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Climate Variability and Dengue Fever in Mexico

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Introduction

Dengue Fever is the most significant mosquito-borne infectious disease in the world. The disease is present in over 100 countries causing about 100 million cases every year and economic losses for millions of dollars. In Mexico, Dengue Fever is present all over the country with 60% of the cases occurring in the Southern half characterized by a warm and humid climate.

Dengue Fever is sensitive to changes in climate. Increases in land temperature and precipitation, and the El Niño effect have been associated with increases in Dengue Fever incidences in several countries including Mexico.

We examined if changes in Dengue Fever incidence were associated to climate variability in the form of El Niño events, and changes in ambient temperature and precipitation in the warm and humid region of Mexico over the period 1985—2007.

Method

We fitted linear multiple regression models using the incidence of Dengue Fever as the dependent variable and various lags of each climatic variable as explanatory variables. We adjusted the models for the number of Dengue Fever cases in the previous month, long-term trends and seasonality. We finally tested the influence of the extreme El Niño event of1997—1998 because its magnitude exceeded that of the previous events and because it coincided with the biggest peak in incidence in the series.

Result

The risk of Dengue Fever infection is higher during El Niño events and the warm and wet season. Besides, increases in sea surface temperature are associated with increases in Dengue Fever incidence during El Niño. This association however is mainly driven by the 1997—1998 El Niño. This could indicate that El Niño events shall exceed a specific threshold to exert an influence upon Dengue Fever incidence. The 1997—1998 El Niño event also coincided with the introduction of the virus serotype "DEN-3". The introduction of this new type of virus questions whether the peak in incidence corresponds solely

to the influence of the regional climate.

Sea surface temperature remained positive and significantly associated to Dengue Fever incidence even after having controlled for temperature in the models. This indicates that El Niño exerts an influence upon Dengue Fever that is not fully explained by its influence on the regional climate.

Increases in minimum temperature are associated to increases in Dengue Fever incidence during the cool and dry season. Research indicates that rising temperatures modify the life increase the vector-host contact rate enhancing Dengue Fever incidence. We did not find associations between Dengue Fever and maximum temperature.

Rainfall is not associated to Dengue Fever incidence presumably because of the indoor activity of the vector and the presence of enough water all year round to create adequate breeding sites.

Climate variability plays a key role in the transmission dynamics of the Dengue Fever in regions with low development. The warm and humid region of Mexico is characterized by high to very high marginalization indices. These marginalization indices increase as a result of poor or nil access to education, health services, inadequate housing and lack of first need goods. High marginalization indices favor the development of the vector and ultimately the transmission of the disease.

Conclusion

Dengue Fever incidence is statistically associated to the presence of extreme El Niño events. This association, however, is only apparent when El Niño exceeds a specific temperature threshold only exceeded by the strongest events. The influence of El Niño is not restricted to its influence upon the regional climate; however, the influential mechanisms above its influence on weather are not clear. The concurrence between the 1997—1998 El Niño and the introduction of the virus serotype DEN-3 questions if the 1997—1998 outbreak was due to climatic conditions, and may indicate that previous studies may have overestimated the influence of El Niño event upon the disease.

Increases in minimum temperature during the cool and dry season are associated with increases in Dengue Fever incidence. This suggests that rising temperatures induce changes in the biology of both the virus and the vector that are related to increases in Dengue Fever transmission. Climate change is likely to increase the temperatures in Mexico during the 21st century. Consequently, it is likely to increase the incidence of Dengue Fever in the region, particularly over the cool and dry season.

Precipitation does not show a statistical association presumably

because of its abundance all year round. The domestic behaviour of the vector may also be a cause for this lack of association.

Climate variability plays a key role in the transmission dynamics of Dengue Fever in the region because it interplays with high marginalization indices. Creative and immediate measures are urgently needed to decrease the vulnerability of the region.