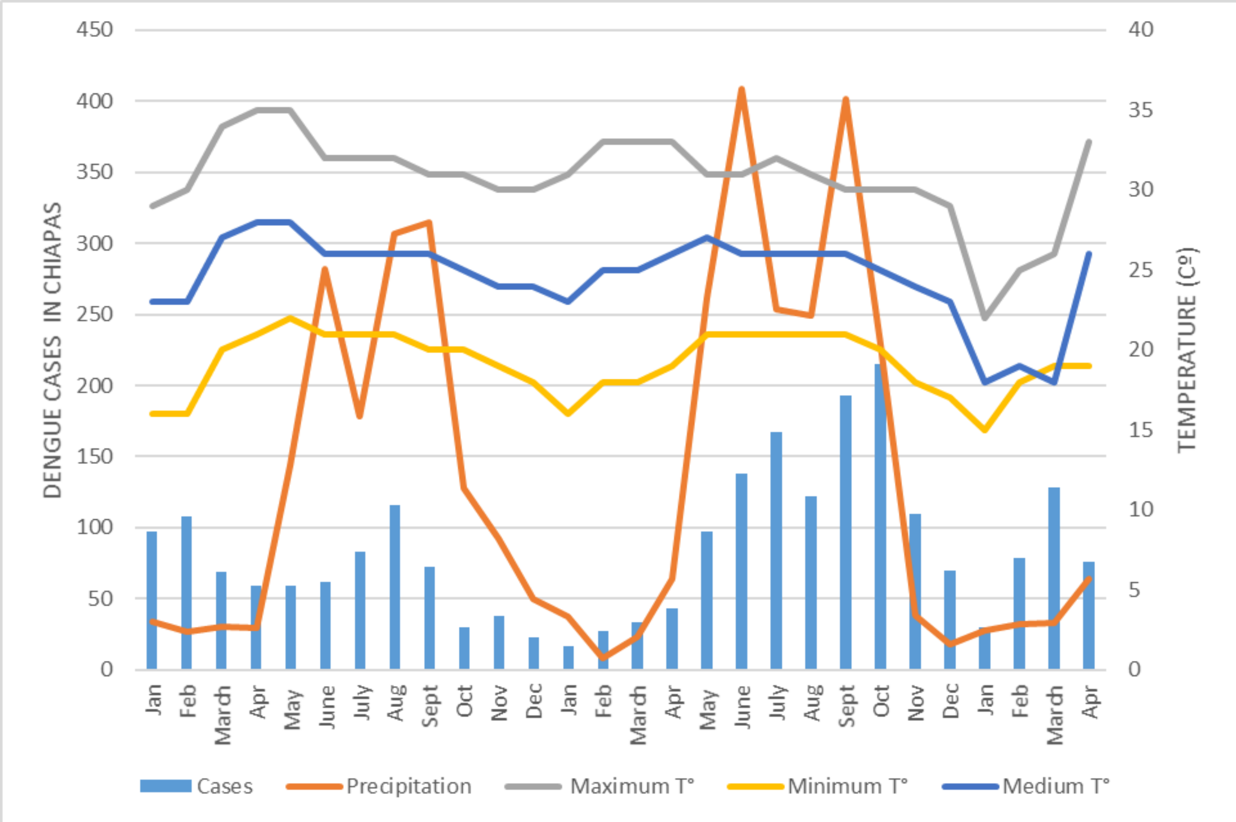

Figure 5: Monthly cases of dengue fever minimum, average and maximum temperature and precipitation in Chiapas 2016-2018 (Until week 14).

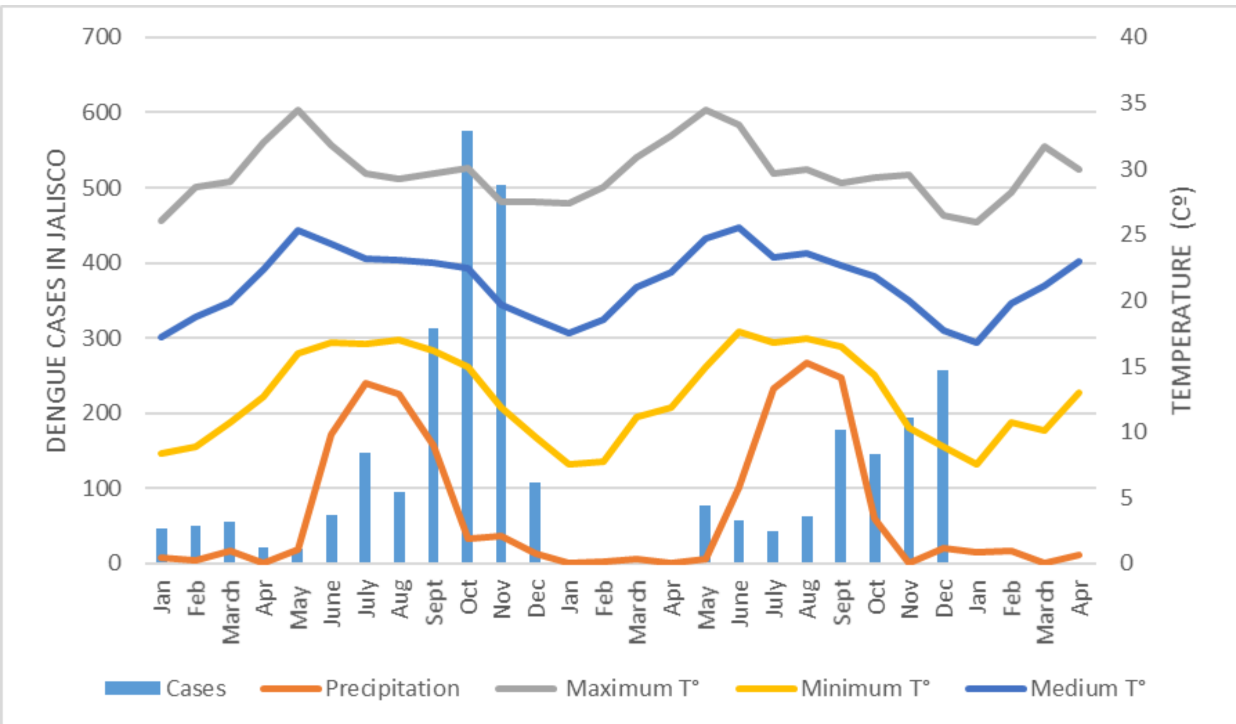

Figure 6: Monthly cases of dengue fever minimum, average and maximum temperature and precipitation in Jalisco 2016-2018 (Until week 14).

gue fever incidents for urban villages in a city". Though an adjusted prediction model system considering co-variates that included three different levels of spatial effect with four periods of delay time, including population density and weather conditions, they received alerts 16 weeks in advance [22].

Ortiz PL, et al. in the study "Spatial Models for Prediction and Early Warning of Aedes aegypti Proliferation from Data on Climate Change and Variabil-

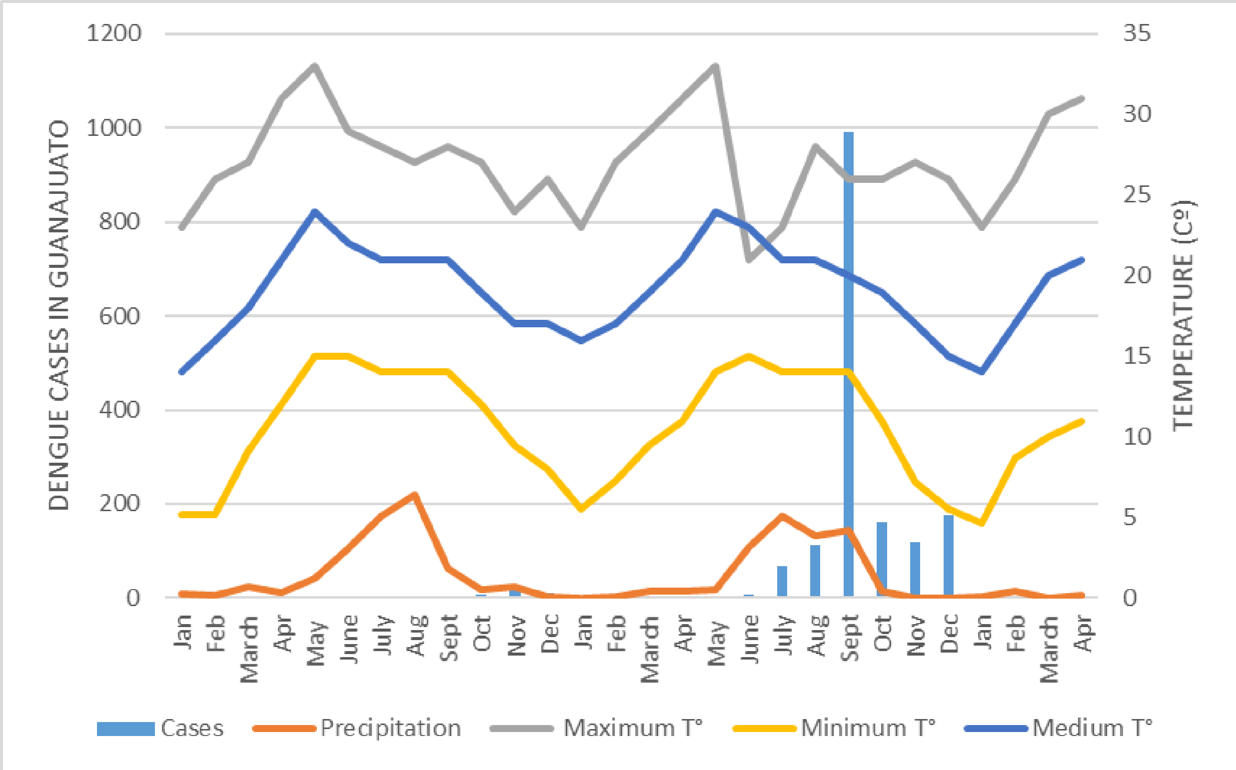

Figure 7: Monthly cases of dengue minimum, average, and maximum temperature and precipitation Guanajuato 2016-2018 (Until week 14).

ity in Cuba" identified the climatic variability range that affected Ae. Aegypti populations and created prediction maps at the municipal level. Later on, they demonstrated the construction of spatial models with this purpose was possible. Therefore, providing surveillance alerts on vector populations, thus demonstrating the usefulness for epidemiological control [16].

Lemus ER, et al. in their study on "Climatic change related to the presence of dengue in Cuba" conducted a characterization of climate change and its relationship with dengue in Cuba; they concluded, it is necessary to keep close watch on the climate impact in the elements that intervene in the transmission of this disease for decision making [15].

Eastin MD, et al. in their study "Intra- and interseasonal autoregressive prediction of dengue outbreaks using local weather and regional climate for a tropical environment in Colombia", developed two prognostic, autoregressive, multivariate models based on the environment, that allow to anticipate dengue outbreaks from 2 weeks to 6 months. These models have the potential of improving existing early warning systems against dengue and, ultimately supporting public health decisions regarding timing and scale of vector control efforts [17].

Sharmin S, Glass K, Harley D in their study "Interaction of Mean Temperature and Daily Fluctuation Influences Dengue Incidence in Dhaka, Bangladesh" they used a harmful generalized binomial linear model rain adjusted, anomalies in the temperature of the sea surface (an index of El Niño-Southern Oscillation), population density, the number of cases of dengue in the previous month and the long-term trend of dengue. In addition to the significant associations of mean temperature and temperature fluctuation with the dengue incidence, they found that the interaction of the mean and temperature fluctuation significantly influence the transmission of the disease with a delay of one month [23].

Researchers believe that instead of traditional statistical models for large spatial areas and weekly or monthly temporary units, what public health workers urgently need is a suitable method of predicting risks for small areas. This risk prediction would provide information for early warning, goal monitoring, and intervention and can serve as a useful tool for decision-making for front-line public health workers to control dengue epidemics. The accuracy of spatial and temporal units can be easily adjusted to different settings for different regions [16,23].

In our study, we observed, six of the seven states included, reported high-temperature values at least two months before the presence of an increase in the incidence of dengue and at least one month before an increase in precipitation.

Dengue control is an emerging problem that withstands traditional solutions, therefore requires systemic thinking to understand several aspects of the dynamics of this disease. The study of climatic variables by regions to predict the increase of cases of dengue is crucial since it allows the implementation of control measures.

When the complex interactions variables between climate, population and incidence of dengue are known through an efficient surveillance system, valid information can be obtained to support decision-making regarding the prediction and the control of dengue and its vector. These surveillance systems can be simple and use limited resources.

Conclusions

Meteorological surroundings are considered one of the most critical factors related to the spread of dengue epidemic outbreaks; among the climatic variables with the most influence, temperature elevation humidity and precipitation volume are reported [24-26].

There is scientific evidence that the optimum temperature for dengue transmission is 28-30 °C, although, in recent years, there has been a transition to a more permissive temperature (25-27 °C) in several regions of the world [18].

Mexican territory is characterized by its climatic diversity, including states where the high environmental temperatures with little variability that allow an active mosquito lifespan throughout the year.

The study of climatic variables by regions to predict the increase of cases of dengue is vital since it allows the implementation of control measures.

A surveillance system with early warning for epidemic outbreaks could increase the efficiency of vector control campaigns to delay or prevent an epidemic dispersion of dengue, thus reducing the impact of the disease.

References

1. Ivonne Torres I, Cortés D, Ingeborg Becker (2014) Dengue en México: Análisis de dos décadas. Gaceta Médica de México 150: 122-127.
2. Helmersson JL (2018) Climate change, dengue and aedes mosquitoes. Department of public health and clinical medicine epidemiology and global health Umea, Sweden.
3. Mustafa MS, Rasotgi V, Jain S, Grupta V (2015) Discovery of the fifth serotype of dengue virus (DENV-5): A new public health dilemma in dengue control. Med J Armed Forces India 71: 67-70.
4. World Health Organization (2009) Dengue guidelines for diagnosis, treatment, prevention and control. TDR.
5. McMichael AJ, Woodruff RE, Hales S (2006) Climate change and human health: Present and future risks. Lancet 367: 859-869.
6. World Health Organization (2019) Dengue y dengue grave.
7. Ministerio de Salud Pública (2006) Plan Nacional de Contingencia para una epidemia de dengue. Uruguay.
8. Programa Sectorial de Salud (2013) Prevención y control de Dengue 2013-2018. Programa de acción específico, México.
9. Pollet S, Melendrez MC, Maljkovic Berry (2018) Understanding dengue virus evolution to support epidemic surveillance and counter -measure development. Infection, Genetics and Evolution 62: 279-295.
10. Rosa-Freitas M, Schreiber K, Tsouris P, Weimann E, Luitgards-Moura J (2006) Associations between dengue and combinations of weather factors in a city in the Brazilian Amazon. Rev Panam Salud Publica 20: 256-267.
11. Pinto E, Coelho M, Oliver L, Massad E (2011) The influence of climate variables on dengue in Singapore. Int J Environ Health Res 21: 415-426.
12. Marcelo Margon Rossi, Luis Fernandez Lopez, Eduardo Massad (2015) The Dynamics of temperature-and rainfall-dependent dengue transmission in tropical regions. Ann Biom Biostat 2: 1020.
13. Chanprasopchai P, Pongsumpun P, Tang IM (2017) Effect of rainfall for the dynamical transmission model of the dengue disease in Thailand. Comput Math Methods Med 2017: 2541862.
14. Tilwani K, Dave G, Nadurbarkar V (2018) Impact of climatic fluctuation on dengue virus etiology. J Mol Genet Med 12: 1-8.
15. Lemus Lago ER, Corratgé Delgado H (2009) Cambio climático y dengue en Cuba. Rev Cubana Med Gen Int 25: 196.
16. Ortiz Bultó PL, Rivero Valencia A, Linares Vega Y, Pérez Carreras A, Vázquez Cangas JR (2015) Spatial models for prediction and early warning of Aedes aegypti proliferation from data on climate change and variability in Cuba. MEDICC Rev 17: 20-28.
17. Eastin MD, Delmelle E, Casas I, Wexler J, Self C (2014) Intra- and interseasonal autoregressive prediction of dengue outbreaks using local weather and regional climate for a tropical environment in Colombia. Am J Trop Med Hyg 91: 598-610.
18. Sánchez G, Conde R, Noguez R, López PC (2018) Prediction of dengue outbreaks in Mexico based on entomological, meteorological and demographic data. PLoS One 13: e0196047.
19. Thirión J (2003) El Mosquito Aedes aegypti y el dengue en México.
20. Contreras C, Galindo G (2018) Cambio climático y escenarios futuros de la expansión del Dengue en México. Geomedicina y la tecnología espacial aplicada al caso de los vectores en salud humana. UASLP-CIACyT-LAGES, 161-180.
21. PAHO (2018) Integrated management strategy for dengue prevention and control in the region of the Americas.
22. Chan TC, Hu TH, Hwang JS (2015) Daily forecast of dengue fever incidents for urban villages in a city. Int J Health Geogr 14: 9.
23. Sharmin S, Glass K, Viennet E, Harley D (2015) Interaction of mean temperature and daily fluctuation influences dengue incidence in Dhaka, Bangladesh. PLoS Negl Trop Dis 9: e0003901.
24. Gu H, Leung RK, Jing Q, Zhang W, Yang Z, et al. (2016) Meteorological factors for dengue fever control and prevention in South China. Int J Environ Res Public Health 13: E867.
25. Shang CS, Fang CT, Liu CM, Wen TH, Tsai KH, et al. (2010) The role of imported cases and favorable meteorological conditions in the onset of dengue epidemics. PLoS Negl Trop Dis 4: 867.
26. Patz JA, Martens WJ, Focks DA, Jetten TH (1998) Dengue fever epidemic potential as projected by general circulation models of global climate change. Environ Health Perspect 106: 147-153.