Effects of Regional Climatic Variability on West Nile Virus Outbreaks in the United States

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Introduction

West Nile Virus (WNV) was first detected in New York City in 1999, since then it has spread westwards. WNV is transmitted by infected mosquitoes that acquire the virus by feeding on infected birds. Humans and horses are accidental hosts. Human transmission is dependent on prevalence and feeding patterns of mosquitoes. Local ecology and human behavior influences exposure to mosquitoes. Identification of high-risk areas will help to implement prevention strategies. This study examines epidemiology, patterns of WNV disease transmission and identification of high-risk areas in the United States from 2003 to 2014.

Methodology

Trends and relationships of WNV cases and climatic factors were analyzed among the regions of the United States from 2003 to 2014. Human WNV tabulate data and climatic data were obtained from Centers for Disease Control, and NOAA and Climate Data Guide respectively. Canonical correspondence analysis (CCA) was performed using variables: (i) neuroinvasive disease cases, non-neuroinvasive disease cases, deaths, presumptive viremic blood donors, (ii) precipitation, temperature, Palmer Drought Severity Index (PDSI) and population density. The CCA ordination was explained the variability between WNV disease cases and climatic variables. Biplots were used to visualize the associations between WNV cases and climatic anomalies.

Results and Discussion

In 2003 and 2007, WNV cases were high in Northern Great Plains. From 2004-2008 there was a clear movement of WNV in California (Fig. 2).

In 2003 Neuroinvasive Disease cases were high in Colorado, and Texas and there was a continuum of Neuroinvasive Disease from Great Plains to Texas. (Fig. 3).

We compared the state wise WNV disease cases in relation to climatic and population density in the United States from 2003 to 2014. A total of 4064 cases in 2006, 956 cases in 2010 and, 2141 cases in 2014 were reported in the 32 states of the US. Colorado state reported the highest WNV cases in 2003 (2947 cases; 33%), followed by Texas in 2012 (1868 cases; 35%) and California in 2014 (801 case; 37%). CCA ordination showed distinguishable clustering patterns between south central (Texas, Louisiana, Mississippi, Arkansas, and Oklahoma) and northern Great Plains (North Dakota, South Dakota, and Nebraska) regions (Fig. 4). High temperature and prolong drought were the most important variable predictor for high WNV outbreak.

Preventive techniques must be implemented with special focus on areas with high population density and at risk areas based on precipitation and temperature. Monitoring equine populations susceptible to WNV disease within close proximity to urban population might be useful for predicting disease risk in humans.

Conclusion

Vector control methods focusing on prevention must be implemented to avoid epidemics of WNV if high temperature is leading to an unusual drought especially at the risk areas, such as Texas and California. However, high temperature with moist spell anomalies in the south central region showed a negative influence on WNV outbreak.

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