The Influence of Increased Temperature and Precipitation on Shigellosis Case Counts in Texas

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Introduction

Background- As humanity seems on track to miss the goal of keeping global warming below the Paris Climate Accords target of 1.5 degrees Celsius, the impact of climate change on neglected tropical diseases (NTDs) has seen an influx of research. Unfortunately, studies investigating the impacts of diarrheal NTDs, such as Shigellosis, in a US context remain rare. Studies in Taiwan and Korea have identified increased temperature and precipitation as drivers of Shigellosis case counts.

Objectives- To create a model capturing the mathematical relationship of the biological phenomena between Shigellosis Case Counts, Temperature, and Precipitation in Texas.

Methodology

Data Collection- Data from the years 2009-2018 was drawn from open access sources; temperature and precipitation data from the PRISM Climate Group (Oregon State University) and case count data from the Texas Department of State Health Services.

Analysis- Data was introduced into R, and a negative binomial regression model was created using a glm.nb() call. The negative binomial regression was chosen due to the high variance observed in the data, the integer nature of count data, and non-normal distribution of the counts.

Results

A Negative Binomial Regression Model Shows Significant Effects of Increased Temperature and Precipitation on Shigellosis Case Counts.

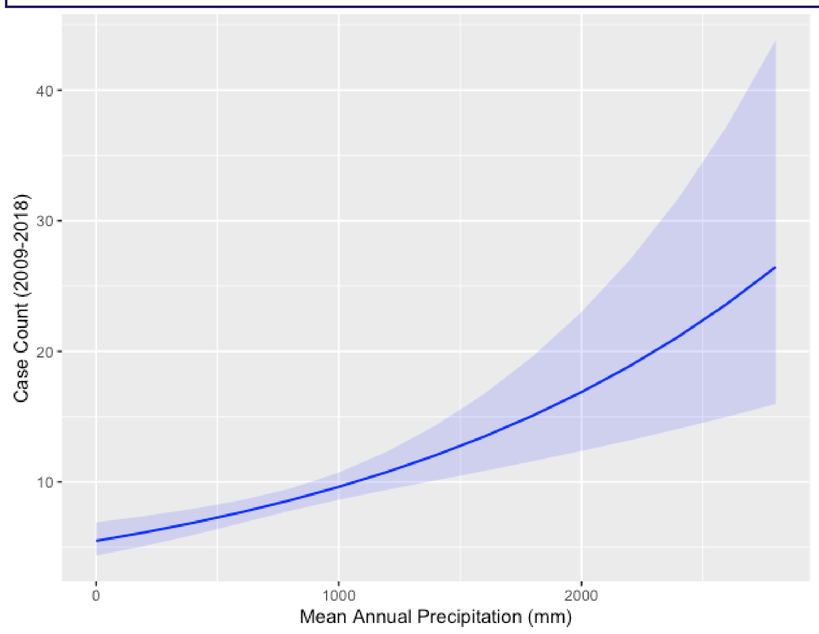

Figure 1- Predicted Effect of Mean Annual Precipitation on Shigellosis Case Count. The regression coefficient for precipitation was found to be 0.000562, with $p < 0.001$. The incidence rate ratio was found to be 1.00096, with $p < 0.001$.

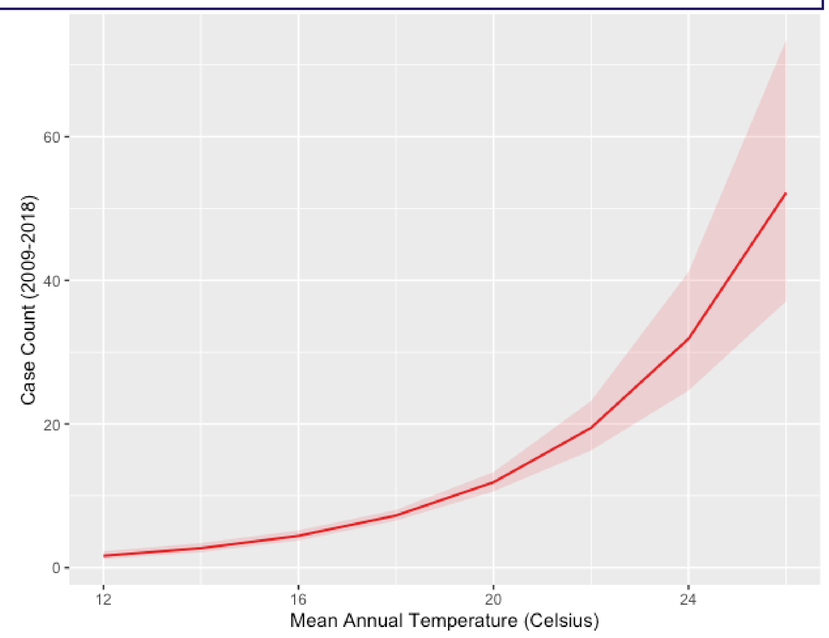

Figure 2- Predicted Effect of Mean Annual Temperature on Shigellosis Case Count. The regression coefficient for temperature was found to be 0.246579, with $p < 0.001$. The incidence rate ratio was found to be 1.3331, with $p < 0.001$.

Discussion

- The effect of temperature on case counts may be due to increased viability of *Shigella* bacteria at temperatures approaching 37 degrees Celsius, the ideal growth temperature *in vitro* [1].
- The effect of precipitation on case counts may be due to *Shigella* bacterias' low infectious dose (~10-100 microbes) [2] and subsequent highly-efficient contamination of water sources and high-density areas.
- A broad model covering all of Texas captures a consistent biological phenomenon across the state's varied geography and demography, and shows the potential impact of climate change on diarrheal NTD case counts in the United States.

Conclusions and Future Research

- A negative binomial model shows a positive relationship between temperature/precipitation and case count.
- Future research may seek to incorporate other datasets to account for confounding phenomena, such as human behavioral alterations caused by high temperatures.
- Generalized additive modeling may be utilized to produce a clearer depiction of the biological relationship between case counts and climate variables.

Acknowledgements

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Citations and Additional Information

For links to citations, data sources, GitHub, and the Carlson Lab website, please scan the QR Code to the left.