Using Hot-Spot Analysis to Target Women, Infant and Children Services

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Esri International User Conference
July 13, 2011
10:15 a.m.-11:30 a.m.
Room 29D
Acknowledgements

• California Department of Public Health, MCAH
  – Chris Krawczyk, PhD
  – Mike Curtis, PhD
  – Kate Cordell, MPH
  – Zipora Weinbaum, PhD

• California WIC Program
  – Michele van Eyken, MPH, RD
  – Pat Gradziel, PhD, RD
  – Barbara Longo, MS, RD
  – Charlene Manning

• UC Davis Mentor in GIS and Spatial Analysis:
  – Estella Geraghty, MD, MS, MPH/CPH
Overview

• Background
• Study Questions
• Methods
• Results
• Discussion
Background: WIC

- Special Supplemental Nutrition Program for Women, Infants and Children (WIC)
  - Provides health education
  - Supplemental food vouchers

- Approximately 1 of 4 pregnant women and roughly 50% of all infants born in the U.S. participate in WIC

- Almost 51% of pregnant women enroll in WIC during 1\textsuperscript{st} trimester

- In California, WIC agencies provide services locally to nearly 1.45 million women, infants and children each month at 650 sites.
Background: Need for GIS and Spatial Analysis in Good Times and Bad...

- “Association of Maternal & Child Health Programs Opposes Major Funding Reduction to Women, Infant and Children (WIC) Program”
  - House Agriculture Appropriations Subcommittee marked up a FY 2012 Agriculture Appropriations bill and included an $832 million funding reduction
  - Up to 500,000 low-income women and children would be denied services
  - Spatial analyses can help monitor impacts over time
Study Questions

• Where are statistically significant clusters of WIC eligible women* located California?

• Where do micro-level clusters of WIC eligible women exist within counties?

*WIC eligible women: Received MediCal during pregnancy (i.e., WIC eligible) but did not receive WIC services
Data

• Multi-step algorithm to merge 2 large data sets
  – Birth Statistical Master File for live births in CA in 2009 (N=518,244)
  – 2009 WIC-ISIS data file (N=257,955)

• Outcome of interest:
  – Women on MediCal (i.e., eligible for WIC) but not receiving WIC services (N=23,147)
Questions:

• How do we know that these patterns are not due to chance alone?

• Where are statistically significant clusters of WIC eligible women located in California?

  – Hint: We need to conduct hot-spot analyses to find out!
Methods: Hot-Spot Analysis
Getis Ord Hot-Spot Analysis (Gi*)

• Spatial analysis tool

• Used to pinpoint locations of clusters
  – Looks at each feature within the context of neighboring features. A feature with a high value is a statistically significant hot spot if it is also surrounded by other features with high values.

  – The local mean for a feature and its neighbors is compared proportionally to the “global mean” of all features.

  – When the observed local mean is much different than the expected local mean, and that difference is too large to be the result of random chance, a statistically significant Z-score results.
Methods: Hot-Spot Geoprocessing Tasks

1) Calculate area for polygons (e.g., census tracts) and select areas that are < 1.5 SD below the mean;

2) Find the appropriate spatial scale for selected tracts (i.e., distance from each tract to 2 nearest neighbors)
   - Starting Distance
   - Incremental Distance
Methods: Hot-Spot Geoprocessing Tasks

3) Conduct incremental spatial autocorrelation analysis (Moran's I)
   – Determine multiple distances at which clustering peaks
   – Find distance of first statistically significant peak (Z-score; p-value)

4) Generate a spatial weights matrix file to assess the spatial connectivity of polygons (i.e., census tracts) included in analyses

5) Conduct hot-spot analysis
   – Determine location of statistically significant clusters
Methods: Hot-Spot Analysis

• Clusters we wish to pinpoint
  – Statistically significant clusters of WIC eligible women across the state
  – Significant clusters of WIC eligible women within selected counties

• Results
  – P-values and Z-scores (map layer)
    • Larger Z-score, more intense the clustering of high values (a hot-spot)
    • Smaller Z-score, more intense the clustering of low values (a cold-spot)
Results: Statewide Hot-Spot Analyses
Let's take a closer look…
Results: County-Specific Hot-Spot Analyses
Hot-Spot Clusters: WIC Eligible Women Sacramento, 2009

Services and Clusters of Need
- WIC Centers (2010)
- Transportation Terminals

Clusters of WIC Eligible Women Who Are Not Receiving Services*
- P<0.01 Very significantly lower than mean
- P<0.05 Significantly lower than mean
- P<0.05 Mean density of WIC eligibles per square mile
- P<0.05 Significantly higher than mean
- P<0.01 Very significantly higher than mean

*Note: Hot-spot analyses based on density of WIC eligible women per square mile on the census tract level.

Data Sources: BSFM and WIC-ISIS
Distance band: 4 km (2.5 miles)
Projected Coordinate System: NAD 83, CA Teale Albers

Author: Tom Stopka
Date: 6/6/2011
Hot-Spot Clusters: WIC Eligible Women
San Francisco, 2009

Services and Clusters of Need
- WIC Centers (2010)

Clusters of WIC Eligible Women Who Are Not Receiving Services*

P=0.01 Very significantly lower than mean
P=0.05 Significantly lower than mean
Mean density of WIC eligibles per square mile
P=0.05 Significantly higher than mean
P=0.01 Very significantly higher than mean

Legend:
- Blue: P=0.01 Very significantly lower than mean
- Light Blue: P=0.05 Significantly lower than mean
- Red: P=0.01 Very significantly higher than mean
- Dark Red: P=0.05 Significantly higher than mean

*Note: Hot-spot analyses based on density of WIC eligible women per square mile on the census tract level.
Threshold Distance: 1.7 km (1.1 miles)
Projected Coord. Sys.: NAD 83,
CA Teale Albers

Source: California WIC Program (WIC-ISIS), Maternal, Child & Adolescent Health, California Vital Statistics (BSMF)

Author: Tom Stopka
Date: 6/6/2011
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 level.

• Findings helped inform WIC program and funding decisions on the state and local level.
Discussion

• Limitations
  – Focused on women alone (not infants and children)
  – Time lag

• Public Health Implications:
  – Hot-spot analyses provided objective method to guide funding decisions
  – Similar analyses can be conducted for other programs to target services
  – Need for GIS and spatial analyses in good times and bad...

• Next Steps
  – Additional hot-spot analyses
  – Statistical modeling
  – Analyses of WIC eligible infants and children
For More Information

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