CCDTR CHICAGO CENTER FOR DIABETES TRANSLATION RESEARCH

Validating the Dasymetric Areal Interpolation Method to Inform Health Policy

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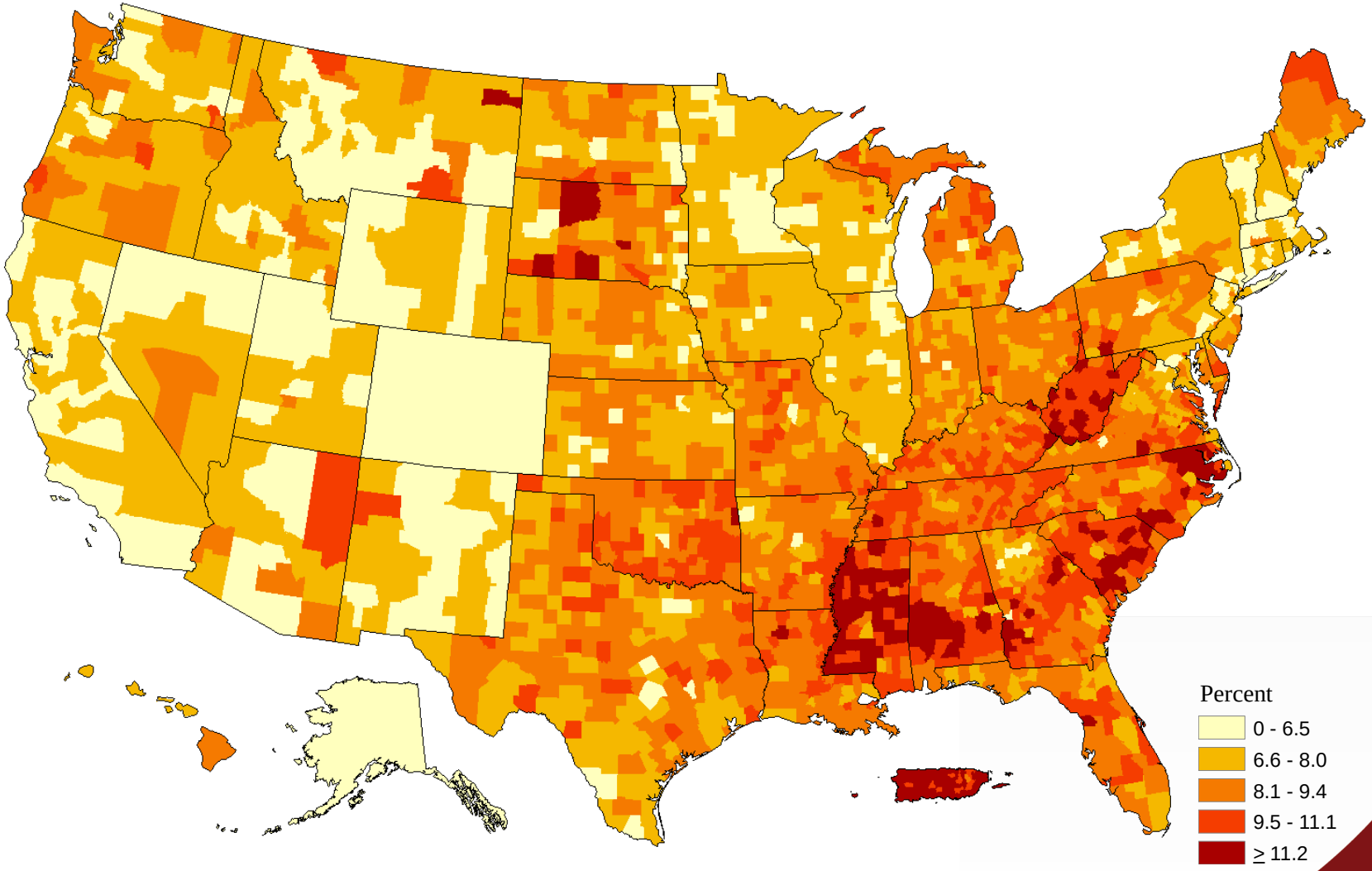
County-level Estimates of Diagnosed Diabetes among Adults aged ≥ 20 years: United States 2004



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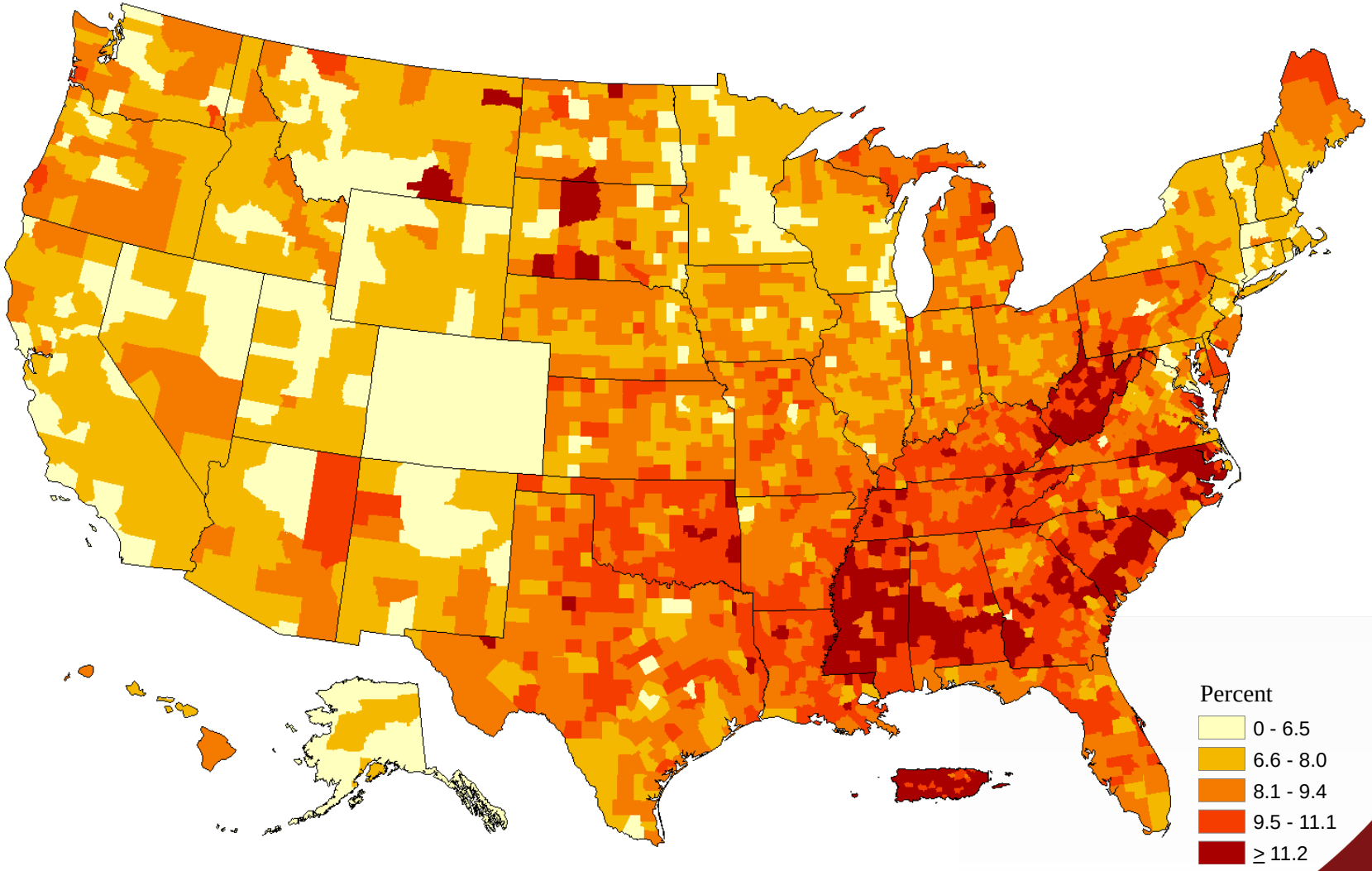

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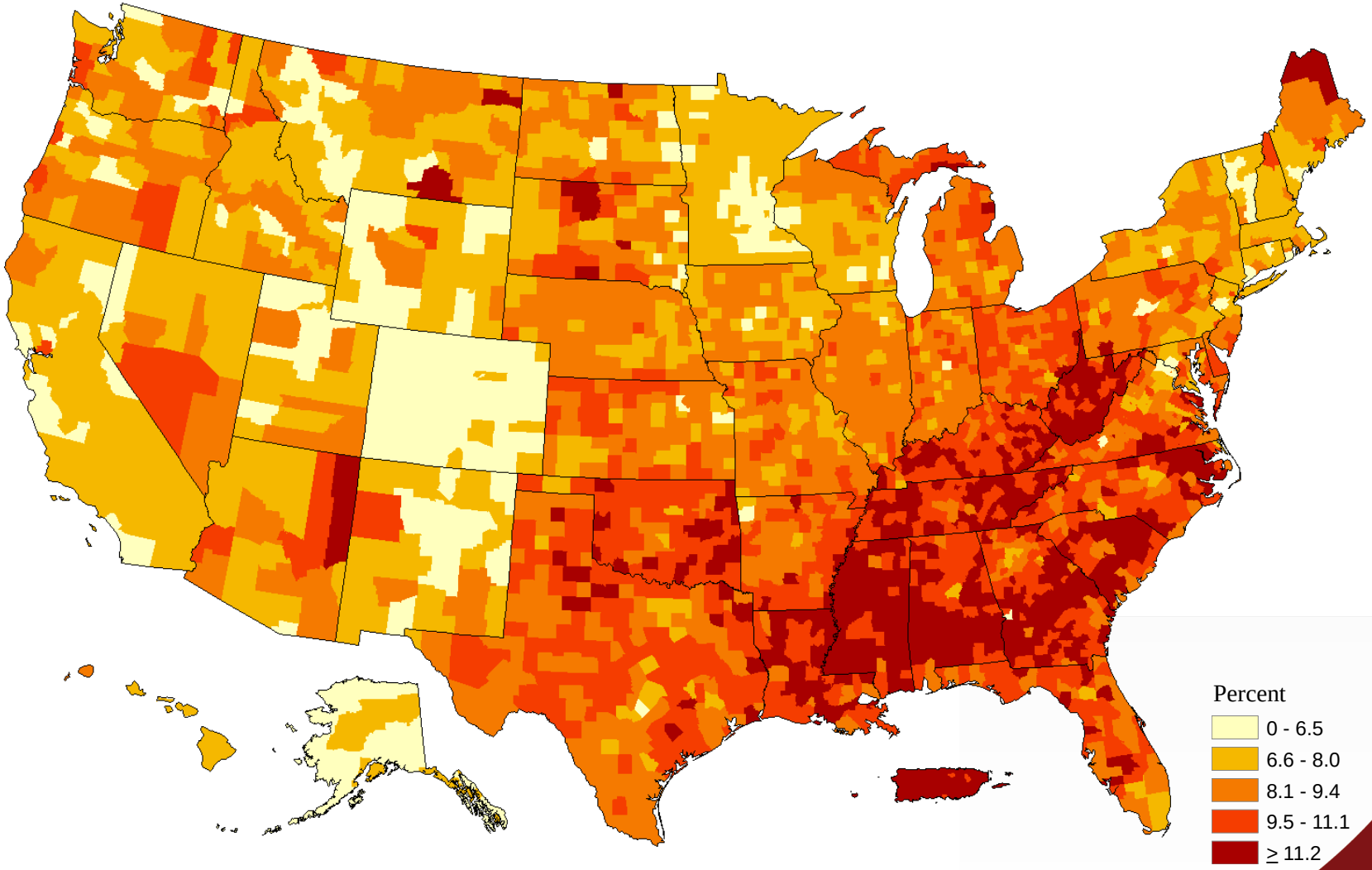
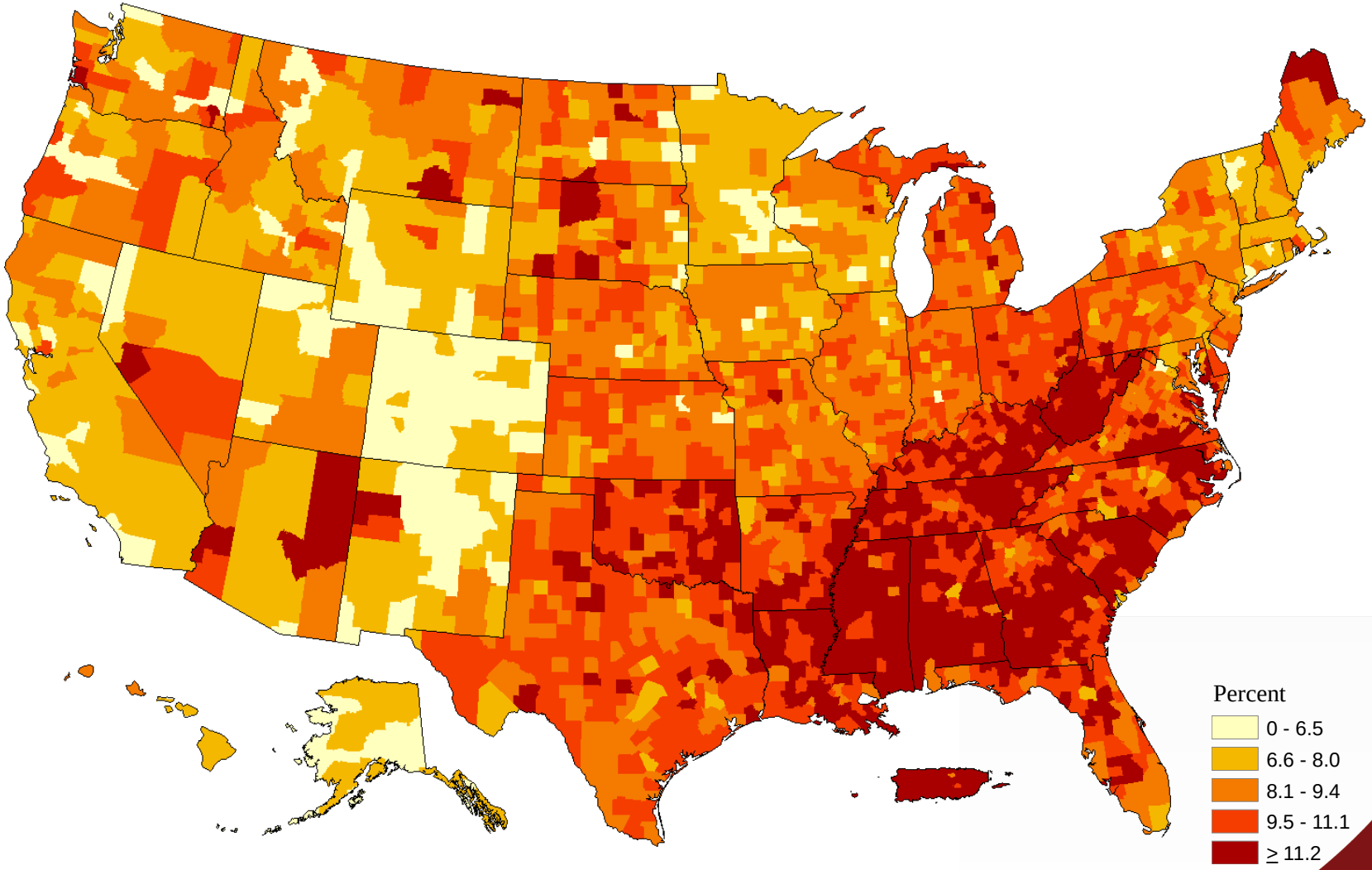
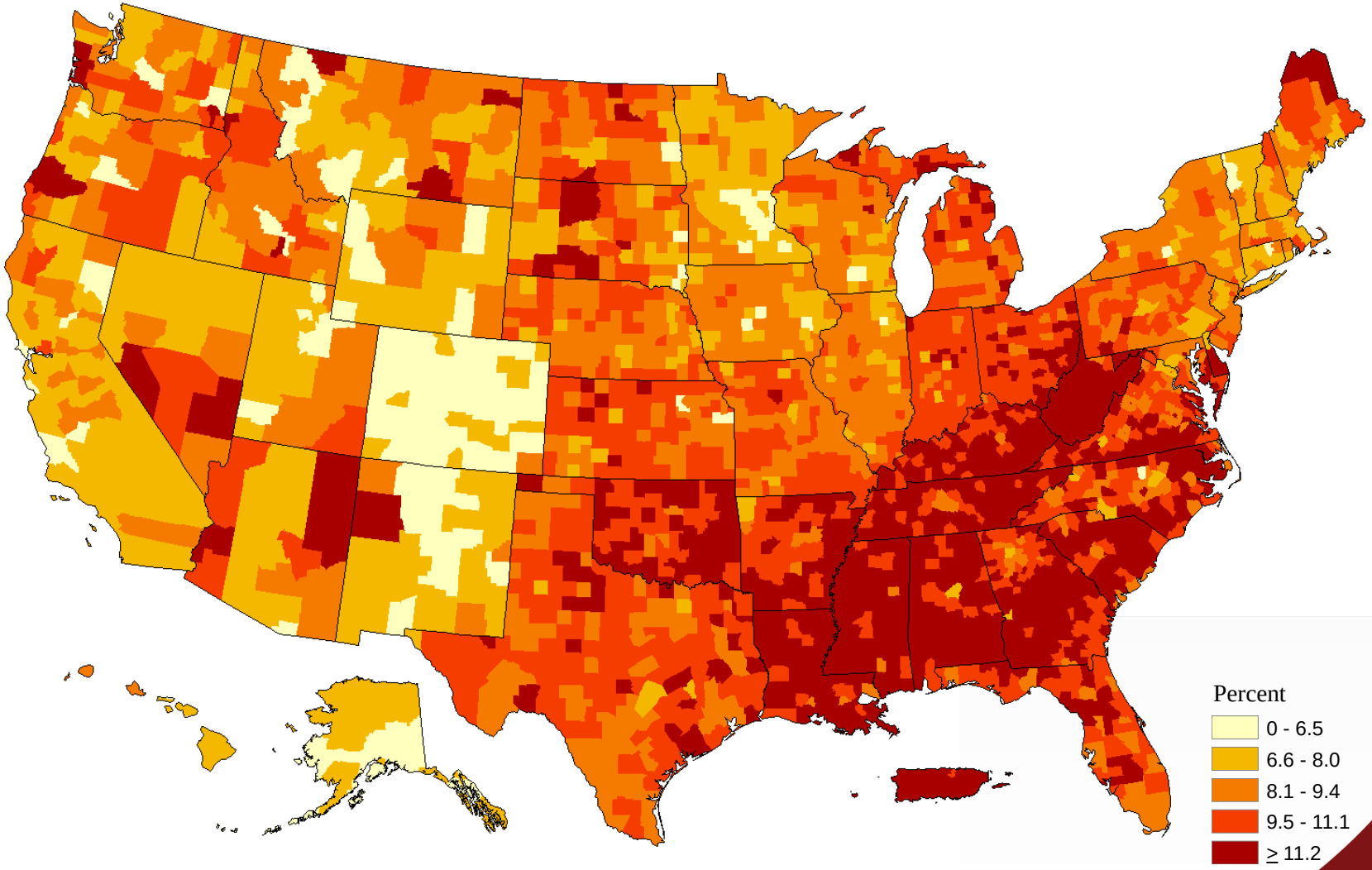


County-level Estimates of Diagnosed Diabetes among Adults aged ≥ 20 years: United States 2007



www.cdc.gov/diabetes

County-level Estimates of Diagnosed Diabetes among Adults aged ≥ 20 years: United States 2008



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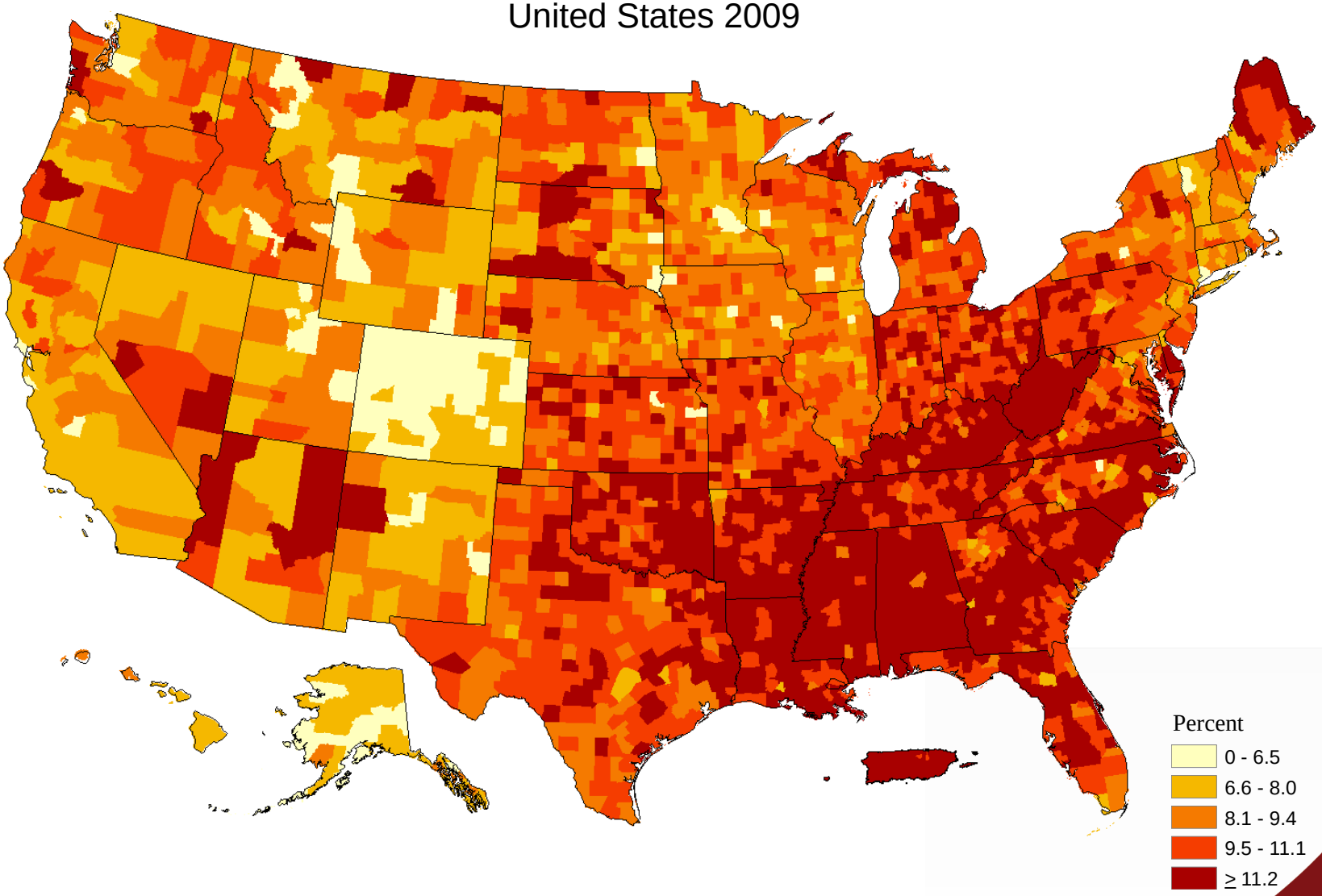
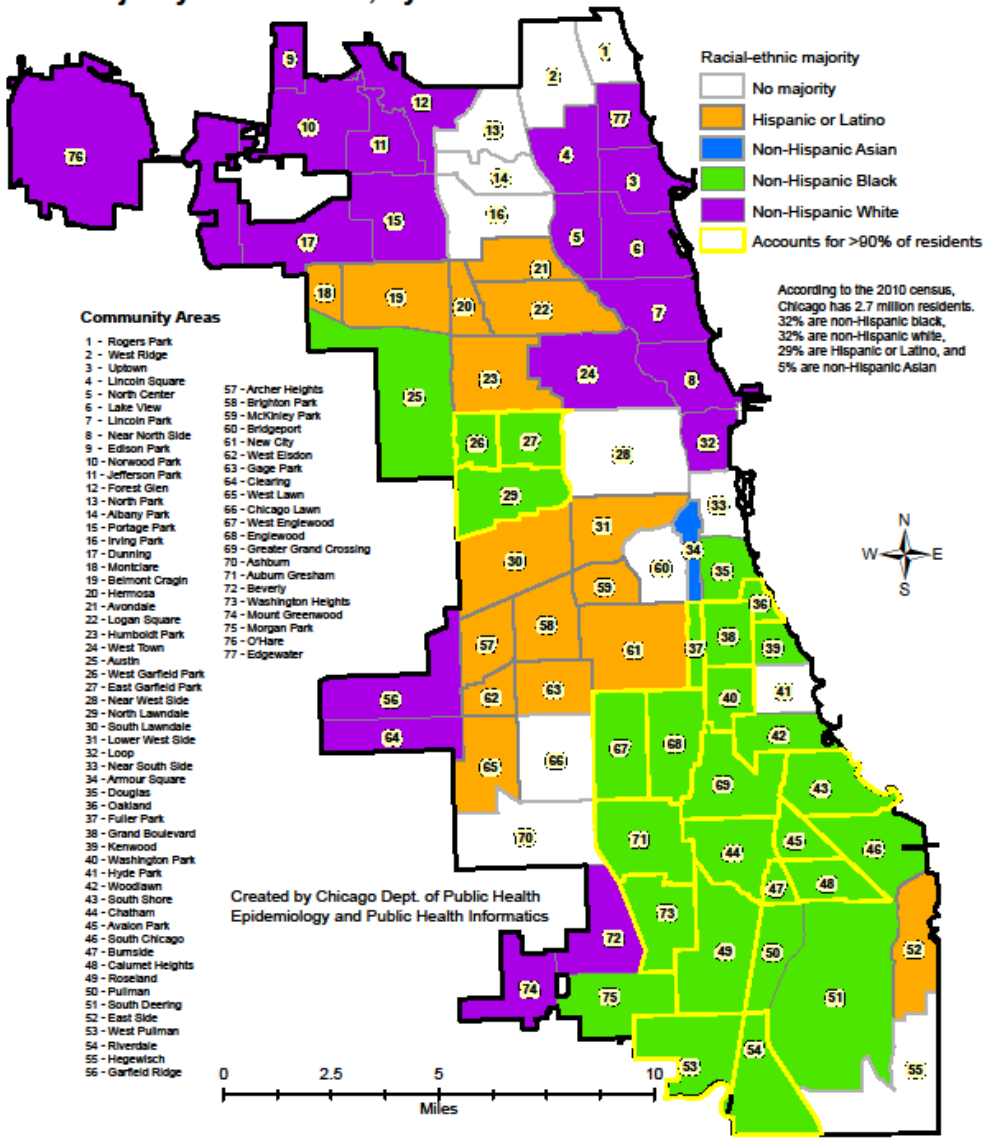
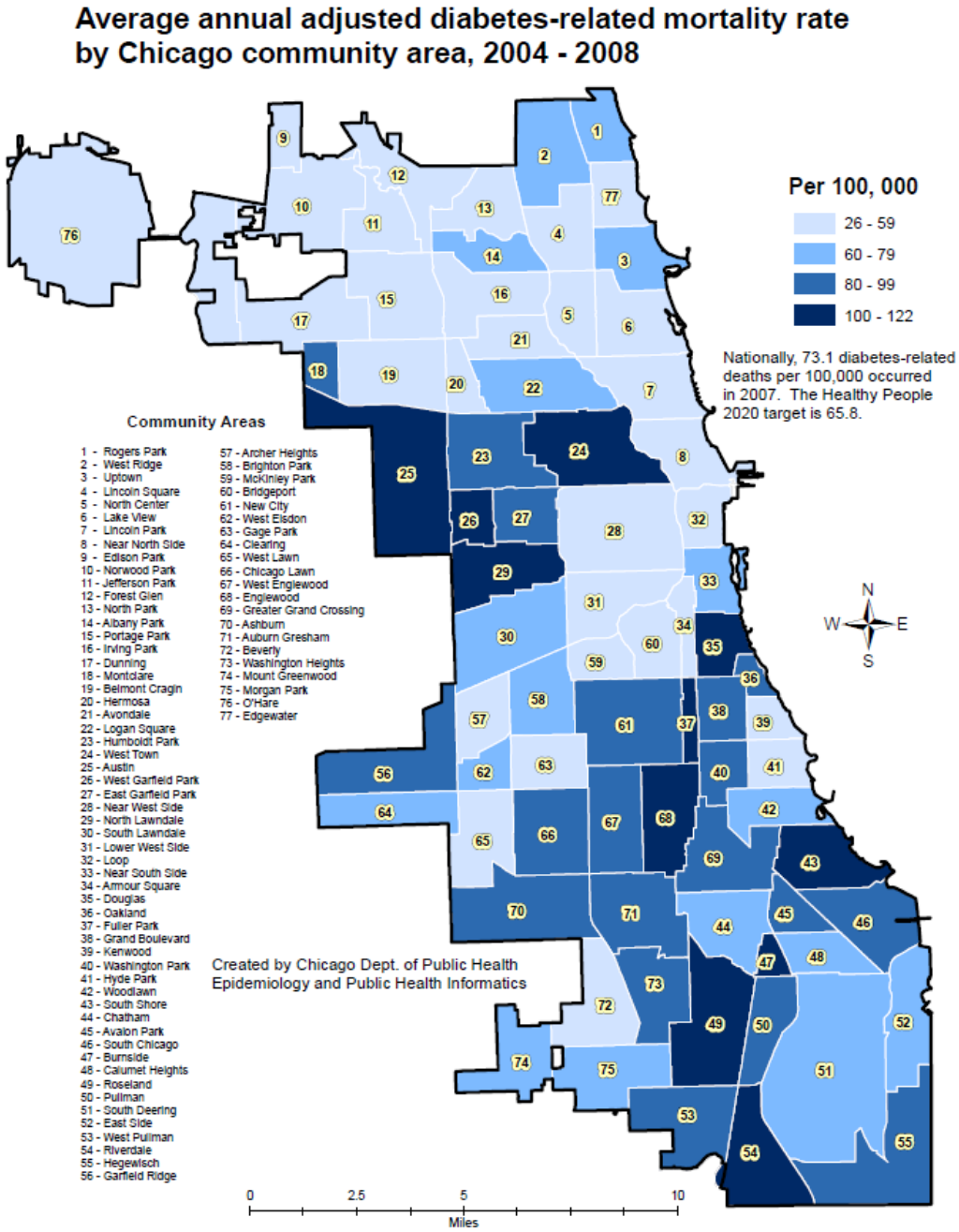
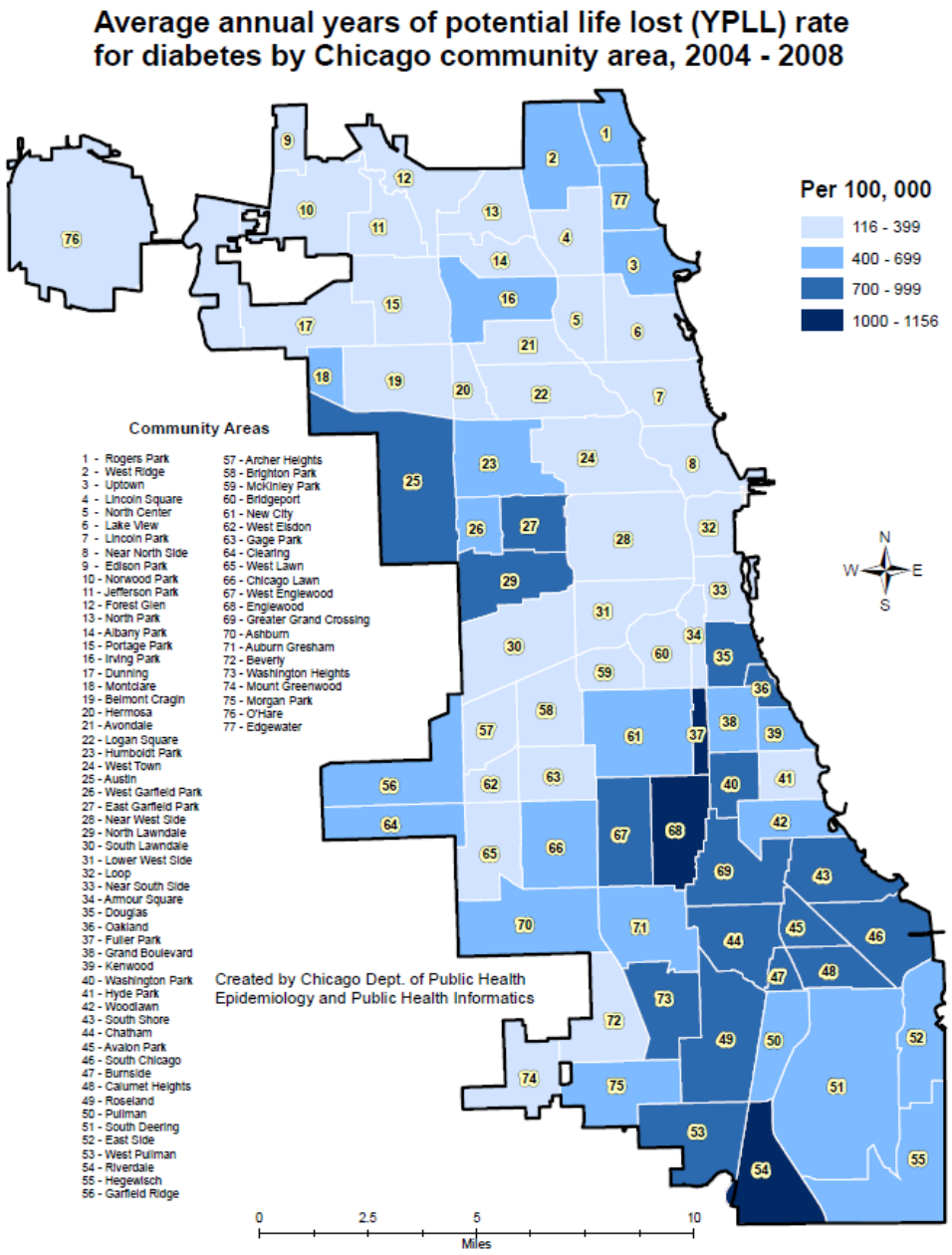


Chicago community areas by the racial-ethnic group that accounts for a majority of residents, by 2010 U.S. Census counts

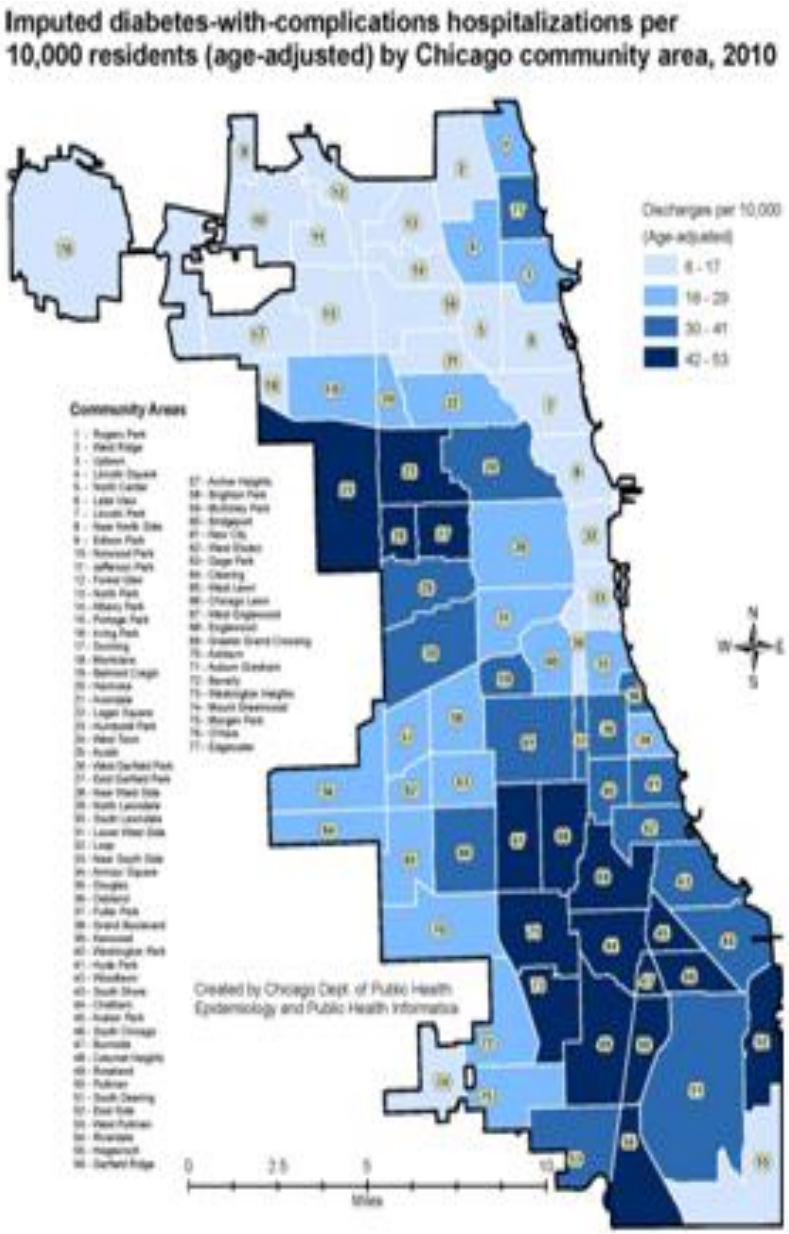




Diabetes mortality in Chicago

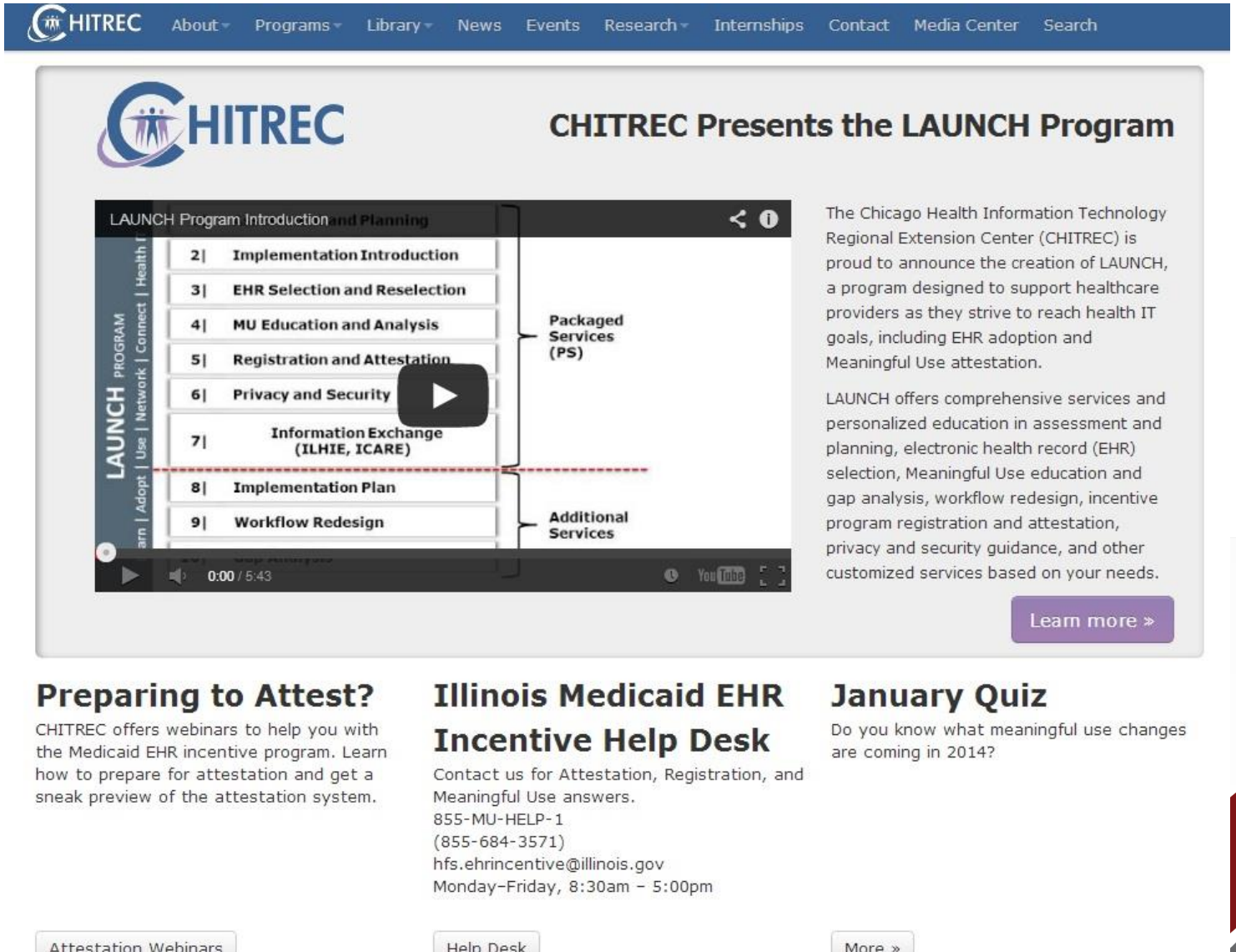


Potential years of life lost in Chicago



Avoidable diabetes-related hospitalizations

Health Information Exchanges



CommunityRx: Healthe*R*x

The South Side is talking about MAPSCorps and HealtheRx

Patients and Neighbors

"The community expert will know where to send me."

"Because these places are all located near me, they'll be easy to get to."

"The **Healthe*Rx*** will be helpful between doctor visits to know where services are in the community."

What is MAPSCorps?

- It is an innovative youth employment program that trains local high school students to map businesses and organizations on the South Side of Chicago
- Youth gain hands-on field experience that prepares them for future jobs and higher education, especially in health, science, technology, engineering and math
- Data are available at SouthSideHealth.org and DondeEsta.org (Spanish)

What is HealtheRx?

- It is a list of resources targeted toward a patient's specific health and wellness needs and located near his or her home
- **Healthe*Rx*** serves patients in 11 zip codes, through two emergency departments at the University of Chicago Medical Center as well as three local health centers: Komed Holman, Friend Family, and Chicago Family
- More zip codes and health centers will be added as we expand the program

How does HealtheRx help people?

- Every **Healthe*Rx*** is designed to help patients find the resources they need to improve their health, live independently, and manage disease
- Patients and caregivers who use services on the **Healthe*Rx*** also stimulate local business and help strengthen their communities

Local Health Providers

Healthe*Rx* is a true community partnership and a solution that benefits everyone. Together, we can significantly improve health, health care, and strengthen our communities at the same time.

Doriane Miller, MD
Associate Professor of Medicine
Director, Center for Community Health and Vitality

As a doctor who treats patients on the South Side every day, I need **Healthe*Rx***. This new kind of 'prescription' goes beyond a diagnosis and medicine. It provides personalized information and support from community resource specialists to help patients stay healthy between clinic visits.

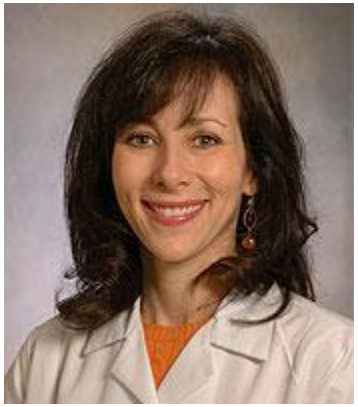
Tim Long, MD
Physician, Komed Holman Health Center

"Fill your prescription! Lose weight! Eat healthier! Stop Smoking!' All day long, we tell patients what we think they should do to be healthier, but we fail to make the connections to places and services they can use to stay well, live independently, and manage with disease. **Healthe**Rx is the connection between health care and self-care.

Stacy Lindau, MD, MAPP
Associate Professor of Ob/Gyn and Medicine-Geriatrics
Project Director, CommunityRx

For more information call **(773) 834-2356** or visit **www.healtherx.org**

MAPSCorps and **Healthe*Rx*** are innovations from CommunityRx, a flagship program of the South Side Health and Vitality Studies at the University of Chicago Medicine's Urban Health Initiative. CommunityRx is supported by grant #1CICMS330997-02-00 from the Department of Health and Human Services, Centers for Medicare and Medicaid Services. Its contents are solely the responsibility of the authors and have not been approved by the Department of Health and Human Services, Centers for Medicare and Medicaid Services.

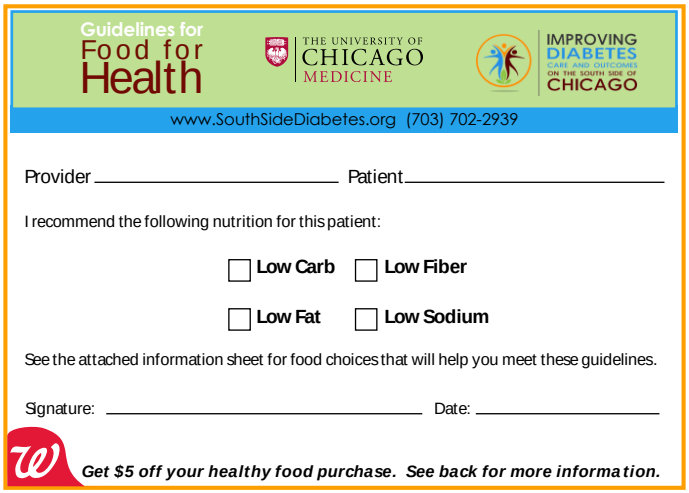


Stacy Lindau, MD, MA

IMPROVING DIABETES CARE AND OUTCOMES ON THE SOUTH SIDE OF CHICAGO

Prescriptions for Food and Exercise

- Chicago Park District
- Walgreens
- Farmer's Market
- Food Depository


Guidelines for Food for Health

THE UNIVERSITY OF CHICAGO MEDICINE

IMPROVING DIABETES CARE AND OUTCOMES ON THE SOUTH SIDE OF CHICAGO

www.SouthSideDiabetes.org (703) 702-2939

Provider _____ Patient _____

I recommend the following nutrition for this patient:

☐ Low Carb ☐ Low Fiber

☐ Low Fat ☐ Low Sodium

See the attached information sheet for food choices that will help you meet these guidelines.

Signature: _____ Date: _____

Get $5 off your healthy food purchase. See back for more information.


Walgreens

Present this Coupon to your pharmacist to receive

$5 OFF your purchase of $20 or more of healthy food

Participating Chicago Locations

- ☐ 1213 W. 79th St. (79th St. & Racine Ave.) (773) 651-2118
- ☐ 5036 S. Cottage Grove Ave. (Cottage Grove Ave. & 51st St.) (773) 373-6266
- ☐ 8636 S. Ashland Ave. (Ashland Ave. & 87th St.) (773) 238-1268
- ☐ 650 W. 63rd St. (63rd St. & Halsted Pkwy.) (773) 994-4467
- ☐ 2015 E. 79th St. (79th St. & Jeffrey Blvd.) (773) 734-2492
- ☐ 2924 E. 92nd St. (92nd St. & Commercial Ave.) (773) 721-6603
- ☐ 1533 E. 67th Place (67th Pl. & Stony Island Ave.) (773) 493-0733

Limit one coupon per customer per offer. Offer expires September 30, 2012. Manufacturer coupon only good at Walgreens. Not valid with any other offer. Customer pays any sales tax. Void if copied or where prohibited.

Goddu AP et al. Food Rx: A Community-University Partnership to Prescribe Healthy Eating on the South Side of Chicago. J Prev Interv Community. In press.

Food Rx: Farmer's Market partnership

IMPROVING DIABETES CARE AND OUTCOMES ON THE SOUTH SIDE OF CHICAGO

Food Rx: Farmer's Market partnership

IMPROVING DIABETES CARE AND OUTCOMES ON THE SOUTH SIDE OF CHICAGO

Challenge

- Leveraging “big data” at zipcode level

Challenge

- Leveraging “big data” at zipcode level
- Meaningful at community level

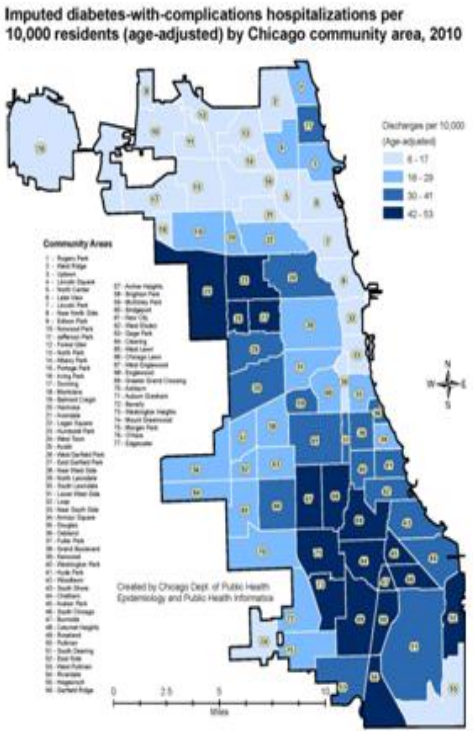
Solution

- Leveraging “big data” at zipcode level

  ⬇ Dasymetric Areal Interpolation

- Meaningful at community level

Chicago Public Health Department Collaboration



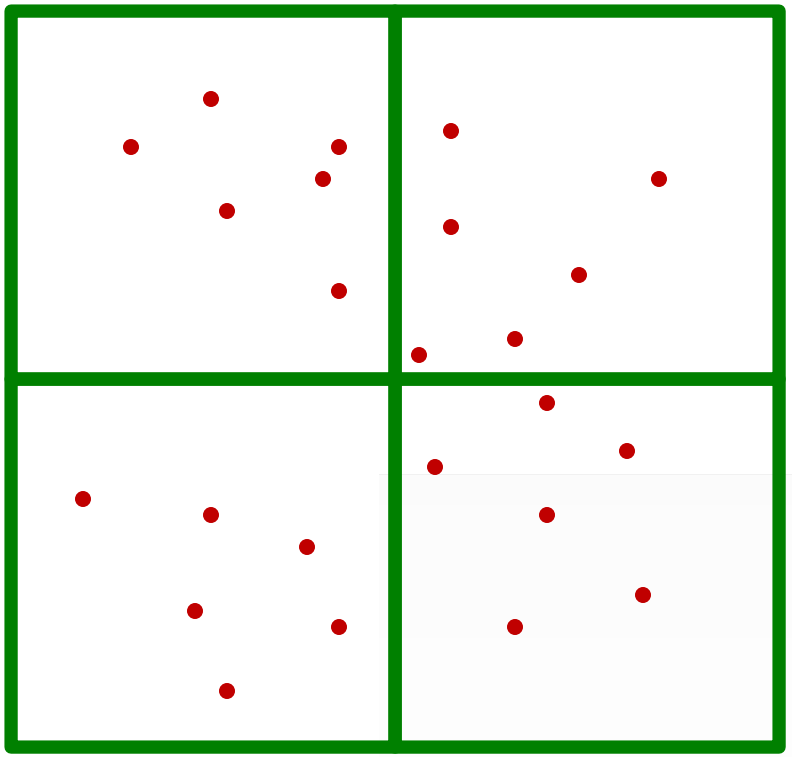
- Problem
- Methods
- Validation
- Conclusions

Challenge: "Modifiable Areal Unit Problem"

- Context: Public Health indicators in Chicago
- Research Question: What is the community-level variation in diabetes-related hospitalizations?
- Trial of dasymetric areal interpolation method

MAUP: Same Total, Different Aggregates

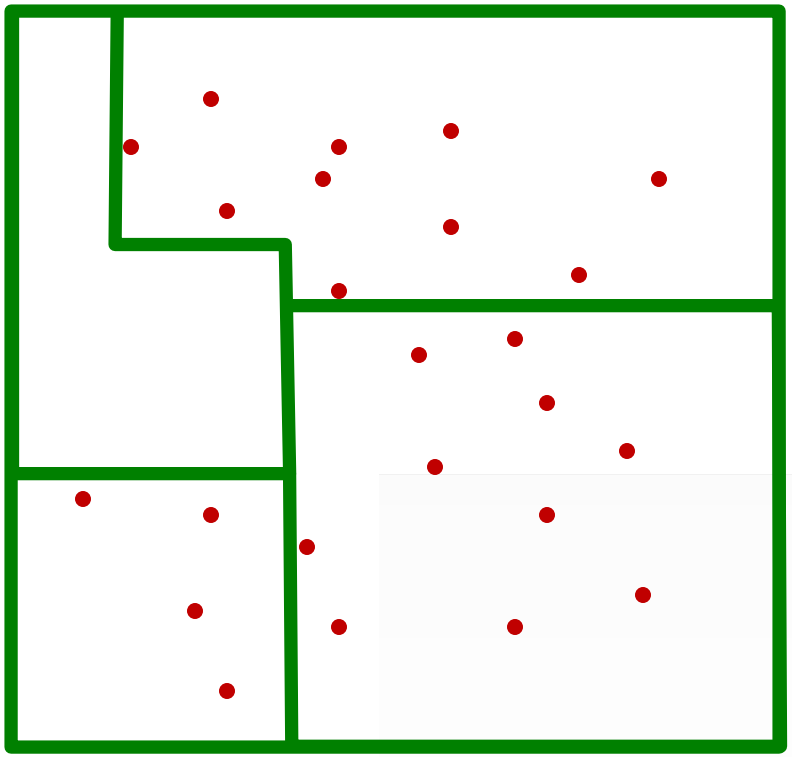
- MAUP
  - Modifiable Areal Unit Problem
- Interpretation of results can change depending on the choice of boundary



Total N=24

MAUP: Same Total, Different Aggregates

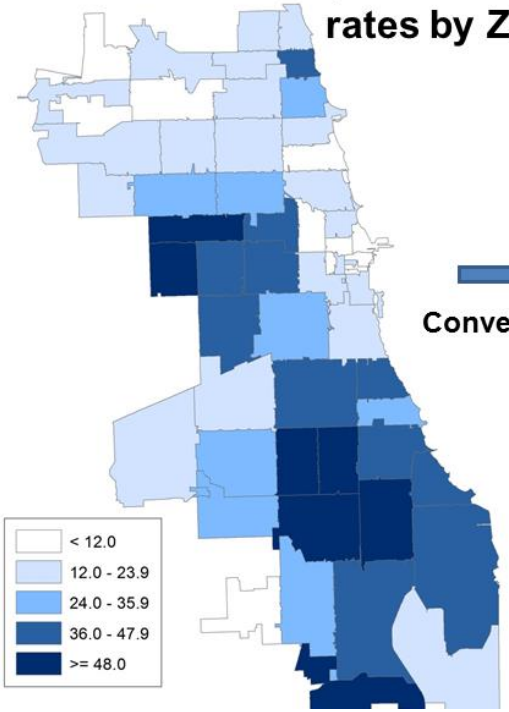
- MAUP
  - Modifiable Areal Unit Problem
- Interpretation of results can change depending on the choice of boundary



Total N=24

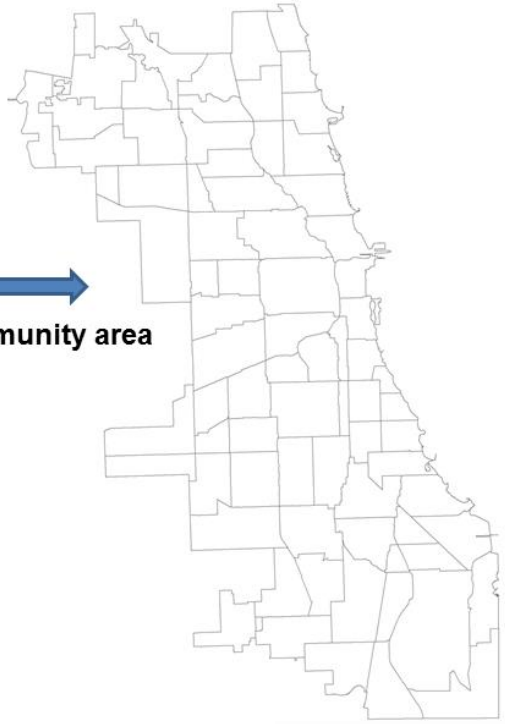
Starting point

Diabetes hospitalization rates by ZIP

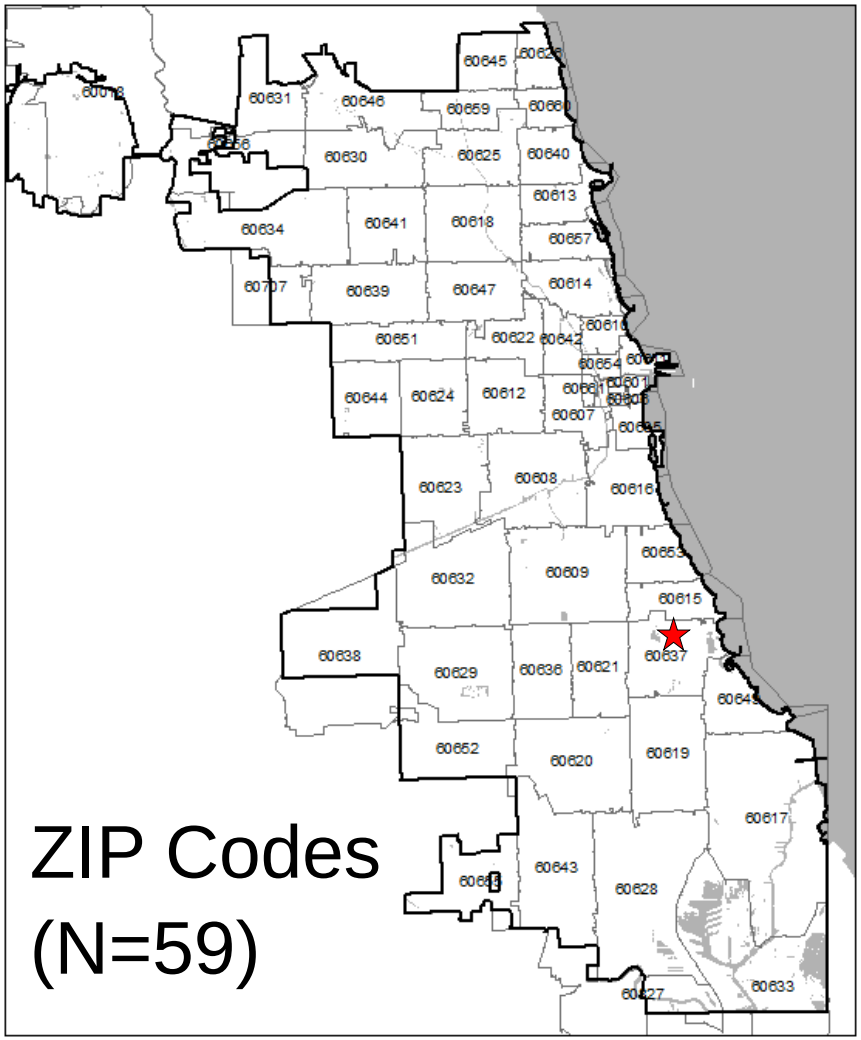


Convert to community area

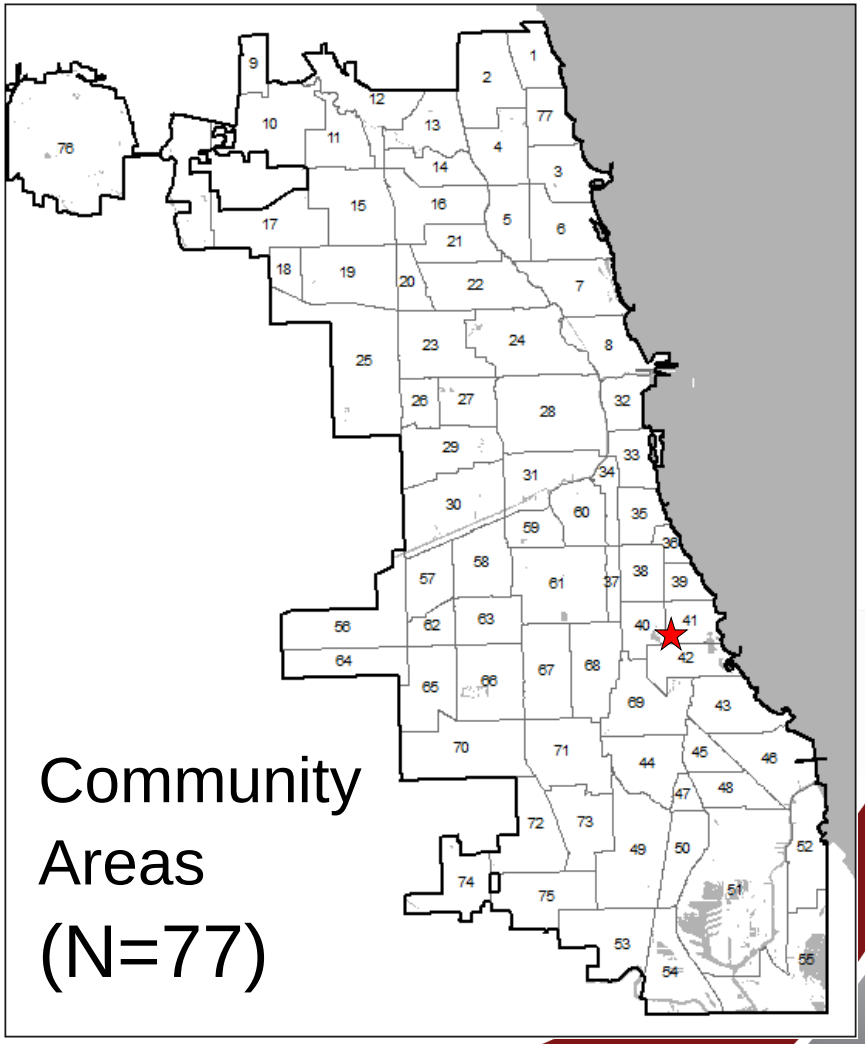
HEALTHY CHICAGO
CHICAGO DEPARTMENT OF PUBLIC HEALTH



ZIP Code & Community Areas



ZIP Codes
(N=59)



Community
Areas
(N=77)

ZIP Code & CA are simliar

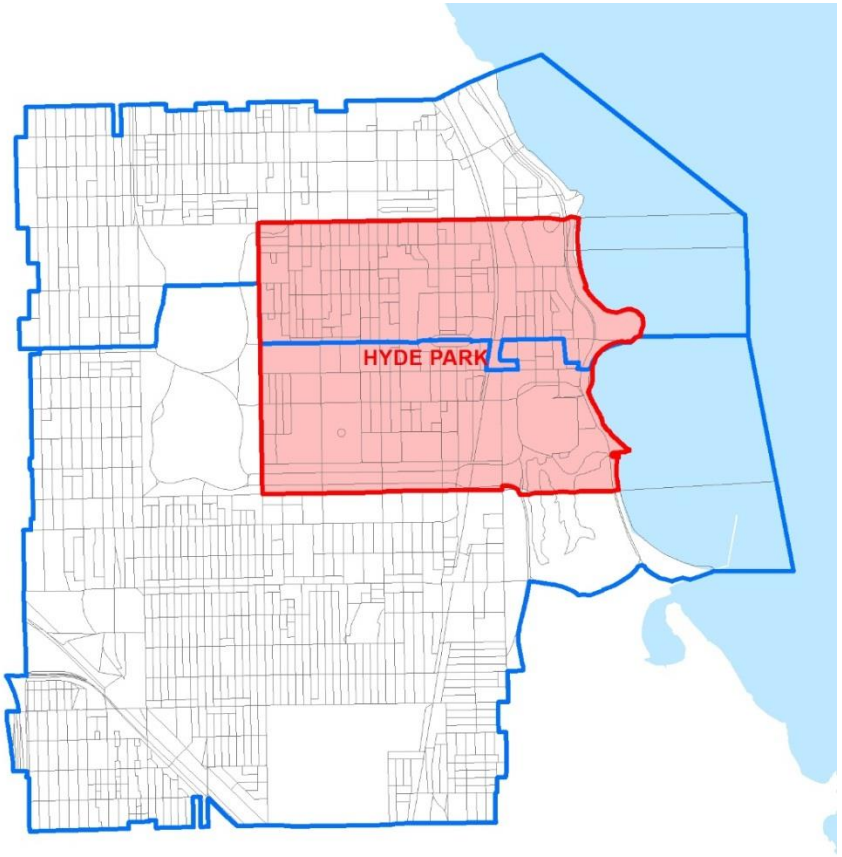
	ZIP Codes (ZCTAs)			Community Areas		
	(N=59)			(N=77)		
	Range	Mean	CV	Range	Mean	CV
Area (square miles)	0.09 – 16.60	4.43	77.8	0.61 – 13.34	3.00	65.7
2010 Population	493 – 133,916	47,143	56.5	2,876 – 98,514	35,008	63.9

* CV (Coefficient of variation) = the smaller, the less variability

Sources: 2010 US Census, the City of Chicago

Blocks are constituents of both Community Areas and ZIP Codes

ZIP Codes over Hyde Park



Why Dasymetric Areal Interpolation?

- **Geographical unit discrepancies**:
  - In Illinois, hospital discharge data comes with **5-digit ZIP Code** only as patient address.
  - In Chicago, summary statistics are tabulated by **Community Areas** (i.e. Chicago neighborhoods).

- **Our solution**:
  - Estimate community level **hospital discharge rate** by allocating the # of discharges of a given ZIP Code to overlapping communities based on **proportions of population** and by ancillary information*.

* Ancillary information used was gender, race and age group

Dasymetric Interpolation Procedure (Stage 1)

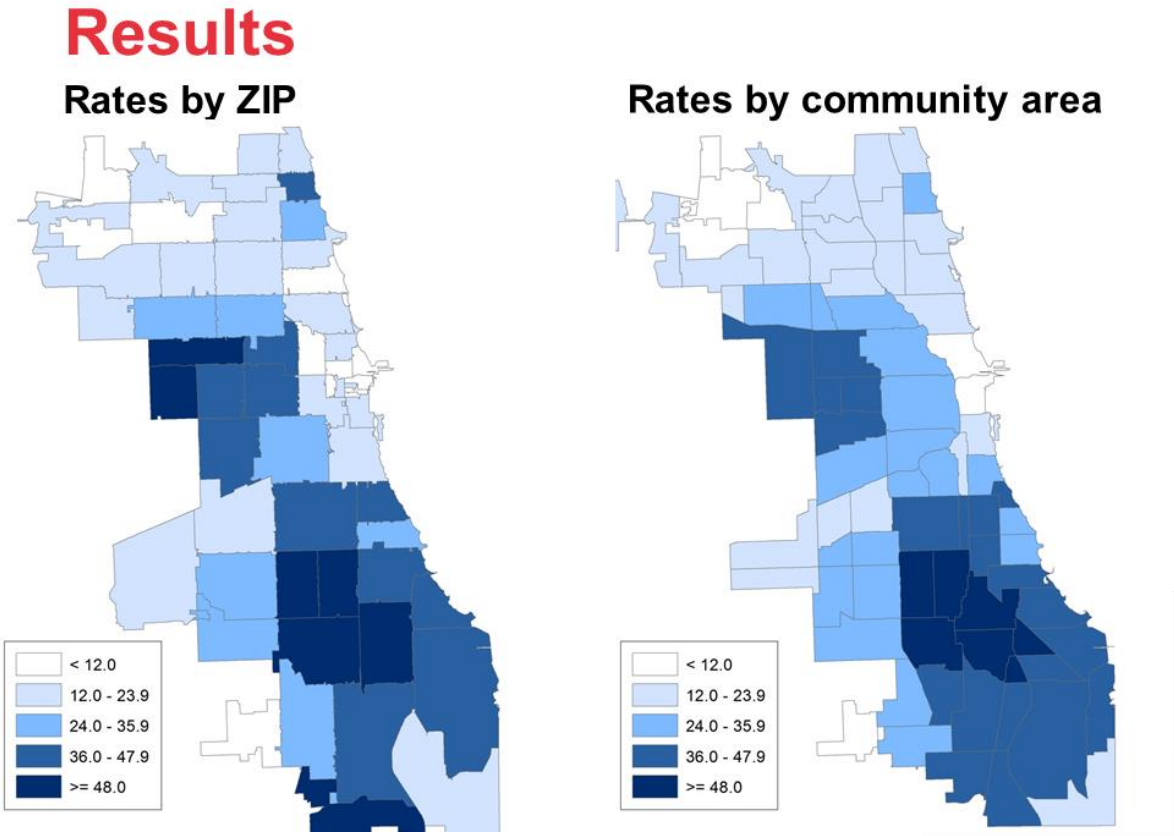
1. Calculate for each ZIP code: male & female x 19 age groups x 4 race-ethnicity groups = 84 age-sex-race-specific rates

2. Apply rates to corresponding population for age-sex-race group in each census block to get case counts

3. Sum counts for each community area by age group

4. Calculate crude and adjusted rates

Results


Results
Rates by ZIP
< 12.0
12.0 - 23.9
24.0 - 35.9
36.0 - 47.9
>= 48.0
Rates by community area
< 12.0
12.0 - 23.9
24.0 - 35.9
36.0 - 47.9
>= 48.0

Results

Actual vs. Interpolated

HEALTHY CHICAGO
CHICAGO DEPARTMENT OF PUBLIC HEALTH

	ZIP Codes (N=58)		Community Areas (N=77)	
	Range	Median	Range	Median
Discharges	0 – 393	109	12 – 462	76
Crude rate (per 10,000)	0 – 57	18	7 – 58	26
Adjusted rate* (per 10,000)	0 – 57	19	9 – 56	29

*Adjusted to the 2000 U.S. Standard Population using four age groups (0–44, 45–64, 65–74, 75+).

Methodological Validation

- Need for validation study using case data geocoded to community area
- Plan:
  - Obtain raw hospital discharges from a single Chicago hospital (UCM)
  - Compared the actual discharge rates to the estimated discharge rates from the dasymetric areal interpolation method Evaluation measure:
  - Statistical significance test:
    - One-tailed Chi-square test ($p < 0.05$)

Data: Validation Study

1. Univ. of Chicago Medicine Hospital Discharges
   - 84,942 cases
     - All discharges (patients), not just diabetes
     - From all departments within the UC Medical Center
   - Date range (1/1/2009-12/31/2011)
     - By discharge date
     - 2009 (n=29,239), 2010 (n=27,649), 2011 (n=28,054)
   - Variables
     - Location: residential street address
     - Demographic: DOB (age), sex, race, ethnicity
     - ICD-9 Diagnosis code (up to 10 per discharge)

Data: Validation Study

2. 2010 Census TIGER/Line Shapefiles
   - http://www.census.gov/geo/maps-data/data/tiger.html
   - Census blocks
   - Census ZCTAs (ZIP Code Tabulation Areas)
3. 2010 Census summary file 1 (block-level, i.e. sumlevel=101)
   - http://www2.census.gov/census_2010/04-Summary_File_1/
   - Sex by age (P012), sex by age by race (P012H&I)
     - Race: NH White, Hispanic, others (= Total – NHW – Hisp.)
4. Chicago community area boundary file
   - https://data.cityofchicago.org/

Identified Data Issues

1. UC Medical Center discharge data
   - Missing values
     - age & sex (0.1%) -> excluded
     - race/ethnicity (13.9%) -> treated as “others” category
     - DX (1.4%) -> excluded
2. 2010 Census TIGER/Line Shapefiles
   - ZCTAs (ZIP Code Tabulation Areas) are generalized ZIP Code zones. They may include addresses associated with ZIP Codes that are not the same as the ZCTA.
3. 2010 Census summary file 1 (block-level)
   - Inability to identify “NH African-American” (47% of discharges)
   - Swapping (statistical disclosure avoidance technique)
     - “A small sample of households” “were swapped with data from other households that had identical characteristics on a certain set of variables but were from different geographic locations.” https://www.census.gov/srd/papers/pdf/rrs2009-10.pdf

UCM Diabetes Discharges

- Patient addresses were geocoded:
  - Software/data: ArcGIS 10.2/ESRI StreeMap Premium
  - 98.3% were geocoded at street address level.
  - Chicago residency, ZIP Code & Community Area were determined based on geocoded location.
- Diagnosis code selection:
  - Diabetes (ICD-9 250.x) discharges only.
- Result:
  - Chicago diabetes discharges with valid variables.
  - Total 6,534 discharges.

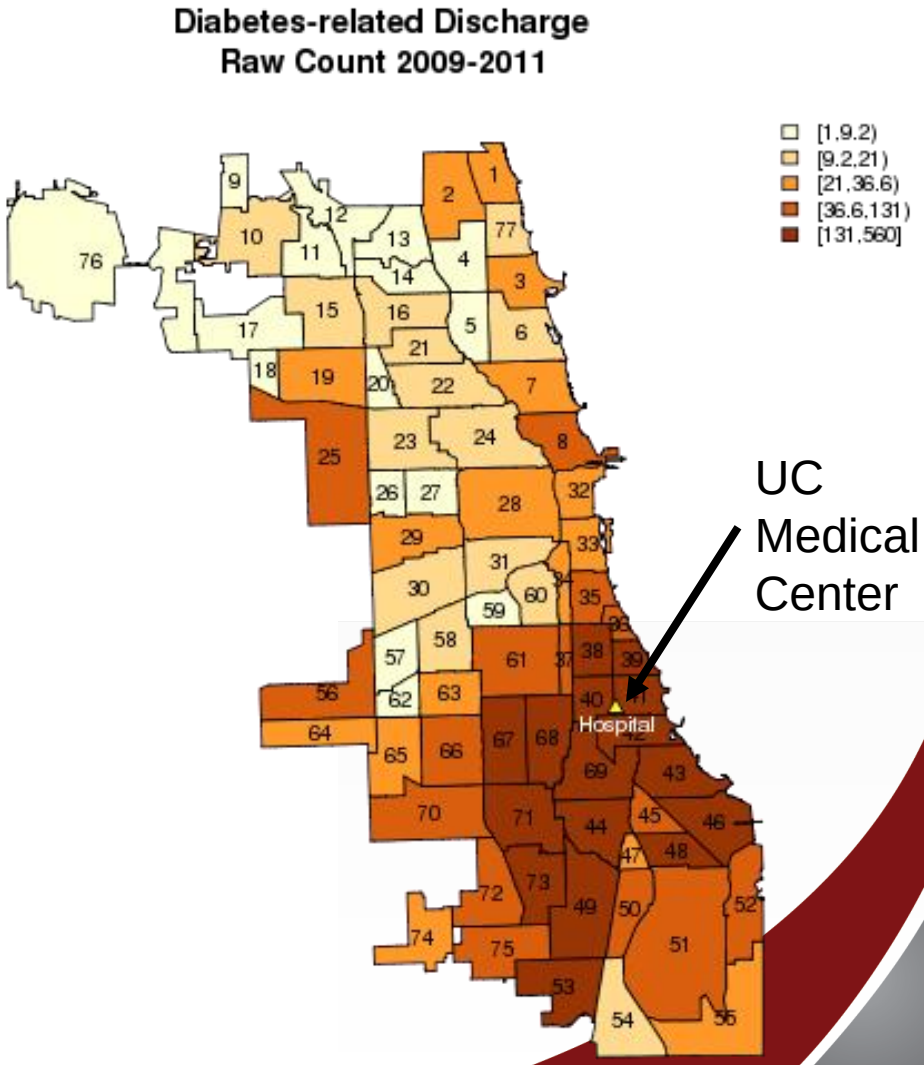
UCM Diabetes Patients: Sociodemographic Characteristics

	Total	NH White	Hispanic	Others
	(n=6,534)	(n=461)	(n=287)	(n=5,786)
All (%)	100%	7%	4%	89%
Male	2,581	279	167	2,135
Female	3,953	182	120	3,651
Age (mean, SD)	61 (17)	64 (16)	62 (16)	61 (17)
Distance Miles (mean, SD)	3.83 (3.08)	7.3 (4.84)	7.14 (2.98)	3.39 (2.59)
Length of Stay (mean, SD)	4.33 (5.27)	4.44 (5.37)	4.18 (4.48)	4.33 (5.29)

Note: Patients might be repeated if they were hospitalized more than once, as our unit of analysis is a discharge, not a patient. Distance is a direct distance between patients' residence and the UC Medical Center and measured in miles.

Diabetes Discharges Results

- Number of diabetes discharges by Chicago community areas.
- N=6,534
- Color in quintiles
- Patients are mostly from the Southside.



Interpolation: Step 1

- Start with a Census block data table with population & discharge counts by race, sex and age group
- Calculate ZIP Code level discharge rate by race, sex and age group.
  - Rate (weight) = Discharge # / Population for the ZIP/age/race/sex group

ZIP Code	Race	Sex	Age group 1	Discharges	Population	Rate (weight)
60637	NH White	Female	35-44	33	2517	0.01311

Interpolation: Step 2

- Transfer the ZIP Code level discharge rate to the Census block table to estimate (interpolate) the number of discharges at the census block level by race, sex and age group.
  - Dasymetric count = Rate (weight) x Population

ZIP Code	Block	Community	Race	Sex	Age group 1	Population	Rate (weight)	Dasymetric count
60637	0364001007	Hyde Park	NH White	Female	35-44	3	0.01311	0.03933

Interpolation: Step 3

- Aggregate the block level estimated discharges for all population (i.e. removing race, sex and age categories, except for four age categories for the subsequent age-adjustment) at a community level.
- Calculate crude discharge rates
  - Rate = Dasymetric count / Population
  - (Need to be age-adjusted next!)

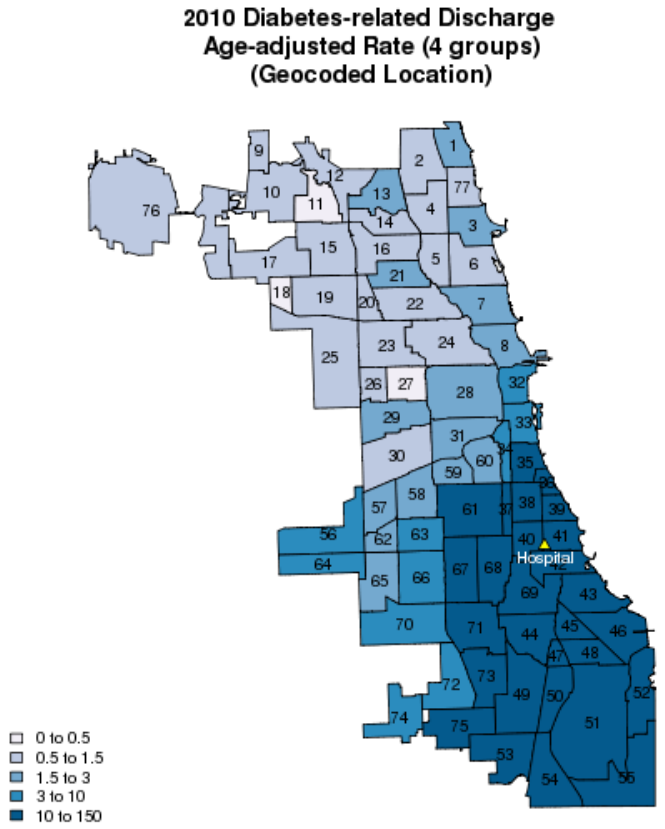
Community	Age group 2	Population	Dasymetric count	Rate
Hyde Park	0-44	10168	295	0.02901

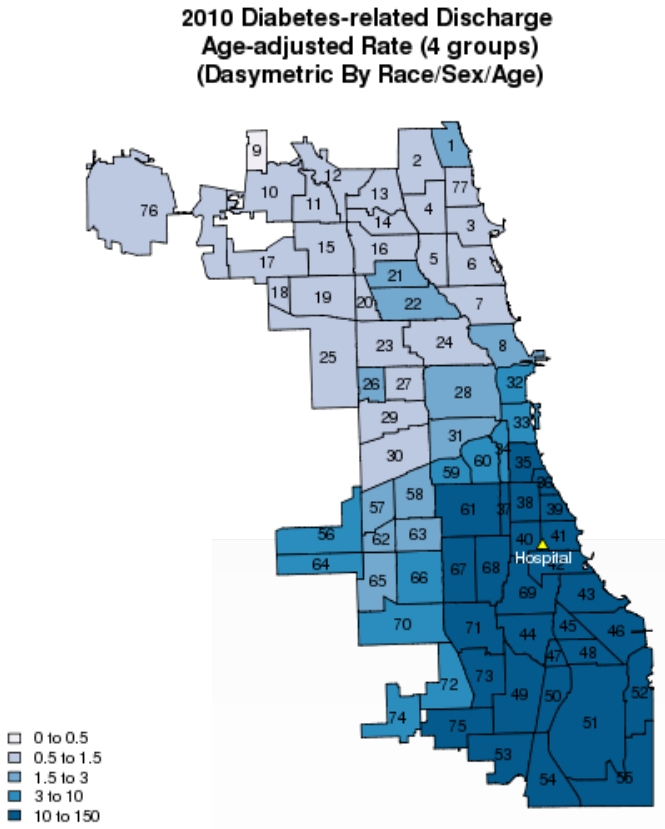
Interpolation: Step 4

- Adjust the crude discharge rates for age using the U.S. standard population

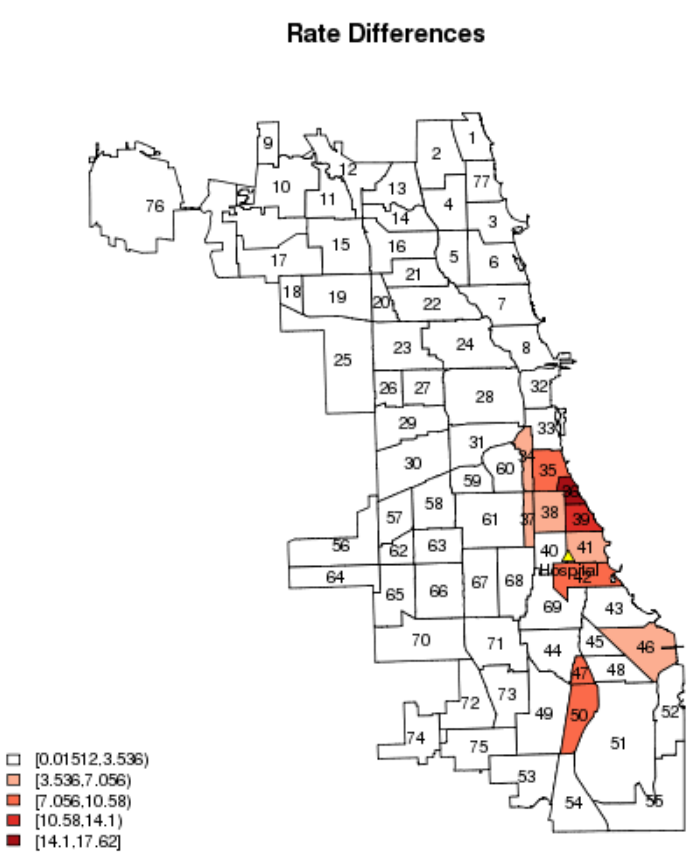
Community	Age-adjusted rate per 10,000 population
Hyde Park	47.26

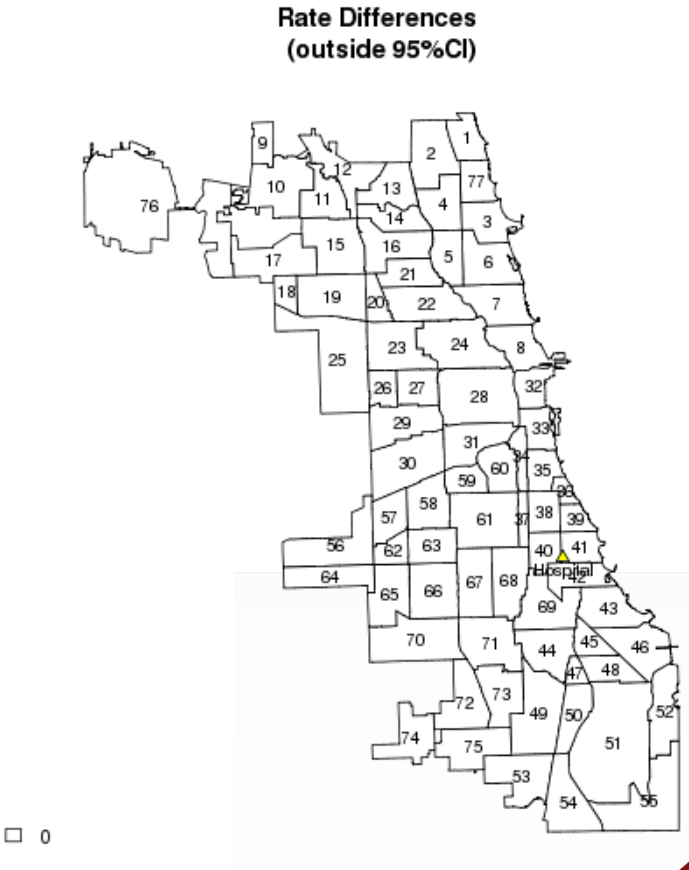
Actual (L) vs. Interpolated (R) Hospital Discharge Rates





Results: Differences





Validation Results

- An estimated 6,544 hospitalizations were calculated using the dasymetric method, for a difference of 10 persons.
  - Raw N=6,534
- Variation in actual vs. estimated discharge rates by neighborhoods were not statistically significant, $X^2(76, N=6,534) = 54$, $p=0.97$.

Conclusions

- Dasymetric Areal Interpolation an effective, validated approach
- Translate zipcode-level data to community-level data
- Inform local health policy and population health management

Acknowledgements

Co-Authors

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Supplemental Discussion

- In the racially diverse city, like Chicago, inclusion of race into calculation turned out to be crucial.
- To prove if inclusion of race in the method makes a difference we ran the same method using age and sex categories only.
- A measure we used for the comparison is root mean squared errors (RMSE) – see the next table.

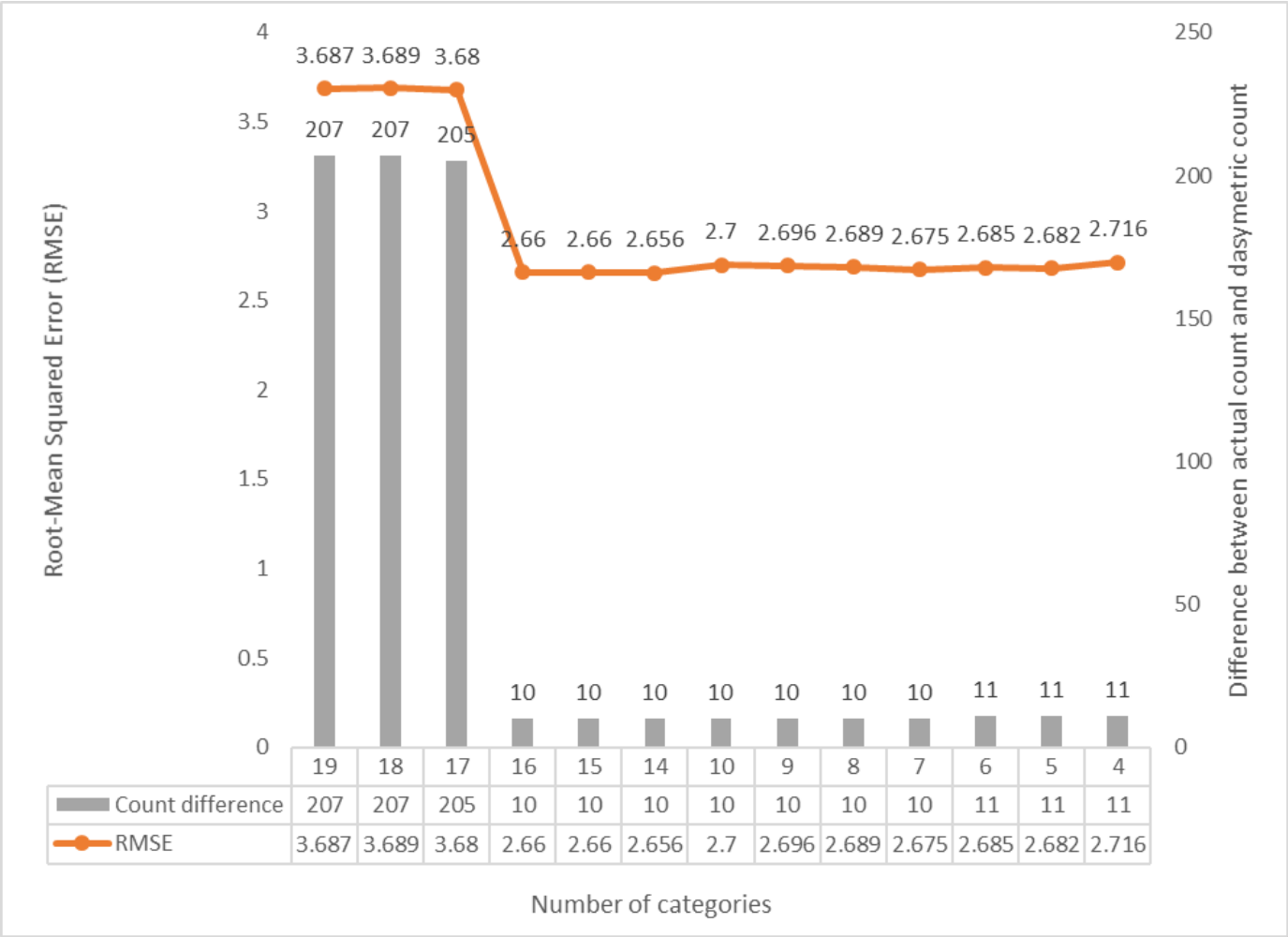
Results (supplement)

	Community Areas (N=77)		
	Range	RMSE	Number of communities*
Community age-adjusted rates	0.10-84.68	(N/A)	(N/A)
Dasymetric (age, sex, race)	0.39-74.63	2.66	0
Dasymetric (age, sex)	0.38-67.23	4.22	4

* * The number of communities whose estimated rates are statistically different from the actual/observed rates at 95% confidence level.

Supplement: How to “group” age

Error comparisons from different age group uses



Supplement: How to “group” age

Number of categories	Minimum Interval	Categories	RMSE	Count difference
19	5	0, 5, 10, 15, 18, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85+	3.687	207
18	5	0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85+	3.689	207
17	5	0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80+	3.680	205
16	5	0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75+	2.660	10
15	5	0, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75+	2.660	10
14	5	0, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75+	2.656	10
10	10	0, 5, 15, 25, 35, 45, 55, 65, 75, 85+	2.700	10
9	7	0, 18, 25, 35, 45, 55, 65, 75, 85+	2.696	10
8	10	0, 18, 30, 45, 55, 65, 75, 85+	2.689	10
7	10	0, 18, 30, 45, 55, 65, 75+	2.675	10
6	10	0, 18, 30, 45, 65, 75+	2.685	11
5	10	0, 18, 45, 65, 75+	2.682	11
4	10	0, 45, 65, 75+	2.716	11

14 = Applied # of age group