Spatial Epidemiology: GIS and Geostatistical Applications for Public Health

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Overview

- Epidemiology / Public Health
- **Spatial epidemiology**
- **GIS applications** for public health
  - Infant nutrition in Africa: Social mapping
  - Pharmacy availability: Hot-spot analysis
  - Crime and HIV prevention: Areal interpolation
  - HIV prevention and pharmacy use: Spatial analysis
  - Women, Infants and Children (WIC): Hot-spot clusters
- Interactive online maps and future directions
• Public Health?

• Epidemiology?
Do you speak Greek?

• Epidemiology: "the study of what is upon the people"

  – *epi* = upon, among
  – *demos* = people, district
  – *logos* = study, word, discourse

http://en.wikipedia.org/wiki/Epidemiology
What is epidemiology?

• **Epidemiology:** “The study of how diseases (health related states) are distributed in populations and the factors that influence or determine this distribution”

Source: Gordis, 3rd Edition
What is spatial epidemiology?

...appears to be some sort of primitive tractor beam, captain...
Example 1: Social Mapping** and Infant Feeding

• What foods are given to infants and when?
  – Nyeri, Kenya
Example 2: Pharmacy Availability

• What factors are associated with the presence of pharmacies?
  - Los Angeles
Background

• In the United States
  – 56,000 people are newly diagnosed with HIV/year
  – More than 14,000 people with die with AIDS/year

• In California
  – >3,000 people are diagnosed with AIDS/year
  – Pharmacy syringe sales can help to decrease HIV risk among injection drug users (IDUs)
Pharmacies and OTC Syringe-Selling Pharmacies in LA County, 2008
Results: Cluster Analyses

Low No. of Pharmacies

Young Population (Percent<18 Years)

= Hot Spot  (p<0.05)

= Cold Spot  (p<0.05)

Poor Population (Percent Received Public Assistance)
Results: Pharmacy Availability

- Pharmacy availability associated with population size, age, and sociodemographic characteristics

- **Cluster analyses** identified
  - Regions with high and low pharmacy availability
  - Clusters of pharmacies that were distant from clusters of younger and poorer populations
Example 3:
Pharmacy Syringe Sales and Crime

- Is crime associated with OTC syringe-selling pharmacies?
  - Los Angeles
LAPD Reporting Districts and OTC Syringe-Selling Pharmacies
Problem:
Different Units of Analysis

• Crime and Pharmacies
  – LAPD reporting district level

• Sociodemographic variables
  – Census tract level

• Need data in same unit of analysis...
Areal Interpolation: Spatial Kriging

Percent Unemployed

Census Tracts

Prediction Surface

LAPD RDs Overlaid

Percent Unemployed in LAPD RDs
Crime Rates in Police Districts With OTC Syringe Sales (n=94)

Crimes Rates per 1,000 Semiannual Periods

- All Crime Rate
- Econ. Mot. Crime Rate
- Violent Crime Rate
- Nuisance Crime Rate
- Other Crime Rate

OTC Sales Began

Semiannual Periods:
- Jan-June, 2006
- July-Dec, 2006
- Jan-June, 2007
- July-Dec, 2007
- Jan-June, 2008
- July-Dec, 2008
Results: Syringe Sales and Crime

- Age, race, and percent unemployed were positively associated with overall crime rates.
- OTC pharmacy syringe sales were NOT associated with increases in crime in LAPD reporting districts.
- **GIS and areal interpolation / spatial Kriging** allowed us to do this study!
Example 4: Pharmacy use and HIV prevention

- Who uses OTC syringe-selling pharmacies?
  - San Francisco
Results: Syringe source during past 6 months (n=563)

<table>
<thead>
<tr>
<th>Syringe Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacy</td>
<td>33%</td>
</tr>
<tr>
<td>Needle Exchange</td>
<td>84%</td>
</tr>
<tr>
<td>Unauthorized Source</td>
<td>65%</td>
</tr>
<tr>
<td>Secondary Syringe Exchange</td>
<td>52%</td>
</tr>
</tbody>
</table>
Factors Associated with OTC Pharmacy Syringe Purchase

Adjusted Prevalence Ratio (95% CI)

- African American IDUs: 0.47
- Older IDUs: 0.98
- Meth IDUs: 1.35
- IDUs with Unsafe Syringe Sources: 1.36

0.47
0.98
1.35
1.36

African American IDUs
Older IDUs
Meth IDUs
IDUs with Unsafe Syringe Sources
Results: Pharmacy use and HIV Prevention

- OTC pharmacy syringe purchase among IDUs was associated with race, drug of choice, and use of unsafe syringe sources

- **Spatial analyses** highlighted neighborhoods that need improved access to safe syringes and HIV prevention
Example 5: Targeting Women Infant and Children (WIC) Nutrition Services

- Where are clusters of WIC eligible non-participants (ENPs)?
  - California
Spatial Epidemiology, Hot-Spot Analyses Target Eligible WIC Recipients

By Thomas J. Stopka, Epidemiologist, California Department of Public Health; Pat Gradziel, Research and Evaluation Specialist, California Department of Public Health; and Christopher Krawczyk, Chief, EEDO Section, California Department of Public Health

The California Department of Public Health’s Women, Infants, and Children (WIC) Program and Maternal, Child, and Adolescent Health (MCAH) Program are working together to use GIS, spatial epidemiology, and hot-spot analyses to identify geographic locations of people who are eligible for but not receiving WIC services.

Results of these efforts are used to guide resource allocation decisions, target outreach efforts, assess program outcomes, and guide public health policy and program enhancement decisions.

In California, WIC agencies provide services to nearly 1.45 million women, infants, and children each month at 650 sites statewide. WIC, the special supplemental nutrition program for women, infants, and children, is a fully federally funded nutrition and health program that provides education and food to low-to-moderate-income families with nutritionally at-risk pregnant and breastfeeding women and infants and children up to the age of five.

continued on page 3
Hot-Spot Clusters: Density of ENPs

Clusters: Density of WIC Eligible Non-Participants (ENPs) per Square Mile

- Blue: P<0.05 Significantly lower than mean
- Red: Mean density of ENPs per square mile
- Dark Red: P<0.05 Significantly higher than mean

*Notes: Hot-spot analyses based on density of WIC eligible non-participants per square mile per census tract (N=7049). Data Source: BSMF merged with WIC-ISIS data. Distance band: 26 km (16.2 miles) Projected Coord. System: NAD 83, CA Teale Albers Author: T. Stopka Date: 08.02.12
Local Hot-Spots
Results

• The 5 geoprocessing steps for **hot-spot analyses** provided a systematic, rigorous, and objective approach

• State level hot-spot analyses helped locate statistically significant clusters of WIC eligible women in key CA counties

• County level hot-spot analyses allowed us to locate clusters of highest WIC need on the local neighborhood level

• Findings helped inform WIC program and funding decisions on the state and local level
Interactive Maps and Future Directions

- Can we put helpful GIS and spatial analysis tools in the hands of stakeholders?
  - California
2-Mile WIC Center Buffers
Distance

Click on the map to measure.

20.76 Miles
Interactive Maps on Smartphones and Tablets
Review

• Epidemiology / Public Health

• **Spatial epidemiology**

• **GIS applications** for public health
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  – Women, Infants, and Children: Hot-spot clusters

• Interactive online maps and future directions
Public Health Impact

• Will science inform policy?
Public Health Impact

• Will science inform policy?

• Potential interventions
  – Work with public health officials
  – Target locations for new services
  – Inform community members & policymakers
  – Use spatial analysis tools for surveillance
    • Health service access (pharmacies, WIC centers)
    • Assess risky behavior, disease spread across populations
    • Assess spatial relationships for health outcomes
Thank you!

Questions?

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