Correlation Analysis of Climatic Variables, Migration, and Dengue Cases in Southeast Florida

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Overview

• Background
• Objective
• Research Method and Design
• Data Collection
• Findings

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• Conclusion
• Limitations
• Recommendations
• References
• Dengue fever is the most common mosquito borne viral disease.

• This viral disease is a global public health threat as non-endemic regions experience outbreaks. (WHO, 2016).
Background

Map of the global spread of dengue fever
The main vector, the *Aedes aegypti* mosquito also transmits other viral diseases:

- yellow fever
- chikungunya
- Zika.
Background

The *Aedes aegypti* mosquito
Several factors can contribute to the emergence of dengue fever in non-endemic regions:

- environmental conditions
- increase of mosquito population
- availability of hosts
- migration of infected carriers (CDC, 2010)
Shang (2010) studied the effects of imported dengue and local weather variables with autochthonous (locally acquired) dengue cases in non-endemic Taiwan.

Results indicated that migration/imported dengue cases may initiate autochthonous dengue cases only with the appropriate weather conditions.
Objective

Determine if there is a relationship between local climate variables (temperature and precipitation) and migration with the geographic expansion of dengue fever in the non-endemic region of southeast Florida.
Methods and Design

• The selected research design for this study was an ecological quantitative study with a archival approach.

• Study was focused on the effects of ecological variables (temperature and precipitation) and migration with autochthonous dengue fever cases.
Methods and Design

• Dependent Variable:

Geographic expansion of dengue fever
The appearance of autochthonous (locally acquired) diagnosed dengue cases in areas where it was previously absent.
Methods and Design

• Independent Variables:
  Climatic variables:
  Temperature and precipitation

Social variable:
  Migration: diagnosed dengue fever cases originated in other regions where dengue fever is endemic, also known as imported dengue fever cases
Data Collection

Dengue fever cases were collected in five counties or regions:

1. Monroe County (Key West)
2. Miami-Dade County
3. Broward County (Fort Lauderdale)
4. Palm Beach County (West Palm Beach)
5. Treasure Coast Region (Martin County, St Lucie and Indian River)
Climatic data included monthly temperature and precipitation for the period of 1980 to 2013 (34 years) per each county or region.
Findings (Bivariate analysis)

Temperature and autochthonous (locally acquired) dengue fever cases

• Statistically significant relationship between temperature and autochthonous (locally acquired) dengue fever cases and a weak correlation ($\rho = .009; p = .000$).
Findings

- The line graph clearly shows the effects of temperature on the number of autochthonous (locally acquired) dengue fever cases.
Findings (Bivariate analysis)

Precipitation and autochthonous dengue fever cases

• No statistically significant correlation between precipitation and autochthonous (locally acquired) dengue fever cases ($rho = .023; p = .306$).
Findings (Bivariate Analysis)

Migration/Imported dengue fever cases and autochthonous dengue fever cases

• Statistically significant relationship between imported dengue fever cases and autochthonous (locally acquired) dengue fever cases and weak correlation ($\rho = .162; p = .000$).
## Negative Binomial Regression Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>B</th>
<th>Std. Error</th>
<th>95% Wald Confidence Interval</th>
<th>Hypothesis Test</th>
<th>Exp(B)</th>
<th>95% Wald Confidence Interval for Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-39.302</td>
<td>2.0174</td>
<td>-43.356 - 35.348</td>
<td>379.523</td>
<td>1.000</td>
<td>1.000E-013 - 1.000E-013</td>
</tr>
<tr>
<td>importdengucases</td>
<td>.050</td>
<td>.0636</td>
<td>.074 - .175</td>
<td>.626</td>
<td>.429</td>
<td>.928 - 1.191</td>
</tr>
<tr>
<td>totalprecip</td>
<td>.009</td>
<td>.0014</td>
<td>.012 - .006</td>
<td>41.218</td>
<td>.000</td>
<td>.988 - .994</td>
</tr>
<tr>
<td>MNTM</td>
<td>.787</td>
<td>.0735</td>
<td>.643 - .931</td>
<td>114.777</td>
<td>.000</td>
<td>1.903 - 2.538</td>
</tr>
</tbody>
</table>

(Scale) 1a

(Negative binomial) 1a

*Dependent Variable: autochthonousdengucases*

*Model: (Intercept), importdengucases, totalprecip, MNTM, offset = Ln_peryacquireddimported*

a Fixed at the displayed value.
Findings (Multivariate analysis)

Temperature

• A positive relationship between temperature and dengue fever cases.

• For every one unit (°C) increase in temperature the rate of autochthonous (locally acquired) dengue fever cases in Southeast Florida increases by 100%.
Findings (Multivariate analysis)

Precipitation
• A negative relationship between precipitation and dengue fever cases
• For every one unit (mm) increase in precipitation, the rate of autochthonous (locally acquired) dengue fever decreases by .9%.
Findings (Multivariate analysis)

Migration/Imported Dengue Cases

Not statistically significant to be a predictor for autochthonous (locally acquired) dengue fever cases ($p = .429$) in Southeast Florida.
Findings (3D Graph)

The 3D graph indicates a higher number of dengue fever cases with an increase of temperature and a decrease of precipitation.
Discussion

The study found an optimal range of temperature and an optimal range of precipitation to predict autochthonous (locally acquired) dengue fever cases in Southeast Florida.
Discussion

Temperature (23°C to 32°C):
• Reduces the time of the mosquito’s lifecycle
• Reduces the time the virus develops inside the mosquito
• Reduces the time between bloodmeals by female mosquito
• Reduces the time between egg laying
• Increases the mosquito population
• Increases dengue transmission
Discussion

Precipitation (100 mm to 500 mm)
• Creates breeding grounds
• Increases mosquito population
• Enhances the risk of dengue fever transmission
Conclusion

Main determinants for geographic expansion of autochthonous dengue fever cases were the favorable weather conditions, in this study, temperature and precipitation.
Conclusion

The findings indicated a favorable temperature range in Southeast Florida for:

• The proliferation and survival of the Aedes mosquito
• Replication and transmission of the dengue virus
Conclusions

The findings indicated an optimal range of precipitation

• Precipitation is needed to help with the proliferation of the mosquito
• Too much precipitation will wash away the larva and the eggs.
Conclusion

Migration/Imported dengue fever cases

• Necessary to introduce the virus in the mosquito ecology
• Not a predictor for locally acquired dengue fever cases in Southeast Florida
Conclusions

The data shows a movement of autochthonous (locally acquired) dengue fever cases from Key West to Miami-Dade to Fort Lauderdale to Palm Beach and finally to the Treasure Coast region.
Limitations

• Reliability and completeness of data on dengue fever cases.
Limitations

- Under-reporting or over-reporting of dengue fever in a region where the health providers were not familiarized with the disease.
Limitations

• Lack of data concerning the distribution mosquito population responsible of transmitting dengue fever, yellow fever, Chikungunya and Zika.
Limitations

- Ecological design can find correlation but not causation.
Recommendations

More studies are needed:
• Understand the factors influencing the Aedes mosquito
• Assess the distribution and changes of mosquito population
• Control the Aedes mosquito population

References

• Shang, C-S., Fang, C-T., Liu, C-M., Wen, T-H., Tsai, K-H., King, C-C (2010). The role of imported and favorable meteorological conditions in the onset of dengue epidemics. PLoS Negl Trop Dis 4(8), e775

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