Spatial Analysis of Lyme Disease in Howard County, Maryland

Methods and Public Health Significance

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Lyme Disease

- Bacteria *Borrelia burgdorferi* causes Lyme disease
- Transmitted to humans through infected ticks during bloodfeeding
- *Ixodes scapularis* (deer tick)
Lyme Disease: Transmission Cycle

- Juvenile ticks (nymphs) most common vector
  - Difficult to see and remove
  - Bacteria transmitted 36 hours after attachment

Photograph by John VanDyk, Iowa State University
Department of Entomology (1996)
Lyme Disease: Clinical Manifestations

- Characteristic bulls-eye rash (erythema migrans, EM)
  - Only 70 – 80% patients manifest EM
- Flu-like symptoms
- Muscle involvement
- Severe headaches, neck stiffness
- Cardiac involvement
- Joint pain

CDC (2007)
Lyme Disease: Public Health Impact

- Most common arthropod-borne disease in the United States
- Maryland: 9th highest incidence rate in United States, 2008
- Howard County: Highest number cases and 3rd highest incidence rate in Maryland, 2008

<table>
<thead>
<tr>
<th></th>
<th>2008 Case Count*</th>
<th>2008 Incidence per 100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>35195</td>
<td>9.4</td>
</tr>
<tr>
<td>Maryland</td>
<td>2216</td>
<td>31</td>
</tr>
<tr>
<td>Howard County</td>
<td>369</td>
<td>133.8</td>
</tr>
</tbody>
</table>

*Confirmed and probable case diagnoses per CDC guidelines

CDC (2009)
Maryland Department of Health and Mental Hygiene (2009)
Study Site: Howard County, MD
Study Methods

- Lyme disease reportable under Code of Maryland Regulations 10.06.01.03
- Cases extracted from the National Electronic Disease Surveillance System (NEDSS)
  - Deidentified to census block and census tract by geocoding in ArcGIS
Analysis: Cluster Detection

- To determine if certain areas show higher than expected case counts (clusters) while accounting for variations in population density

- Kulldorff’s spatial scan statistic
  - Adjusts for uneven population distribution across study area
  - Identifies the existence of disease clusters and their approximate locations
  - Provides single p-value to test null hypothesis of no clusters

Kulldorff et al. (1997)

Legend
- Red: Cluster 1; p-value 0.001
- Orange: Sub-Cluster 1; p-value 0.001
- Brown: Sub-Cluster 2; p-value 0.001
- Pink: Sub-Cluster 3; p-value 0.001
- Yellow: Sub-Cluster 4; p-value 0.001
- Green: Sub-Cluster 5; p-value 0.016
- White: 2000 Census Tract Boundaries

Howard County, MD

Maximum Cluster Size: 50% of Population at Risk

Maximum Cluster Size: 5% of Population at Risk

Doll (2008)
Analysis: Assessing Risk

- Relative Risk
  - Number of cases observed divided by expected number of cases for a given area

- Choropleth map to show changes in relative risk across Howard County

- Differs from 2007 risk analysis
  - 2007 used ordinary kriging to approximate risk
  - Relative risk method expected to produce similar risk maps

Dr. Frank Curriero, personal communication, May 6, 2010

Legend
Prediction Maps
Lyme Disease Incidence
Per 10,000 Persons
- 0 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 150
- 150 - 300
- 300 - 600
- 600 - 1000

Standard Errors
Per 10,000 Persons
- 13.23 - 17.66
- 17.66 - 28.64
- 28.64 - 55.29
- 55.29 - 121.05
- 121.05 - 202.69

2000 Census Tract Boundaries

Doll (2008)
Utilizing the Maps

- Result: Multiple maps to help characterize geographic distribution of Lyme disease in Howard County
- Guide governmental agencies in Lyme prevention activities
  - Education campaigns
  - Pesticide application
  - Environment modification
Geographic Information Systems (GIS) in Public Health

- Computer-based procedures that allow users to input, manipulate, analyze, and output data to investigate spatial patterns and trends
  - Output often in map format
- Spatial component of infectious disease transmission
  - Tick vector distribution for Lyme disease
  - Place of residence as approximation for place of exposure

Glass et al. (1995)
Geographic Information Systems (GIS) in Public Health

- To identify potential risk factors for disease
  - Overlay maps of disease risk with maps of environment to visualize correlations
  - Potential environmental covariates for Lyme disease study:
    - Proximity to forest
    - Soil type
    - Urbanicity
    - Landuse

Glass et al. (1995)
Acknowledgements

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Works Cited


