El Niño and Arboviral Disease Prediction

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Recent El Niño events have stimulated interest in the development of modeling techniques to forecast extremes of climate and related health events. Previous studies have documented associations between specific climate variables (particularly temperature and rainfall) and outbreaks of arboviral disease. In some countries, such diseases are sensitive to El Niño. Here we describe a climate-based model for the prediction of Ross River virus epidemics in Australia. From a literature search and data on case notifications, we determined in which years there were epidemics of Ross River virus in southern Australia between 1928 and 1998. Predictor variables were monthly Southern Oscillation index values for the year of an epidemic or lagged by 1 year. We found that in southeastern states, epidemic years were well predicted by monthly Southern Oscillation index values in January and September in the previous year. The model forecasts that there is a high probability of epidemic Ross River virus in the southern states of Australia in 1999. We conclude that epidemics of arboviral disease can, at least in principle, be predicted on the basis of climate relationships. Key words: arboviruses, climate, prediction, vectorborne disease. *Environ Health Perspect* 107:817–818 (1999). [Online 3 September 1999]http://ehpnet1.niehs.nih.gov/docs/1999/107p817-818maelzer/abstract.html

Results

We found that in southeastern states, epidemic years were well predicted by monthly Southern Oscillation index values in January and September in the previous year. Epidemics were negatively associated with the Southern Oscillation index in January [odds ratio (OR), 0.87; 95% confidence interval (CI), 0.78–0.97] and positively associated with the value for September (OR, 1.23; CI, 1.08–1.39). This relationship can also be seen by calculating the January–September Southern Oscillation index couplet difference. In previous studies, couplet differences (differences in the Southern Oscillation index between two single months) have proved to be useful composite variables (11,12). Figure 1 shows the occurrence of Ross River virus epidemics (vertical bars) for 1928–1998 and the Southern Oscillation index couplet differences for January–September in the previous year. The model forecasts a high probability of an epidemic of Ross River virus in the southern states of Australia in 1999. The model had good predictive ability in data for the state of South Australia, 1956–1996, with a positive predictive value of 88% and a negative predictive value of 91%, using a forecast probability of > 50% to define epidemic years.

Discussion

We demonstrated a relationship between epidemics of Ross River virus and monthly values of the Southern Oscillation index in historical data for southern Australia (1928–1998). A number of previous studies have documented associations between specific climate variables (particularly temperature and rainfall) and outbreaks of arboviral disease (13–16). Rainfall affects vector breeding in particular (because breeding requires standing water), but may also influence adult survival (by increasing humidity) and disease transmission (by affecting the growth of vegetation and the abundance of animal reservoir hosts) (17). In Australia, the El Niño phenomenon explains much of the interannual variation in climate and the Southern Oscillation index is a useful proxy for temperature and rainfall.

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For the purposes of the present study, the Southern Oscillation index has two major advantages over the use of more specific climate variables. First, it avoids the need to make estimates of climate variables for specific geographical areas. There is no reason to suppose that political boundaries define biologically relevant regions for aggregation of climate data. Second, in many parts of the world (including Australia), rainfall can be predicted several months in advance on the basis of El Nino. A rapid rise in the Southern Oscillation index in the austral autumn, followed by sustained high values over the winter, are subsequently associated with a high probability of increased rainfall (18). This sequence occurs when La Niña conditions follow the decay of an El Nino event in late summer (as happened in 1998). Our results are therefore consistent with previous studies that report an effect of rainfall on Ross River virus epidemics.

The data reported here suggest that it is feasible to forecast epidemics of vector-borne disease using climate-based models. Such forecasts could be used to target anti-mosquito measures more effectively in both time and place, with potentially important public health benefits. In the future, the accuracy of the model will provide an objective test of the hypothesis that vector-borne disease transmission is influenced by interannual climate variation.

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