Spatial Analysis of Lyme Disease in Howard County, Maryland

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Study Objective

- Spatial analysis of Lyme disease incidence in the years 2005, 2006 and 2007 in Howard County, Maryland

- Goals:
  - Focus disease prevention, control and treatment methods
  - Enhance understanding of geographic disease patterns in the mid-Atlantic region of the United States

- Methods:
  - Use of geographic information systems (GIS) and SaTScan statistical program to detect clusters of Lyme disease incidence by case residence

- Final Products:
  - Map of Lyme disease risk
  - Policy suggestions for prevention
What is Lyme Disease?

- A vector-borne illness caused by the bacterium, *Borrelia burgdorferi*
What is Lyme Disease?

- Transmitted by the deer tick, *Ixodes scapularis*
  - Tick nymphs are the primary vectors involved in transmission¹

*I. scapularis* nymph

¹ Hayes & Piesman, 2003
What is Lyme Disease?

- White footed mouse serves as reservoir for the bacteria
- Larger vertebrates, such as deer, serve as hosts for adult ticks
- Vector, reservoir and host ecology are important determinants of disease dynamics
Public Health Impact

- 2003-2005: 20,000 cases annually\(^1\)
- 90% of cases successfully managed\(^2,3\)
  - However, 10% cases may lead to:
    - chronic neural, cardiovascular and musculoskeletal disorders
- Incidence highest among children aged 5 to 9 and adults aged 45 to 55 years\(^4\)

\(^1\)CDC, 2007.
\(^3\)Shadick et al., 2001.
\(^4\)Poland, 2001.
Burden of Disease

- Maryland is among 10 states with endemic Lyme disease\(^1\)
- 2005: Howard County had the 2\(^{nd}\) highest number of cases of Lyme disease in Maryland\(^2\)
- Lyme disease in Howard County has doubled from 2001 to 2005\(^2\)

1 CDC, 2007.
Spatial Epidemiology

- As a zoonotic illness, the environment is an integral part of disease
  - Called “spatial epidemiology”

- Spatial clustering of disease is a common feature of Lyme disease in endemic areas in the Northeast\(^1,\)\(^2\)

- Spatial epidemiology of disease is an important factor to consider in relation to disease surveillance, research and prevention\(^3\)

\(^1\)Armstrong et al., 2001.
\(^2\)Steere et al., 2004
\(^3\)Kitron, 1998.
Characterizing Spatial Epidemiology

- Geographic Residence of Cases
  - Residence has been linked to risk of disease\(^2,3\)
  - 87% of cases identified residence as probable source of exposure\(^4\)

- Tick density\(^1\)
  - Unreliable: tick aggregation
  - Difficult to survey
  - Expensive

\(^1\) Poland, 2001.  
\(^2\) Maupin et al., 1991  
\(^3\) Cromley et al., 1998  
\(^4\) Glass et al., 1995.
Methods

- Used address data from confirmed cases of Lyme disease occurring in Howard County during the years 2005, 2006, and 2007
  - Extracted from MERSS and NEDSS databases

- Cluster detection using geographic information systems (GIS) in conjunction with SaTScan statistical software
Results

- 556 confirmed cases of Lyme disease
  - Age of cases ranged 1 to 83 years
    - Bimodal Distribution:
      - Aged 5 to 14 years
      - Aged 45 to 55 years
  - 66% male and 44% female
- Successfully geocoded 503 records
  - Residences of 23 cases outside of county
  - Remaining 30 cases:
    - 8 missing addresses
    - 8 post office box addresses
    - 1 rural route address
    - 13 incorrect addresses
Significant* Clusters and Sub-Clusters of Lyme Disease Incidence in Howard County, MD During the Years 2005, 2006, and 2007 Controlling for Cluster Population Size

*Based on alpha <0.05

Howard County, MD

Maximum Cluster Size: 50% of Population at Risk

Legend

- Red: Cluster 1; p-value 0.001
- Orange: Sub-Cluster 1; p-value 0.001
- Dark Brown: Sub-Cluster 2; p-value 0.001
- Light Brown: Sub-Cluster 3; p-value 0.001
- Yellow: Sub-Cluster 4; p-value 0.016
- Green: Sub-Cluster 5; p-value 0.016
- White: 2000 Census Tract Boundaries
Predicted Incidence and Corresponding Standard Errors of Lyme Disease Per 10,000 Persons in Howard County, Maryland Over a 3-Year Period Using Ordinary Kriging
Discussion

- Confirms geographic focal point of Lyme disease similar to northeastern United States

- Large, single cluster may be indicative of spatial homogeneity and endemicity of disease in Howard County

\(^1\text{Maupin et al., 1991.} \quad \^2\text{Cromley et al., 1998.}
Limitations

- Passive surveillance
  - Underreporting of Lyme disease\(^1,2\)
  - Overdiagnosis of Lyme disease\(^3,4\)

- Assume residence is a surrogate for Lyme disease exposure

- Aggregation of data: modifiable areal unit problem (MAUP)\(^5\)

- Ecologic Fallacy

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\(^1\)Meek et al., 1996.
\(^2\)Naleway et al., 2002.
\(^3\)Qureshi et al., 2002.
\(^4\)Steere et al., 1993.
\(^5\)Openshaw & Taylor, 1981.
Public Health Significance

- Endemicity findings suggest need for county-wide prevention initiative
- Prevention program should focus on education, including: $^{1,2,3}$
  - Outdoor precautions
  - Tick checking and removal
    - Risk of disease reduced if tick removed within 36 hours
  - Identify primary symptom of disease erythema migrans
  - Reduce tick habitats at place of residence

$^{1}$ DHMH, 2007.
$^{2}$ Hunterdon Health Department, 2007.
$^{3}$ Poland, 2001.
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Questions?

Protect Yourself Against Lyme Disease in Spring, Summer, and Fall

1. Walk in the middle of trails, away from tall grass and bushes.

2. Wear a long-sleeved shirt.

3. Wear white or light-colored clothing to make it easier to see ticks.

4. Wear a hat.

5. Spray tick repellent on clothes and shoes before entering woods.

6. Wear long pants tucked into high socks.

7. Wear shoes—no bare feet or sandals.
Works Cited


