Are Distance Based on Addresses Better Than ZIP Codes for Assessing Geographic Access to Cancer Treatment?

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Integrated Cancer Information and Surveillance System
Overview

• What distances are commonly used in public health studies?
• Geocoding
• Geographic coordinates
• Why do we care about distance?
• A study comparing distance effect on cancer care
What Distances Are Commonly Used?

- Driving distance, network distance
- Straight-line distance, Euclidean distance
Geocoding

Assign latitude and longitude for a location on the Earth’s surface

Lat: 40° North
Long: 60° East
Geographic Coordinates: (Latitude, Longitude)
Geocoding: Examples

- 101 E. Weaver Street, Carrboro, NC 27510
  \[ (35.9110, -79.0720) \]
- ZIP code?

Polyhedral ZIP Code Representation
Postal Delivery Route (Roads)

Massengill et al, Paper in SAS Global Forum 2010
Why Do We Care About Distance?

• Distance as a proxy measure for geographic access to healthcare
• Findings about distance effect are inconsistent
  – Distance measures vary across studies
  – Geography (urban-rural) complicates the findings
Why Do Urban and Rural Areas Matter?
Study Objectives

• Compare distance effect on health care utilization:
  – Straight-line and driving distance
  – Addresses and ZIP codes data

• Examine distance effects across urban-rural areas
Study Design

• Retrospective cohort:
  – Women age 65+, diagnosed with breast cancer in 2003-2005
  – Had breast conserving surgery
  – Needed to follow with radiation therapy (RT), usually given 5 days a week for about 5-6 weeks
Data Sources

• NC Central Cancer Registry linked to Medicare claims
  – Cancer patients data and geocode addresses
  – All physicians who provided radiation treatment
• Medicare Physician Identification & Eligibility Records (MPIER)
  – Linked to physicians’ data for providers’ addresses
• Rural-Urban Commuting Area (RUCA) Data
  – Rural and urban indicator at ZIP code
• Area Resource File
  – Area-level control variables
Distance Measures: Computation

• Geocoded addresses and ZIP codes
• Nearest distance between patient’s residence to radiation treatment physician
  – Straight-line distance: SAS GEODIST function
  – Driving distance: ESRI ArcGIS 10.1
    o Straight-line distance, addresses
    o Straight-line distance, ZIP code centroids
    o Driving distance, addresses
    o Driving distance, ZIP code centroids
Statistical Analysis

• Logistic Regression Models
  – Outcome variable: receipt of RT (yes vs. no)
  – Key independent variables: distance (logged), urban indicator, and their interactions
  – Control variables: patient demographics, comorbidities, tumor characteristics, county-level racial composition, median household income, and population density
  – Generalized Estimating Equation for clustered data
Results: Correlations between Addresses and ZIP Codes

- **Straight-line Distance**
  - $R^2 = 0.92$

- **Driving Distance**
  - $R^2 = 0.93$
Table 1. Descriptive Data among Different Distance Measures (N=1,938)

<table>
<thead>
<tr>
<th></th>
<th>Straight-line Distance (Miles)</th>
<th>Driving Distance (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Address</td>
<td>ZIP Centroid</td>
</tr>
<tr>
<td>Mean</td>
<td>9.96</td>
<td>9.97</td>
</tr>
<tr>
<td>Median</td>
<td>6.55</td>
<td>7.65</td>
</tr>
<tr>
<td>Min, Max</td>
<td>0.1, 52.0</td>
<td>0, 53.9</td>
</tr>
</tbody>
</table>

* p< 0.05

- Mean straight-line distances were similar between ZIP codes and addresses
- Mean driving distance from ZIP codes was longer than that from addresses
Table 2. Coefficient Estimates from Regression Models

<table>
<thead>
<tr>
<th></th>
<th>Straight-line Distance</th>
<th>Driving Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Address</td>
<td>ZIP code</td>
</tr>
<tr>
<td>Urban vs. Rural</td>
<td>0.27</td>
<td>0.76</td>
</tr>
<tr>
<td>Linear Distance</td>
<td>-0.24</td>
<td>0.02</td>
</tr>
<tr>
<td>Quadratic Distance</td>
<td>0.07</td>
<td>0.01</td>
</tr>
<tr>
<td>Linear Distance x Urban</td>
<td>0.38</td>
<td>-0.16</td>
</tr>
<tr>
<td>Quadratic Distance x Urban</td>
<td>-0.16*</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

a: Models also included demographics, tumor characteristics, county level racial composition, median household income, and population density.

* p<0.05

- Estimates for the key independent variables were similar between models using ZIP codes
- Estimates for the key independent variables using address showed a significant interaction effect
Predicted Probabilities by Distance and Urban-Rural Areas

- Probability of receiving RT increased by distance using addresses and then decreased (after 3 miles)
- Probability of receiving RT decreased by distance using addresses and then increased (after 6 miles)
Summary of Findings

• Same granularity of data (ZIP code and address) produced similar results

• Distance effect differed by urban-rural areas, found in address data only

• Findings about person level factors were consistent with literature: older, not married, low-income, more comorbidities, and earlier stage cancer diagnosis were associated with lower probability of receiving RT
Conclusion

• Are distance based on addresses better than ZIP codes for assessing geographic access to cancer treatment?

• YES!
Limitations and Future Studies

• Results may not be generalizable to:
  – Other states
  – Women <65 years old
• Limitations of claims data
• Further examination of women in rural area
  – Stayed in nearby areas to receive RT
Acknowledgements

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Thank you!

Questions?

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