

Author:  
Lauren Jones, BA

Thesis Committee:  
Fuqing Wu, PhD  
Jennifer Walker, PhD  
Cici Bauer, PhD  
Yun Hang, PhD

Affiliation:  
UT Health Science Center Houston School of Public Health

# A COMPARATIVE ANALYSIS OF WEST NILE VIRUS INCIDENCE AND RAINFALL DEVIATION TRENDS IN TEXAS AND FLORIDA (2010-2024)



## Background

- West Nile Virus (WNV) is the most common mosquito-borne illness in the United States.
- Changes in temperature and precipitation have influenced WNV transmission and incidence rate.
- Higher temperatures and areas near large bodies of water are associated with an increased risk of WNV.
- There is a research gap in rainfall and WNV incidence because the relationship between flooding and precipitation on mosquito-borne illness incidence is complex and has conflicting results.
- This thesis examined whether rainfall deviation affected human WNV cases in Texas and Florida from 2010 to 2024.

## Methods

- The data was obtained from the Centers for Disease Control and Prevention (CDC) Arbo NET, the Texas and Florida Health Departments, the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI), and population count from the United States Census Bureau.
- Rainfall deviation measures how much the annual rainfall differs from the historical average rainfall. A Z-score was calculated to standardize rainfall extremity relative to each state's historical baseline.
- A correlation matrix was created to assess the association between rainfall and temperature on WNV incidence.
- A negative binomial regression model with fixed effects was the primary model in this study, and a lagged-effect model was the secondary analysis conducted as a robustness check.

## Results

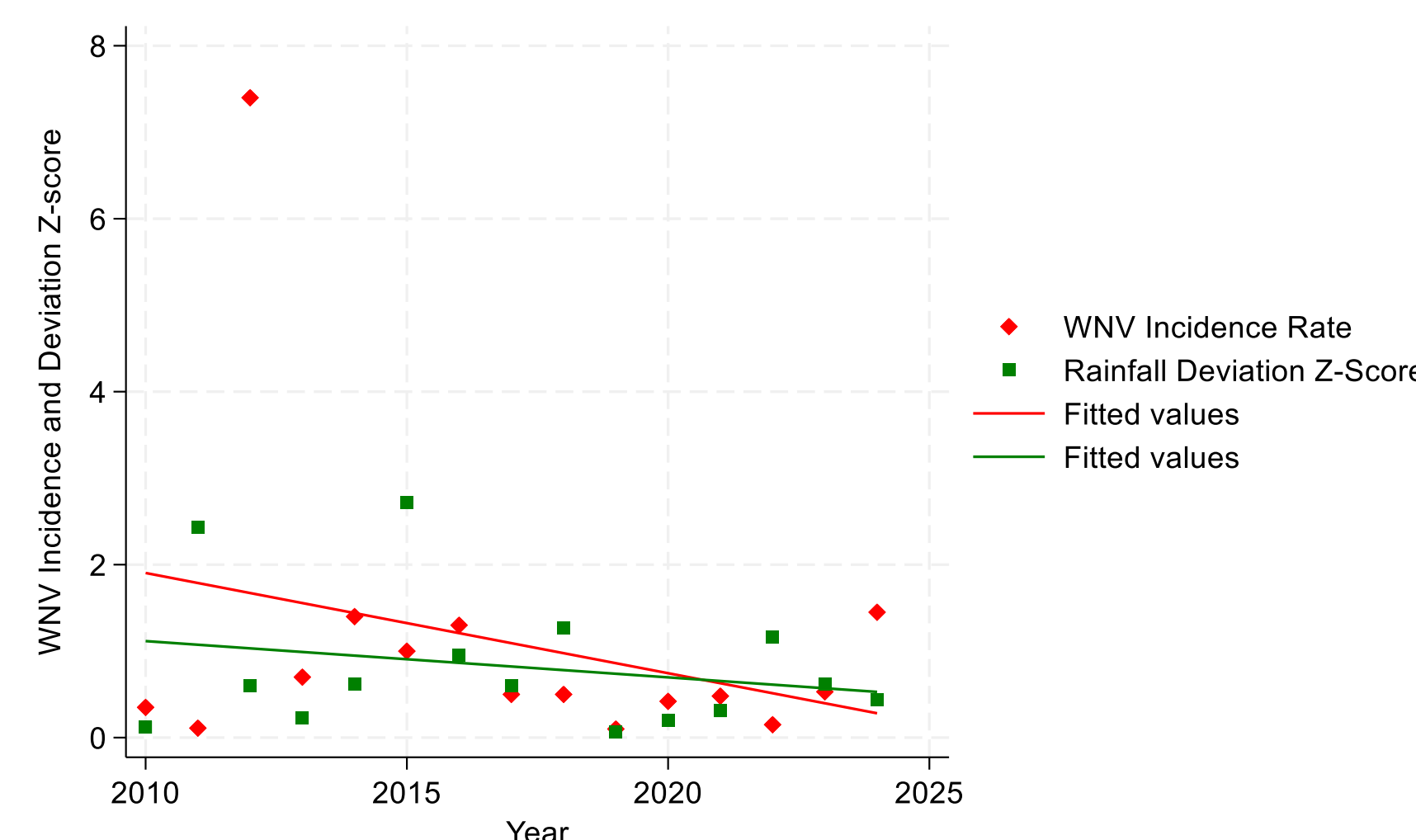
Descriptive Statistics by State (2010 – 2024)

Annual State-Level	Texas (N=15) Mean (SD)	Florida (N=15) Mean (SD)
WNV Cases	295.47 (454.26)	19.53 (19.74)
WNV Incidence Rate (per 100,000)	1.09 (1.08)	0.09 (0.10)
Average Annual Rainfall (inches)	27.36 (6.00)	54.86 (3.85)
Rainfall Deviation Z-Score	0.82 (0.80)	0.51 (0.37)
Average Annual Temperature (°F)	66.58 (1.14)	72.2 (1.13)
State Population	28,238,156 (1,855,004)	20,878,446 (1,409,657)

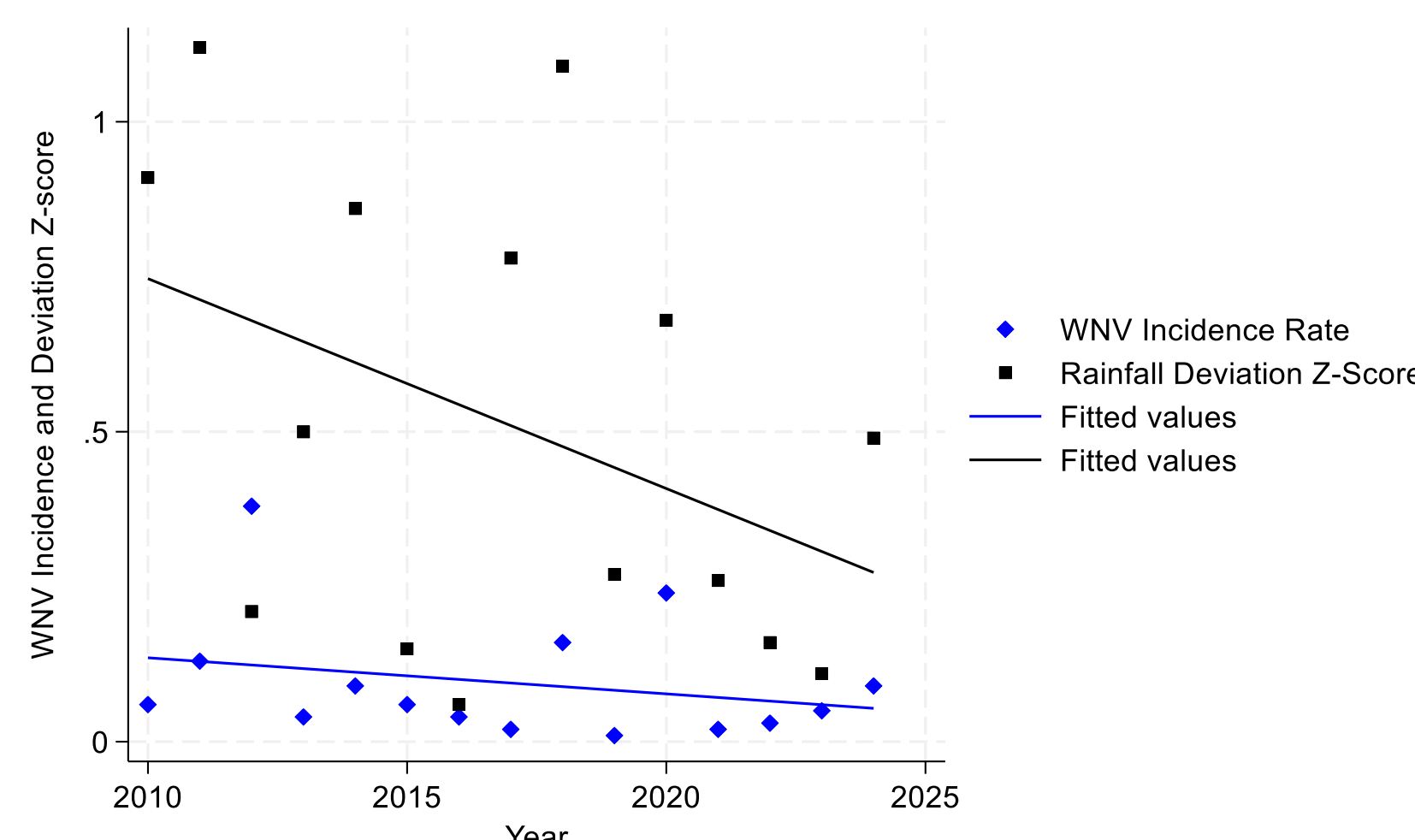
Correlation Matrix

	West Nile Virus Incidence	Rainfall deviation Z-score
Rainfall	0.0398	-
Annual	0.2767	-0.2743
Average Temperature		

Texas Scatterplot of West Nile Virus Incidence and Rainfall Deviation Z-score vs. Year



Florida Scatterplot of West Nile Virus Incidence and Rainfall Deviation Z-score vs. Year



Negative Binomial Regression ( $X^2_4 = 5.83, p = 0.213$ )

$$\log(WNV_{it}) = \beta_0 + \beta_1(RainfallZ_{it}) + \beta_2(Temp_{it}) + \beta_3(Year_t) + \beta_4(RainfallZ_{it} \times State_i) + \log(Pop_{it}) + s_{0i} + \epsilon_{it}$$

Variable	Coefficient (β)	95% Confidence Interval	Std. Error	Z	p-value
Year	-0.042	(-0.121, 0.0370)	0.040	-1.04	0.298
Rainfall Deviation Z-score	-0.130	(-0.614, 0.354)	0.247	-0.53	0.598
Average Annual Temperature	0.094	(-0.057, 0.245)	0.077	1.22	0.223
Rainfall Interaction Term	0.644	(-0.410, 1.698)	0.538	1.20	0.231
Intercept	61.184	(-94.730, 217.097)	79.549	0.77	0.442
Log (Population)	1	-	-	-	-

Lagged Effect Regression ( $X^2_4 = 12.84, p = 0.012$ )

$$\log(WNV_{it}) = \beta_0 + \beta_1(RainfallZ_{it-1}) + \beta_2(Temp_{it-1}) + \beta_3(Year_t) + \beta_4(RainfallZ_{it-1} \times State_i) + \log(Pop_{it}) + s_{0i} + \epsilon_{it}$$

Variable	Coefficient (β)	95% Confidence Interval	Std. Error	Z	p-value
Year	-0.082	(-0.161, -0.004)	0.040	-2.05	<b>0.040</b>
Lagged Rainfall Deviation Z-score	0.581	(0.188, 0.975)	0.201	2.89	<b>0.004</b>
Lagged Average Annual Temperature	0.143	(-0.007, 0.292)	0.076	1.87	0.061
Lagged Rainfall	-0.213	(-1.215, 0.790)	0.511	-0.42	0.678
Interaction Term Intercept	139.012	(-17.255, 295.278)	79.729	1.74	0.081

## Conclusion

- The lagged rainfall deviation was a strong predictor of WNV cases and was the most plausible, indicating that the environmental effects take years to influence WNV cases.
- Texas and Florida did not differ between rainfall deviation and WNV incidence (using annual data)
- Public health interventions, i.e., disease surveillance, vector control, and providing personal protective equipment, are necessary to limit WNV and other vector-borne diseases.
- It is important to continue educating the public about vector-borne diseases. The mosquito control efforts from Texas and Florida are well implemented and continue to be effective.

## Limitations

- Using annual data may have limited this study's findings.
- Annual data may have introduced a temporal bias, as long-term correlations were examined.
- For future analysis, monthly data could provide a clearer understanding of WNV cases and environmental factors.
- Other states or countries could be compared in the future.

## Public Health Significance

- Evaluating the relationship between WNV and lagged rainfall deviation can inform vector-control strategies.
- Integrating rainfall anomaly and lag information into surveillance systems would guide clinical preparations.

## Contact

Lauren Jones  
lvj.815@gmail.com