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

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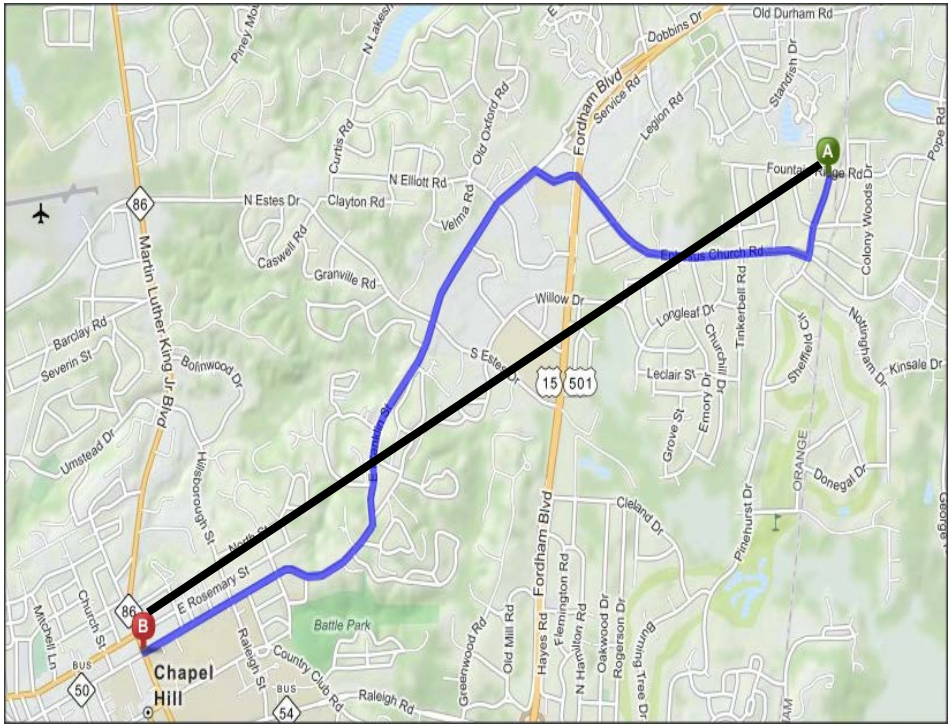
# Overview

- 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

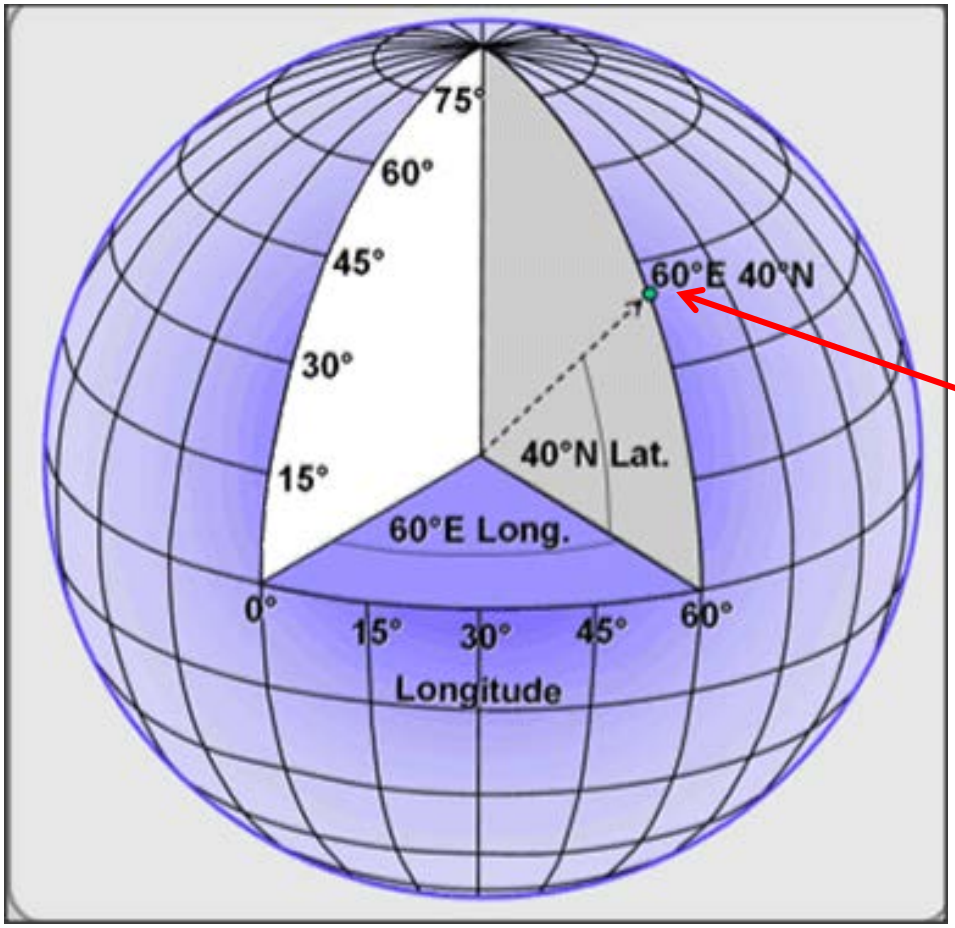
# What Distances Are Commonly Used?




Driving distance, network distance

Straight-line distance, Euclidean distance

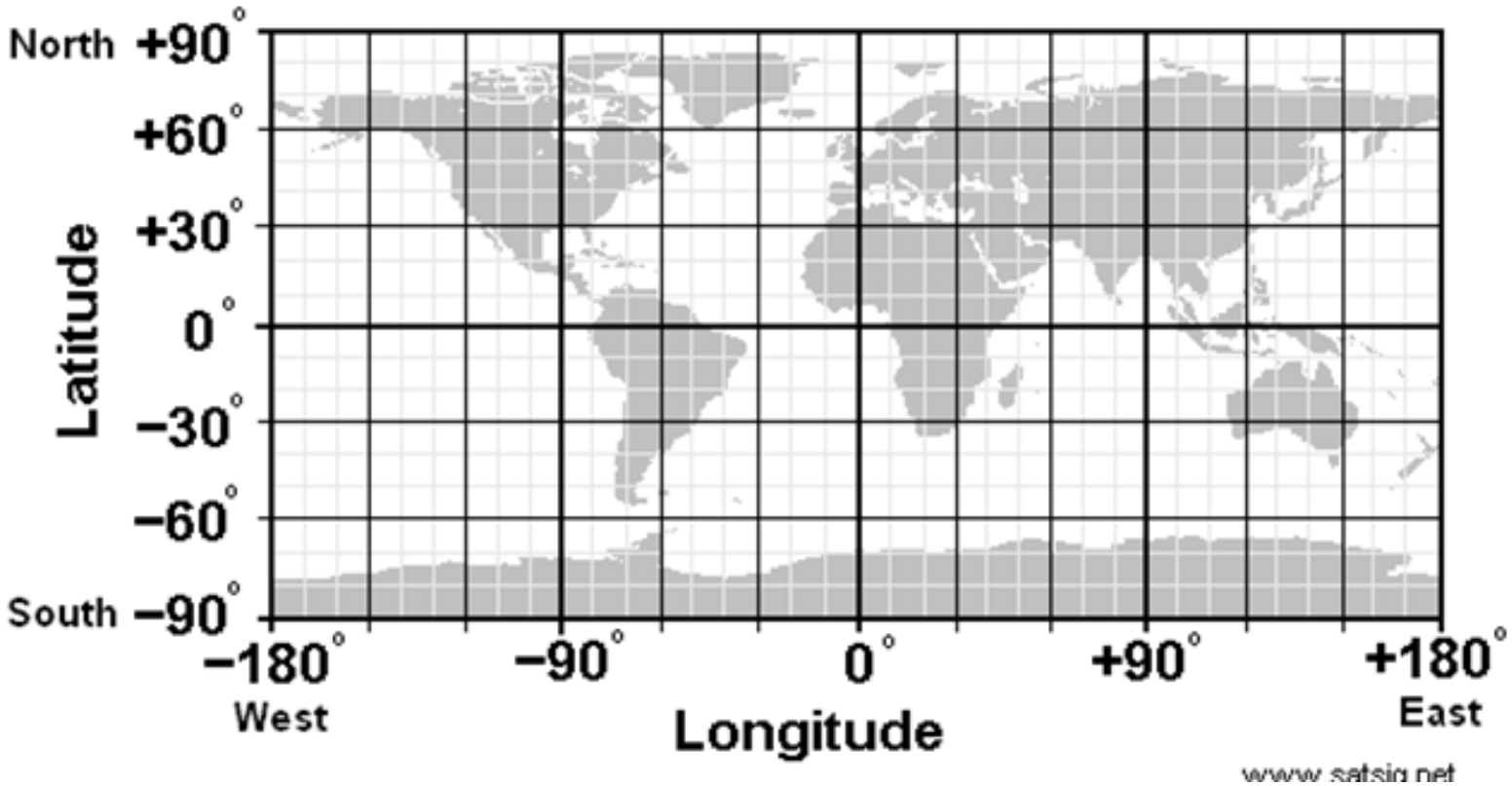
# Geocoding




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

Lat: 40 $^{o}$ North
Long: 60$^{o}$ East

# Geographic Coordinates: (Latitude, Longitude)

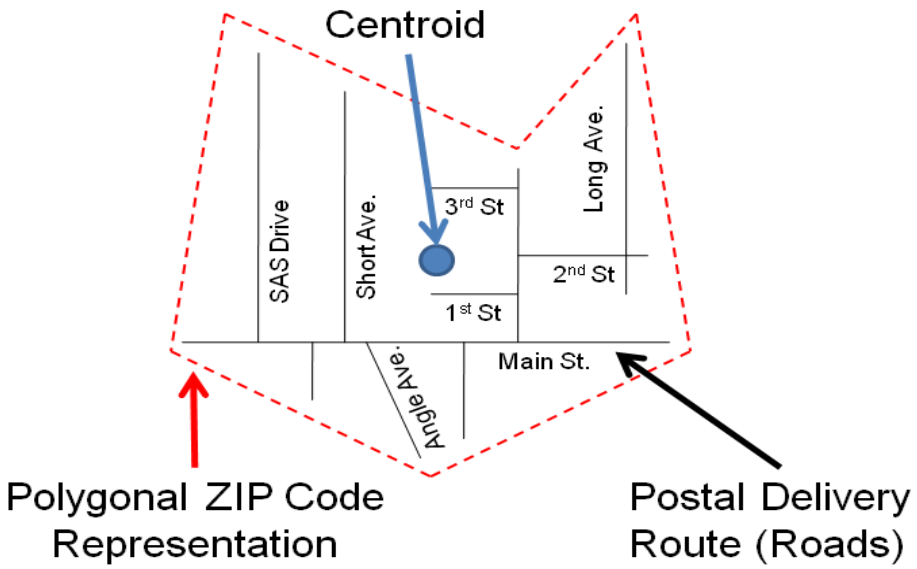


# Geocoding: Examples

- 101 E. Weaver Street, Carrboro, NC 27510

  ➡ (35.9110, -79.0720)

- ZIP code?




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

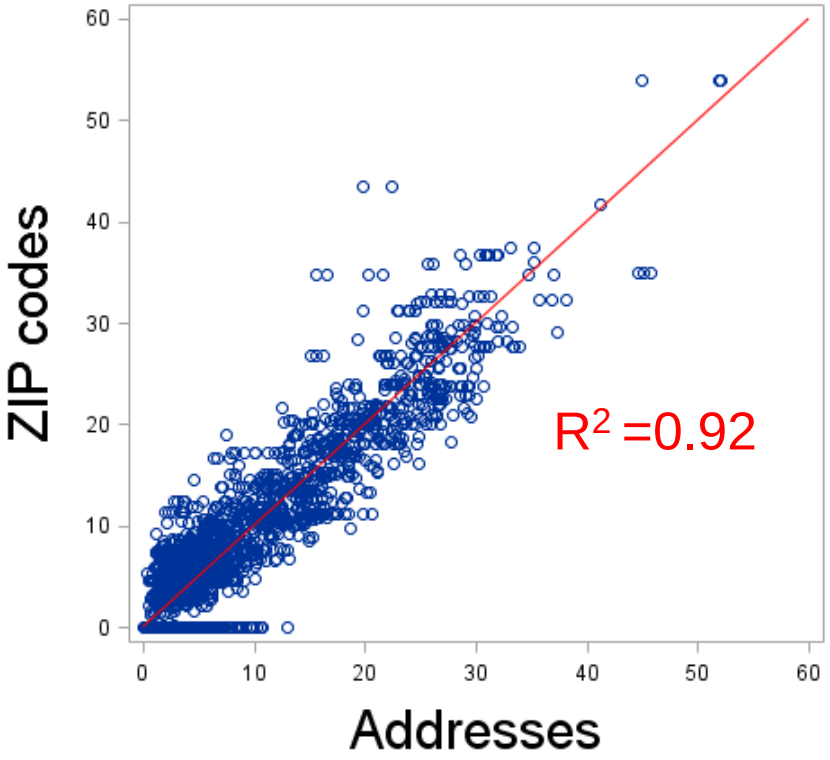
- Geocoded addresses and ZIP codes
- Nearest distance between patient's residence to radiation treatment physician
  - Straight-line distance: SAS GEODIST function
  - Driving distance: ESRI ArcGIS 10.1
    - Straight-line distance, addresses
    - Straight-line distance, ZIP code centroids
    - Driving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

# Statistical Analysis

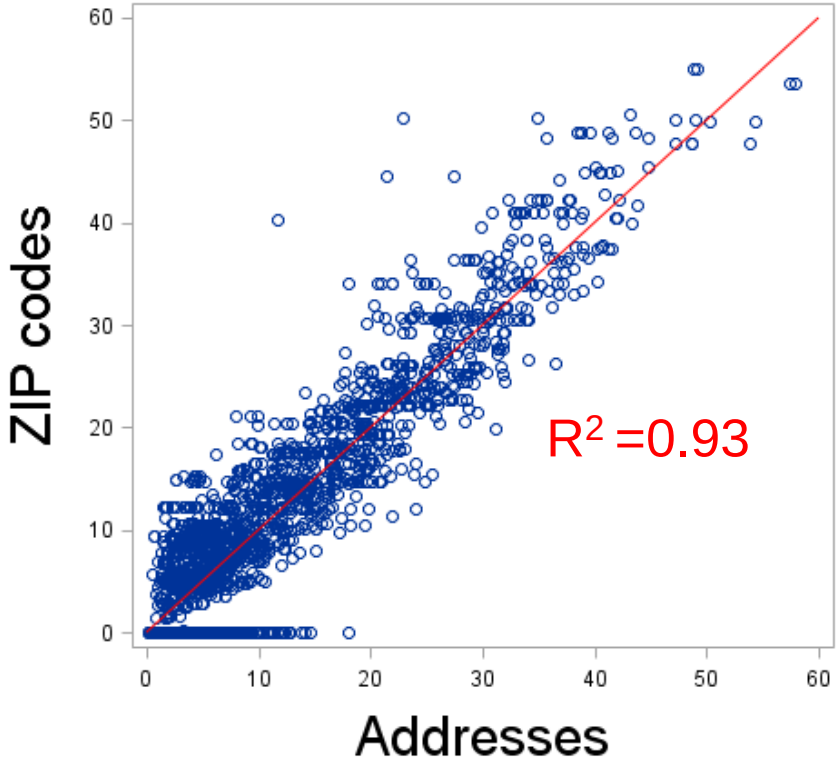
- Logistic Regression Models
  - Outcome variable: receipt of RT (yes vs. no)
  - Key independent variables: distance (logged), urban indicator, and their interactions
  - Control variables: patient demographics, comorbidities, tumor characteristics, county-level racial composition, median household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

# Results: Correlations between Addresses and ZIP Codes

Straight-line Distance




Driving Distance



# Table 1. Descriptive Data among Different Distance Measures (N=1,938)

| | Straight-line Distance (Miles) | | Driving Distance (Miles) | |
|---|---|---|---|---|
| | Address | ZIP Centroid | Address | ZIP Centroid |
| Mean | 9.96 | 9.97 | 12.3 | 12.9* |
| Median | 6.55 | 7.65 | 8.27 | 9.93 |
| Min, Max | 0.1, 52.0 | 0, 53.9 | 0.1, 72.7 | 0, 74.6 |

* $p < 0.05$

- 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[a]

| | Straight-line Distance | | Driving Distance | |
|---|---|---|---|---|
| | **Address** | **ZIP code** | **Address** | **ZIP code** |
| **Urban vs. Rural** | 0.27 | 0.76 | 0.10 | 0.72 |
| **Linear Distance** | -0.24 | 0.02 | -0.34 | 0.01 |
| **Quadratic Distance** | 0.07 | 0.01 | 0.09 | 0.01 |
| **Linear Distance x Urban** | 0.38 | -0.16 | 0.51 | -0.14 |
| **Quadratic Distance x Urban** | -0.16* | -0.02 | -0.17* | -0.02 |

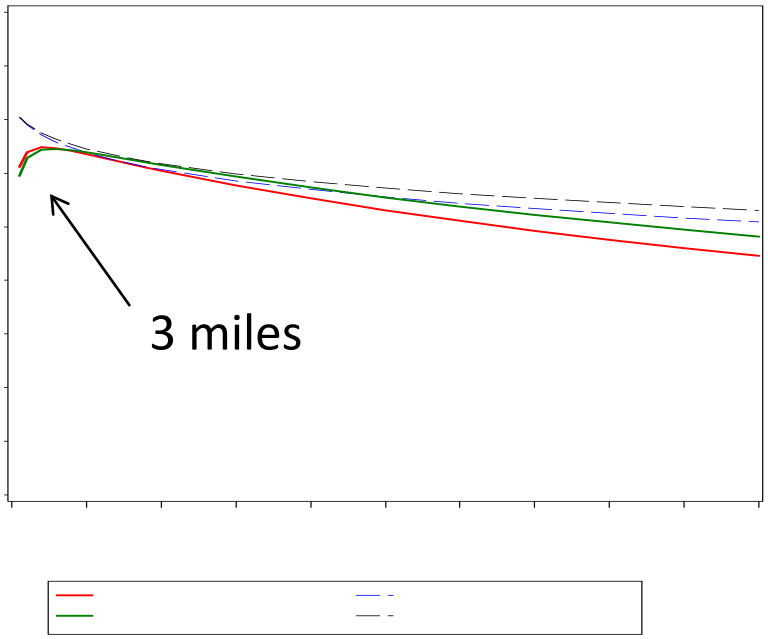
a:Models also included demographics, tumor characteristics, county level racial composition, median household income, and population density.

* $p<0.05$

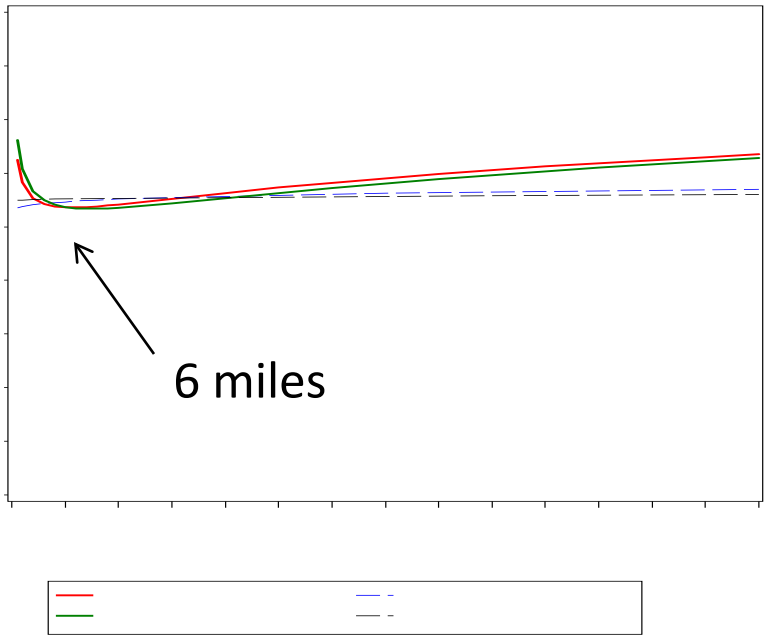
- Estimates for the key independent variables were similar between models using ZIP codes
- Estimates for the key independent variables using address showed a significant interaction effect

# Predicted Probabilities by Distance and Urban-Rural Areas

Urban Areas




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

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# Thank you!

Questions?

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