Rocky Mountain Spotted Fever Dynamics in Arizona

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Introduction

- Rocky Mountain Spotted Fever (RMSF) is a bacterial disease most often transmitted by the bite of an infected tick. Cases have been reported throughout the contiguous United States, but most prominently in the southeastern states (Centers for Disease Control and Prevention, 2022).
- RMSF has become increasingly common in some regions of Arizona over the last several years; between 2002-2021, more than 500 cases and 28 fatalities occurred (Centers for Disease Control and Prevention, 2022).
- Indigenous groups are particularly vulnerable because they have fewer resources to deal with RMSF (Alvarez et al., 2014).
- On the three most affected native reservations in Arizona, the average annual incidence for 2009-2012 was more than 150 times the national average (Nelson, 2015).

Research Question

Is there an association between race/ethnicity, specifically Native American, and Rocky Mountain Spotted Fever prevalence in Arizona?

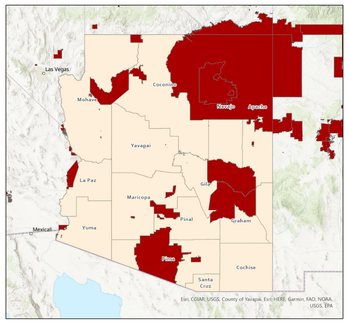
Hypothesis:

H_0: coefficient slope equals zero versus H_A: coefficient slope is different from zero.

Methods

- **Data Sources**
  - The Arizona Department of Health Services provided annual county-level RMSF case data from 2006 to 2021.
  - Population and demographic data by county are from the United States Census Bureau.
  - State, county, and tribal land boundary data is from ArcGIS Online.

Figure 1:
The area of study (Arizona, in peach) and Tribal Land within the state (red).



- **Variables**
  - Native American population percentage for 15 counties of Arizona (`NativePopPercent`, 0-100, population as a percentage).
  - Rate of RMSF per county (`Rate`, 0-1, Total Cumulative Cases/Total Population in decimal form).
- **Statistical Method**
  - A simple linear regression model was fit between the Native American Population Percentage and the Rate of RMSF.

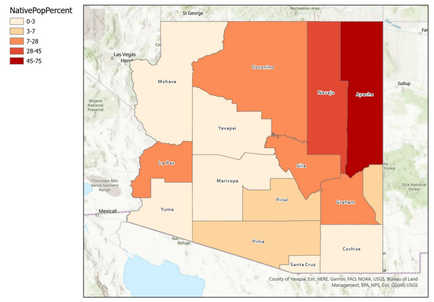


Figure 2:
The percentage of population that identifies as Native American by county.

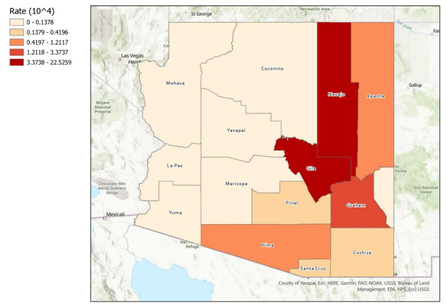


Figure 3:
The rate of RMSF by county.

Results

- Based on table, we reject the null hypothesis in favor of the alternative, that the slope is not equal to zero. A significantly positive association exists between the Rate of RMSF and the Native American population percentage.
- As the Native American population percentage increases, the rate of RMSF increases.

Figure 2:
Simple linear regression model of Native Population Percentage versus RMSF Rates.

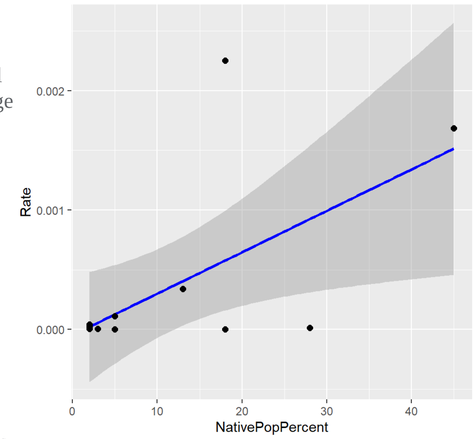


Table 1:
Simple Linear Regression Results

Characteristic	Estimate	Standard Error	t-value	p-value
Intercept	-6.54E-05	2.10E-04	-0.3	0.77
NativePopPerent	3.50E-05	1.28E-05	2.74	0.02

Discussion

- The results obtained by this study support the previous literature that in counties with greater populations of Native American groups, the rate of RMSF is higher (Alvarez et al., 2014; Nelson, 2015). Thus, Indigenous populations are an important subgroup for targeted RMSF intervention programs.

Limitations

- Apache County had a high Native American population percentage and a low rate of RMSF. This observation was identified as an outlier and removed as it was highly influential and violated the model assumptions. This may be explained by the data used, which located each case of RMSF in the county in which it was diagnosed, which may differ from the contraction location. Additionally, the data does not include RMSF cases that were undiagnosed.

Future Work

- Considering the outlying observation, Apache County, an analysis of additional social determinants of health by county in Arizona may explain this observation.
- The primary host of RMSF, an infected tick, thrives in warm, shady, moist areas. An analysis of environmental data and RMSF rates may indicate climate factors contributing to the spread of RMSF. We plan to gain access to zip code-level RMSF data to show a more detailed analysis of case dynamics.
- Previous literature identifies dogs as a host of RMSF. Integrating dog movement and RMSF disease pattern data may improve the modeling and prediction of RMSF.

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References

Centers for Disease Control and Prevention. “Rocky Mountain Spotted Fever (RMSF) | Tick-borne Diseases | Ticks.” *CDC*, 5 August 2022, https://www.cdc.gov/ticks/tickbornediseases/rmsf.html.
Alvarez, G., et al. “Rocky Mountain Spotted Fever, a Reemerging Disease in Arizona and Sonora - Case Study.” *Journal of Case Reports and Studies*, vol. 2, no. 3, 2014, p. 301, doi: 10.15744/2348-9820.1.601.
Nelson, Roxanne. “Rocky Mountain spotted fever in Native Americans.” *The Lancet Infectious Diseases*, vol. 15, no. 9, 2015, pp. 1013-1014.
Dantas-Torres, Filipe. “Rocky Mountain spotted fever.” *The Lancet Infectious Diseases*, vol. 7, no. 11, 2007, pp. 724-732, https://doi-org.libproxy.unm.edu/10.1016/S1473-3099(07)70261-X.
ArcGIS Online. “USAIndianReserv.” *ArcGIS Online*, 9 November 2021.
United States Census Bureau. “QuickFacts.” *Census.gov*, 2022, https://www.census.gov/.
Arizona Department of Health Services. “Disease Data, Statistics & Reports.” *Arizona Department of Health Services*, 30 December 2022, https://www.azdhs.gov/index.php.
Arizona Association of Counties. “About Arizona's Counties.” *Arizona Association of Counties - Official Website | Official Website*, 2022, https://www.azcounties.org/.

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