



The Spirit of Detroit

—Monument's Bronze Statue Created by **Marshall Fredericks**

https://en.wikipedia.org/wiki/The_Spirit_of_Detroit

https://commons.wikimedia.org/wiki/File:Spirit_Of_Detroit.jpg

Photo Taken By **Nicholas Domingo** on 24-July-2016.

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Detroit, Michigan: A Case Study for DEI via Decentralized Clinical Trials (DCTs)

06-November-2023

SA03

Mark Rothe, Johnson & Johnson (Janssen)

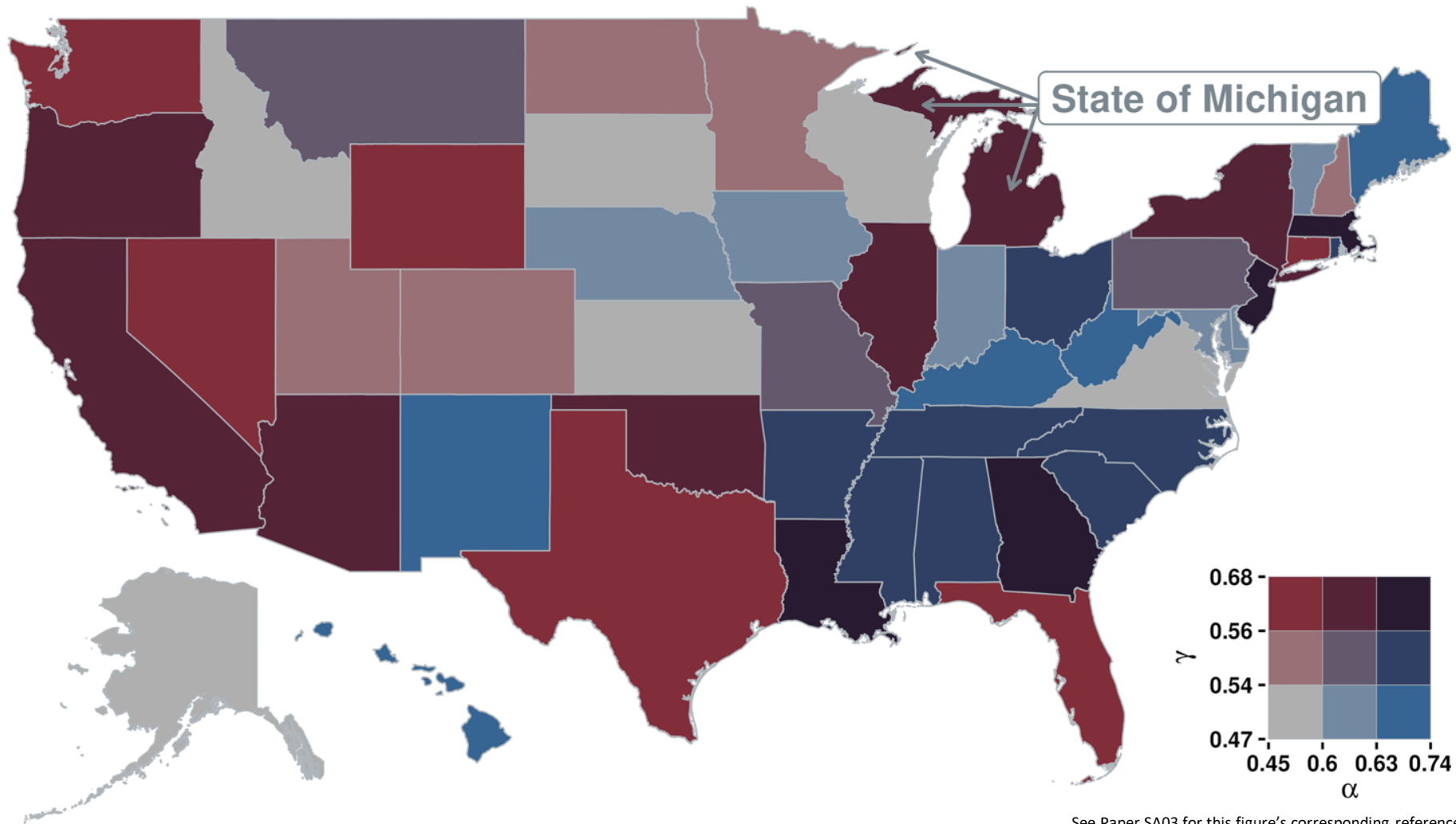
PHUSE Presentation Disclaimer: The ideas shared in Paper SA03 and its corresponding presentation **have not been officially endorsed by Johnson & Johnson or Janssen.** The ideas build on the slides presented by Axel Muehlig and Mark Rothe during the 2022 PHUSE US Connect's PHUSE/FDA Challenge.

Presentation “In a Nutshell”:

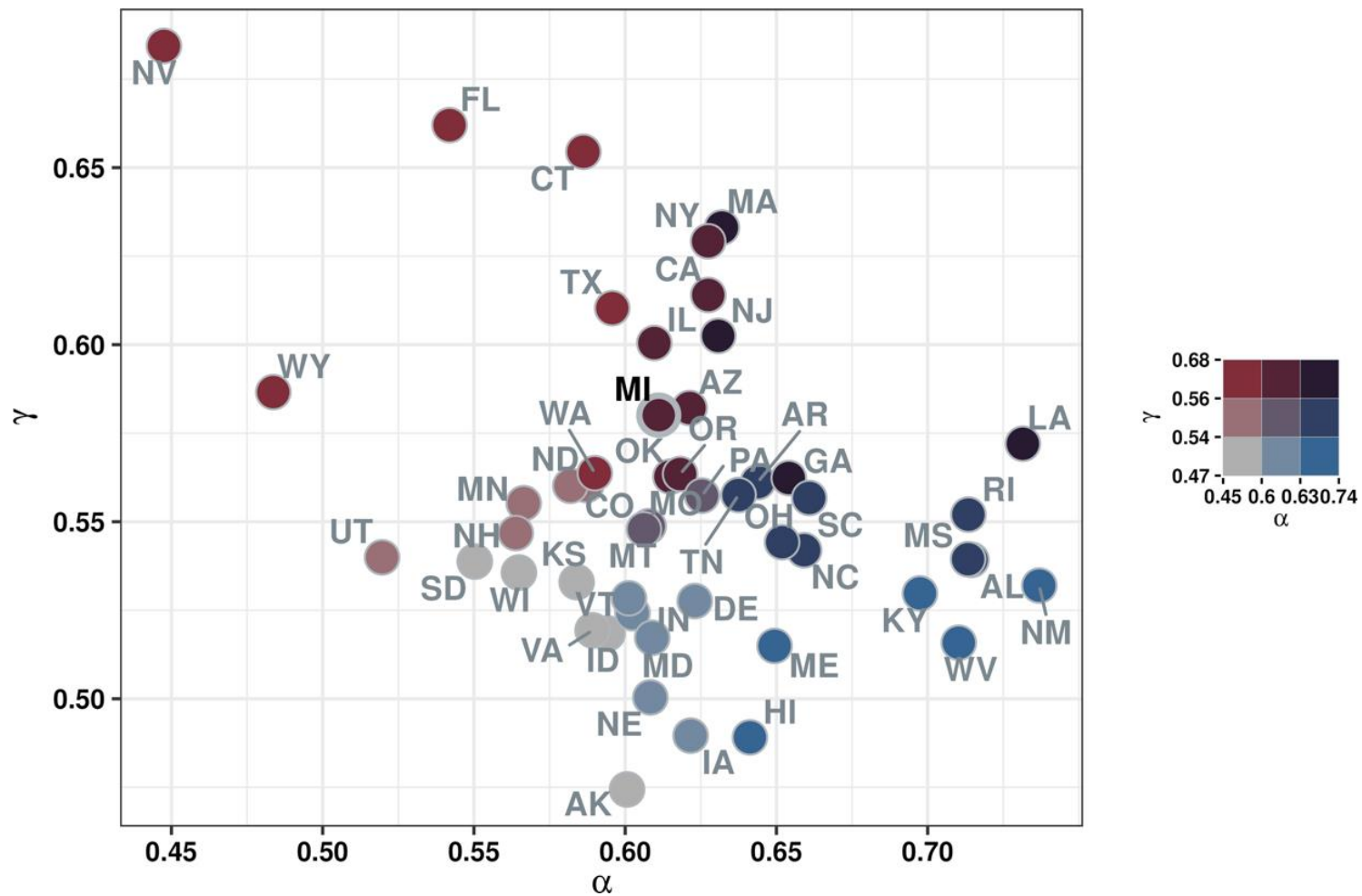
1. **Diversity Plans to Improve Enrollment of Participants From Underrepresented Racial and Ethnic Populations in Clinical Trials** (13-April-2022, *Draft Guidance*)
2. **Decentralized Clinical Trials (DCTs) for Drugs, Biological Products, and Devices: Guidance for Industry, Investigators, and Other Stakeholders** (01-May-2023, *Draft Guidance*)
3. Employ **R** as a **Geographic Information Systems (GIS) software tool** that uses **open access data** to find prospective patients and local healthcare providers (HCPs) for DCTs in the *immediate Detroit metropolitan area*.
4. Focus on estimates of **economic inequality**, **level of health**, and **race / ethnicity**.

“40,000 Foot View” of the United States—Relative to α and γ Economic Inequality

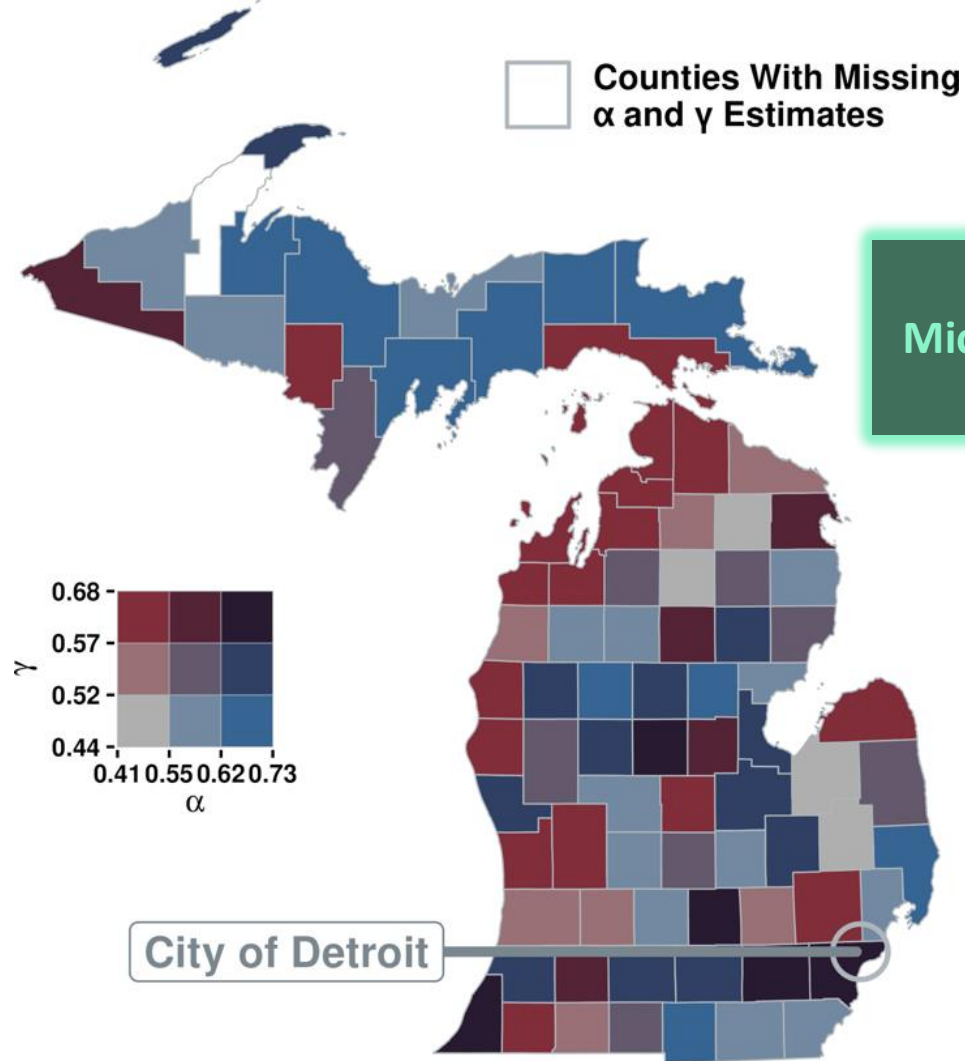
- Single Parameter Model:
 - **Gini** coefficient: Traditional measure of economic inequality.
- Two-Parameter Ortega Model:
 - α inequality: Focuses more on lower end of income distribution.
 - γ inequality: Focuses more on upper end of income distribution.



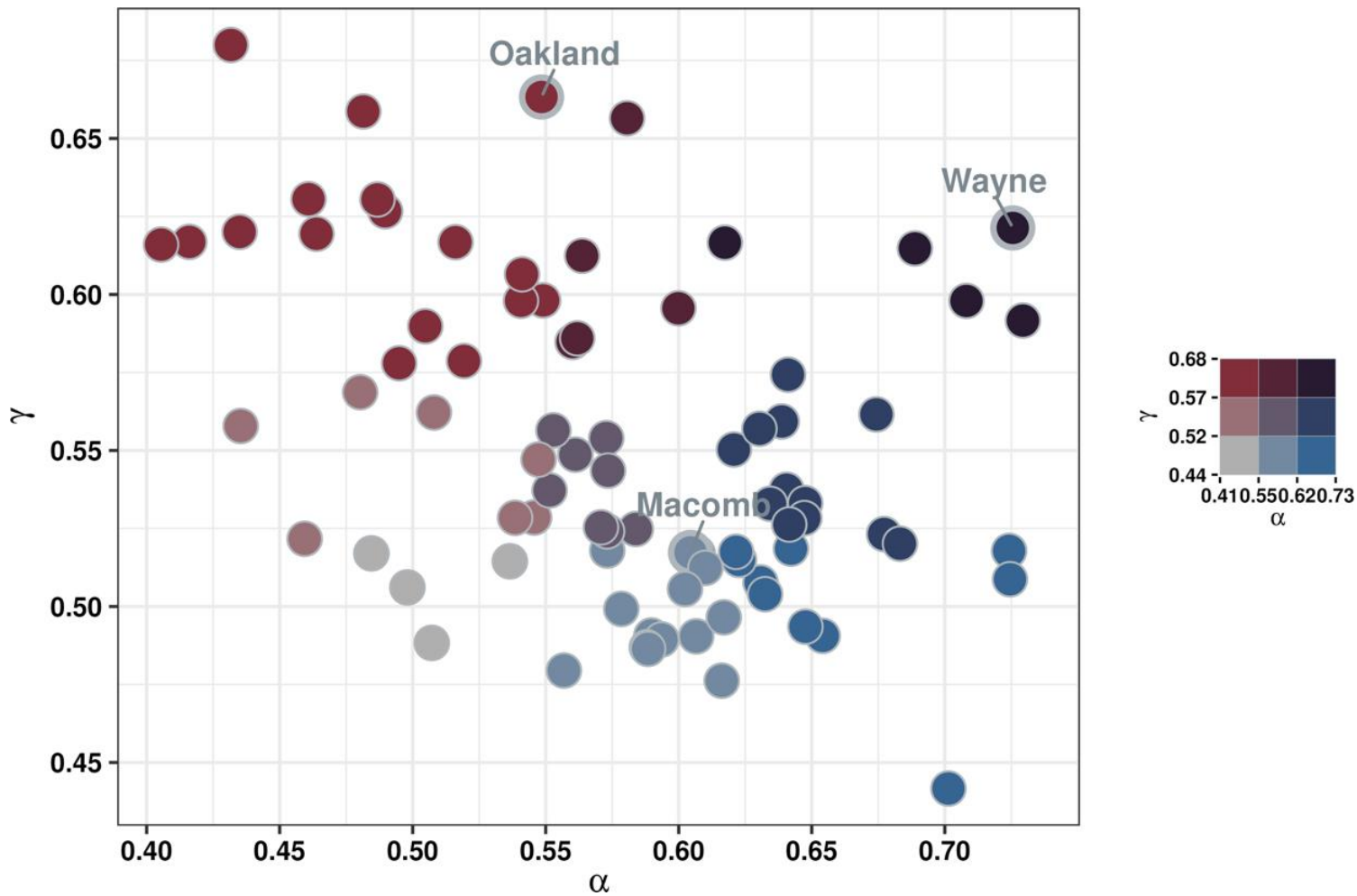
See Paper SA03 for this figure's corresponding references.



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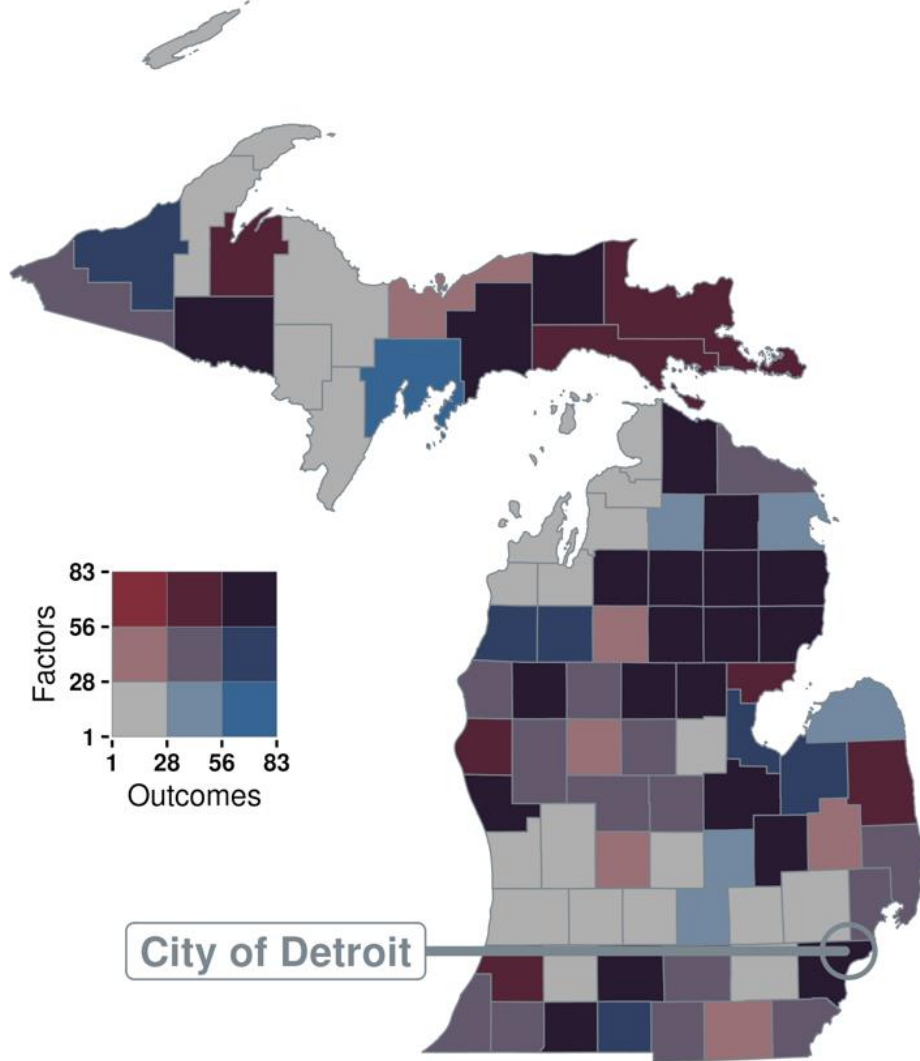


“10,000 Foot View” of
Michigan—Relative to α and γ
Economic Inequality

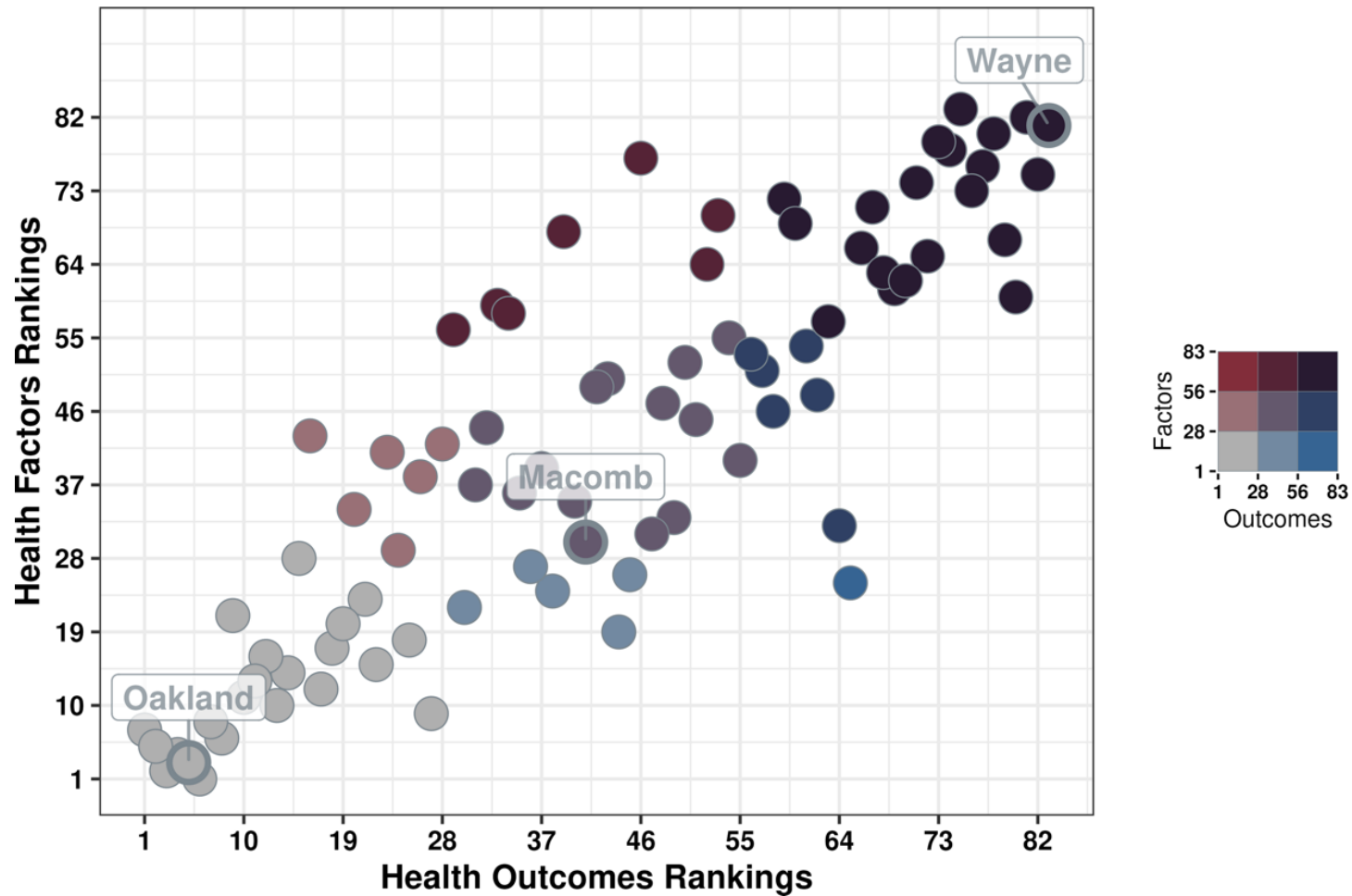


“10,000 Foot View” of Michigan—Relative to Health Factors and Outcomes Rankings

- **County Health Rankings & Roadmaps (CHR&R):**
 - University of Wisconsin Population Health Institute
 - Health Factors Rankings
 - Health Outcomes Rankings
 - County rankings within each state.



See Paper SA03 for this figure's corresponding references.

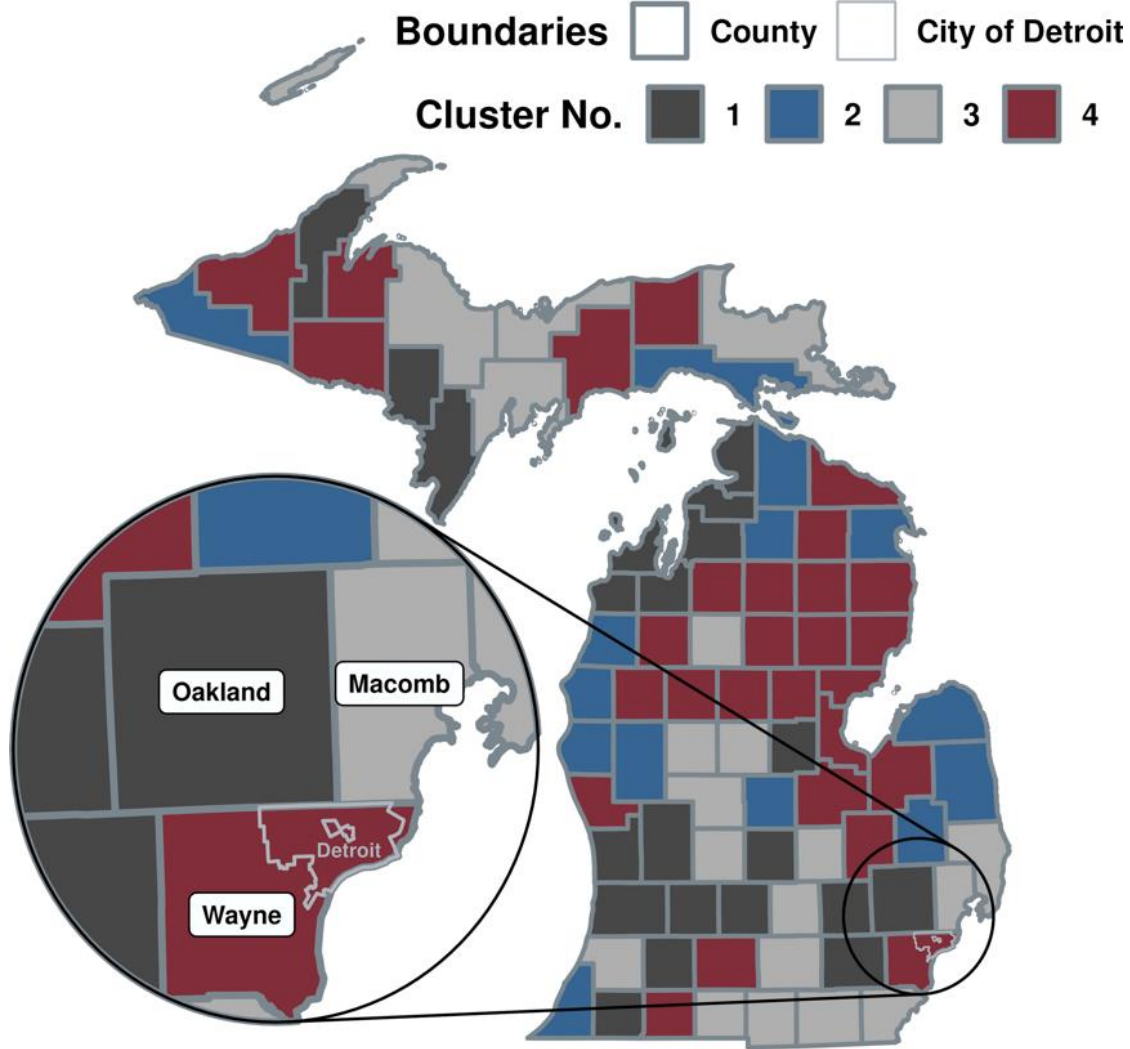


Combine α , γ , Health Factors Subrankings, and Health Outcomes Subrankings

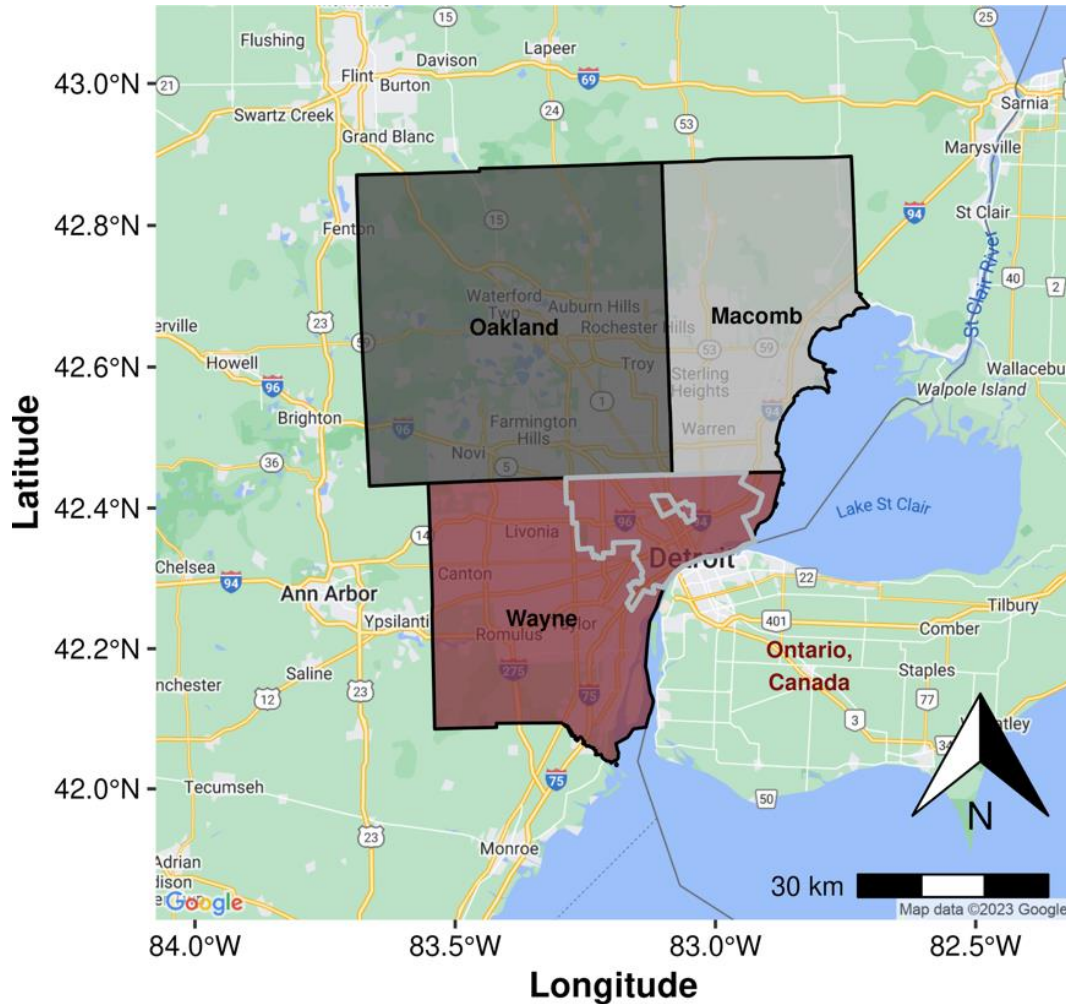
- $\frac{1}{4}$ α
- $\frac{1}{4}$ γ
- $\frac{1}{4}$ Health Factors Subrankings
 - 30% *Health Behaviors*
 - 20% *Clinical Care*
 - 40% *Social and Economic Factors*
 - 10% *Physical Environment*
- $\frac{1}{4}$ Health Outcomes Subrankings
 - 50% *Length of Life*
 - 50% *Quality of Life*

Unsupervised Machine Learning

1. Determine relationships among 83 counties using the **Gower Distance**.
2. Reduce 8 dimensions to 2 via **Self-Organizing Maps (SOMs)** and assess data similarities via **Partitioning Around Medoids (PAM)** clustering.



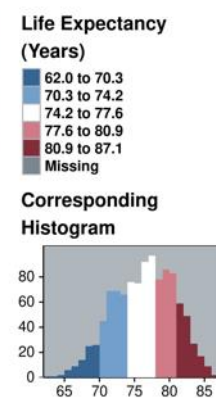
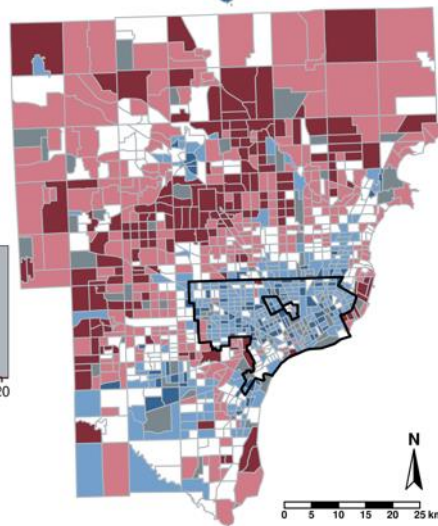
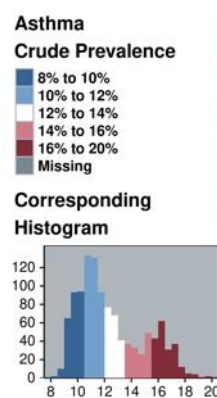
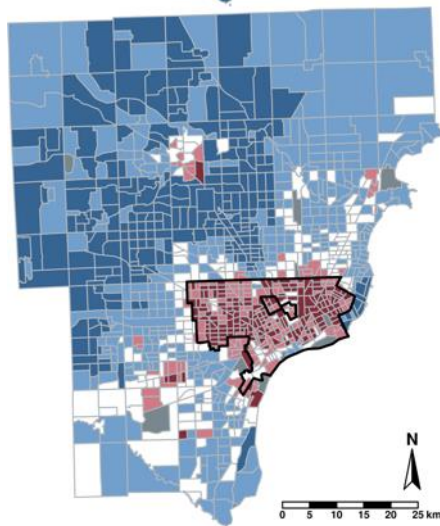
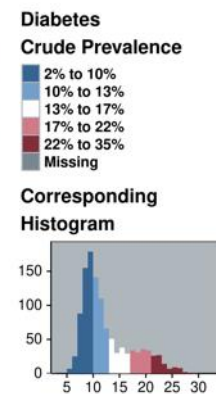
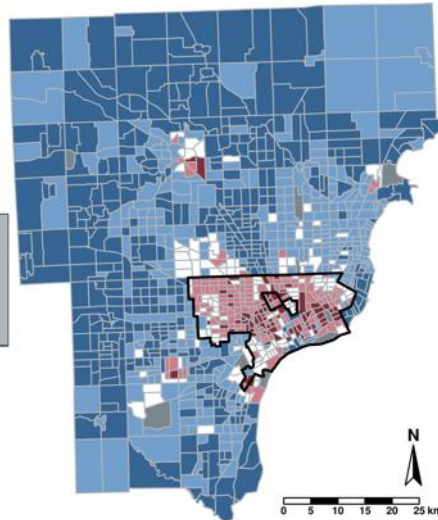
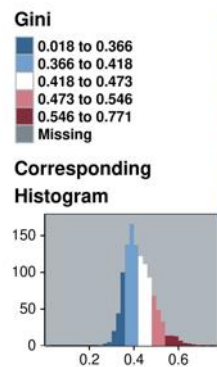
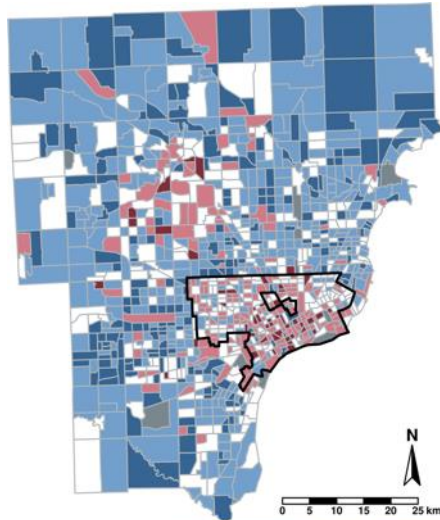
See Paper SA03 for this figure's corresponding references.



“5,000 Foot View” of the *Immediate* Detroit Metropolitan Area

“5,000 Foot Views” of the Immediate Detroit Metropolitan Area

- Census tracts now become visible. ← Counties can be divided into tracts!
- 1165 US census tracts in Macomb, Oakland, and Wayne Counties.
- α and γ economic inequality estimates not available at tract level.
- → Use Gini estimates from the American Community Survey (ACS) provided by the US Census via the R package tidy census.
- The county is the most granular level for CHR&R.
- → Use 29 CDC health measures made accessible via the R package Rsocrata.
- Download CDC life expectancy estimates from USALEEP.

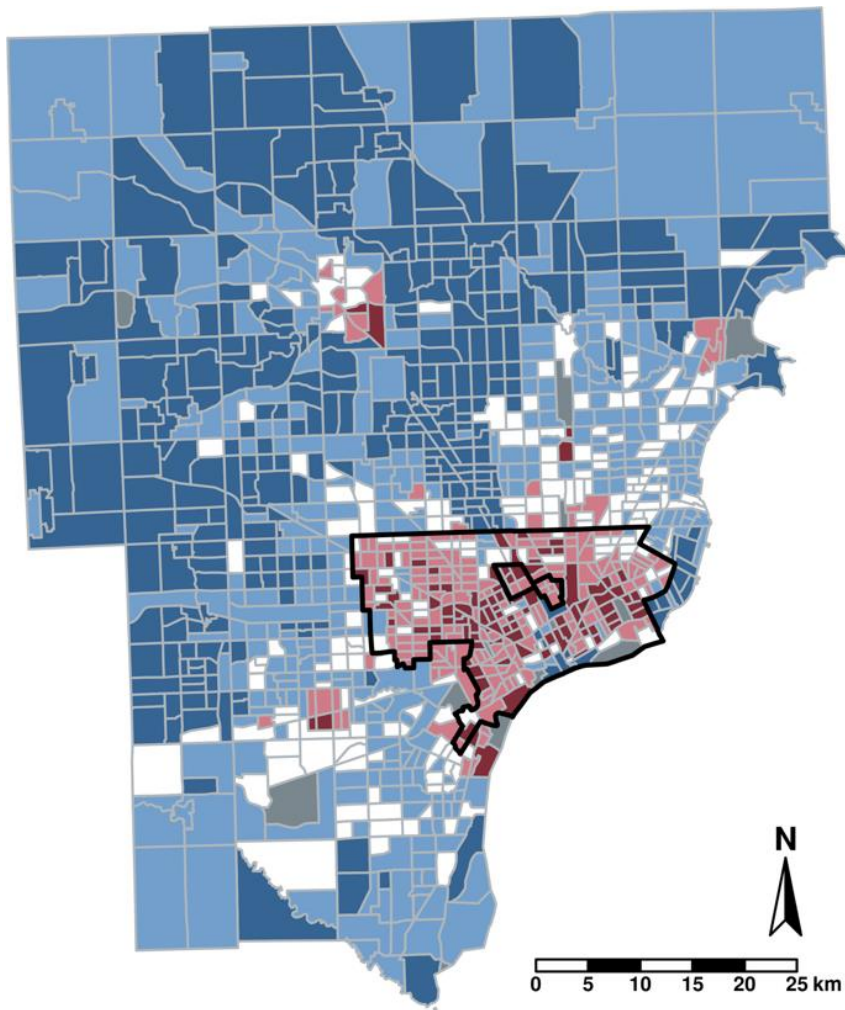


Combine Gini, CDC Health Measures, and CDC Life Expectancy Estimates

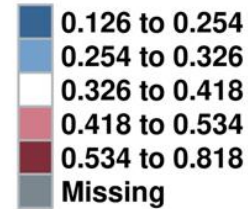
Gini	29 (30) Health Measures	Life Expectancy	TOPSIS
33 Variables <i>or</i> Columns			
1165 (1151) Census Tracts <i>or</i> Rows: • <u>Drop</u> 14 tracts with ≥ 31 missing values. • Impute remaining missing values using predictive mean matching via the <u>mice</u> R package.			

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS):

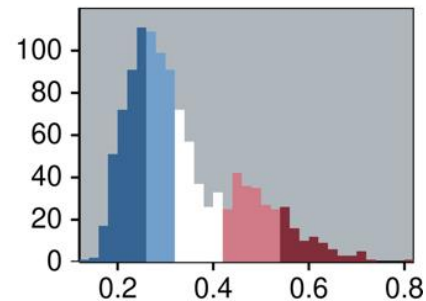
- Orders the 1151 census tracts from most equitable / most healthy (smaller TOPSIS scores) to least equitable / least healthy (larger TOPSIS scores)
- Derived via the topsis R package.



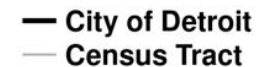
TOPSIS Score



Corresponding Histogram



Borders



Reduce Dimensions to Better Visualize Relationships Among Census Tracts

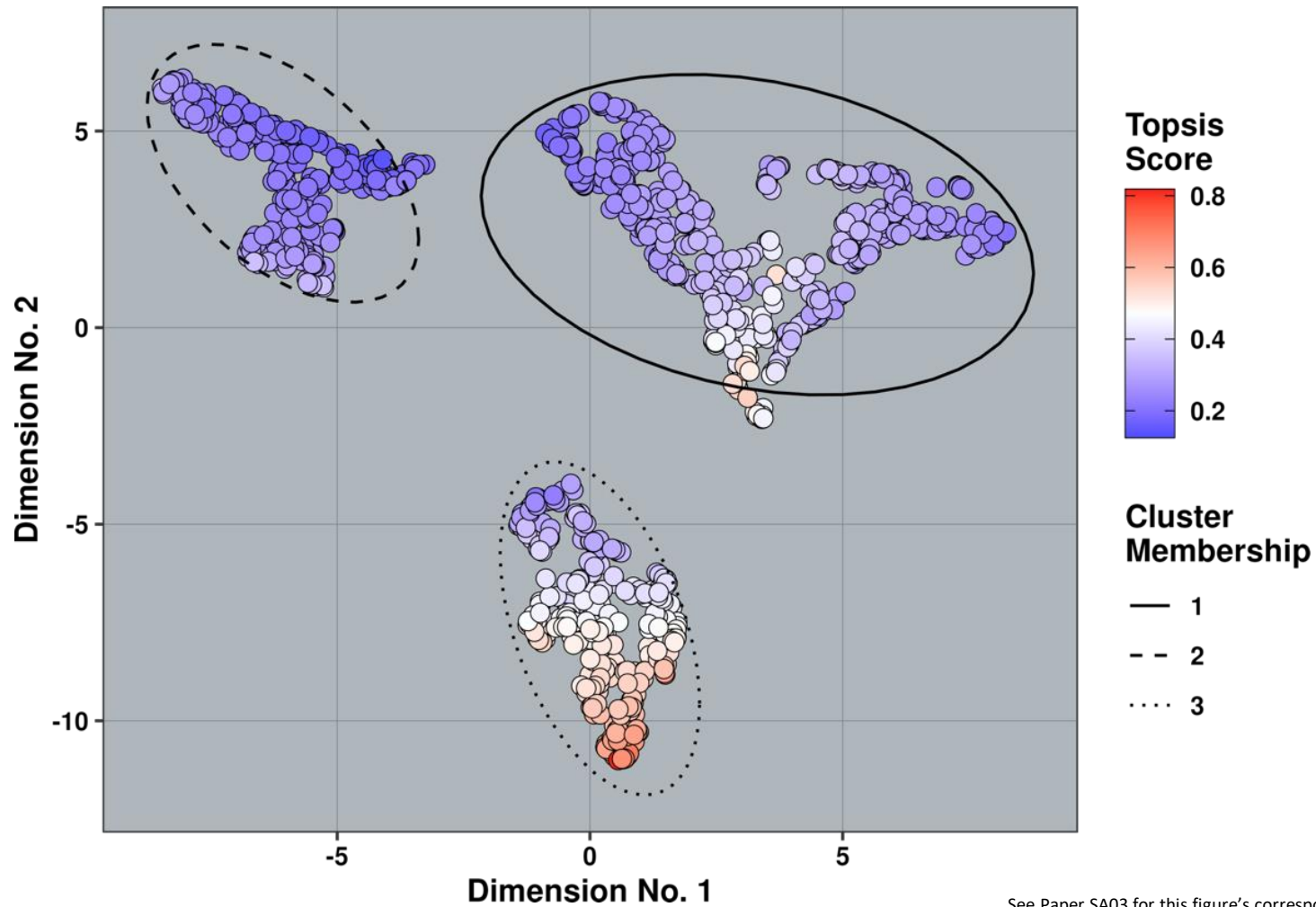
Gini	29 (30) Health Measures	Life Expectancy	TOPSIS
...	...	...	...
...	...	...	...
...	...	...	...

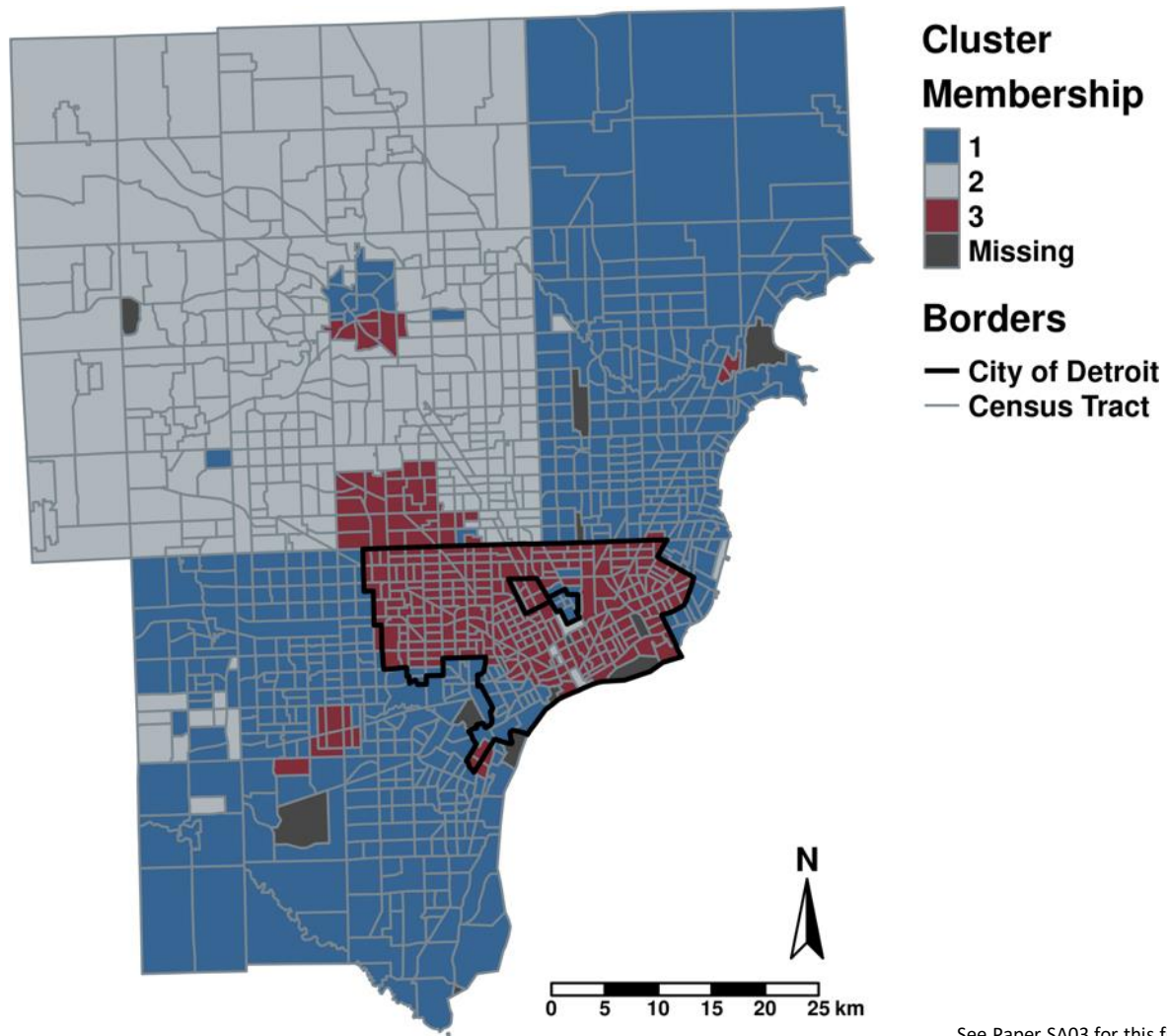
33 Variables or Columns

1151 Census Tracts or Rows

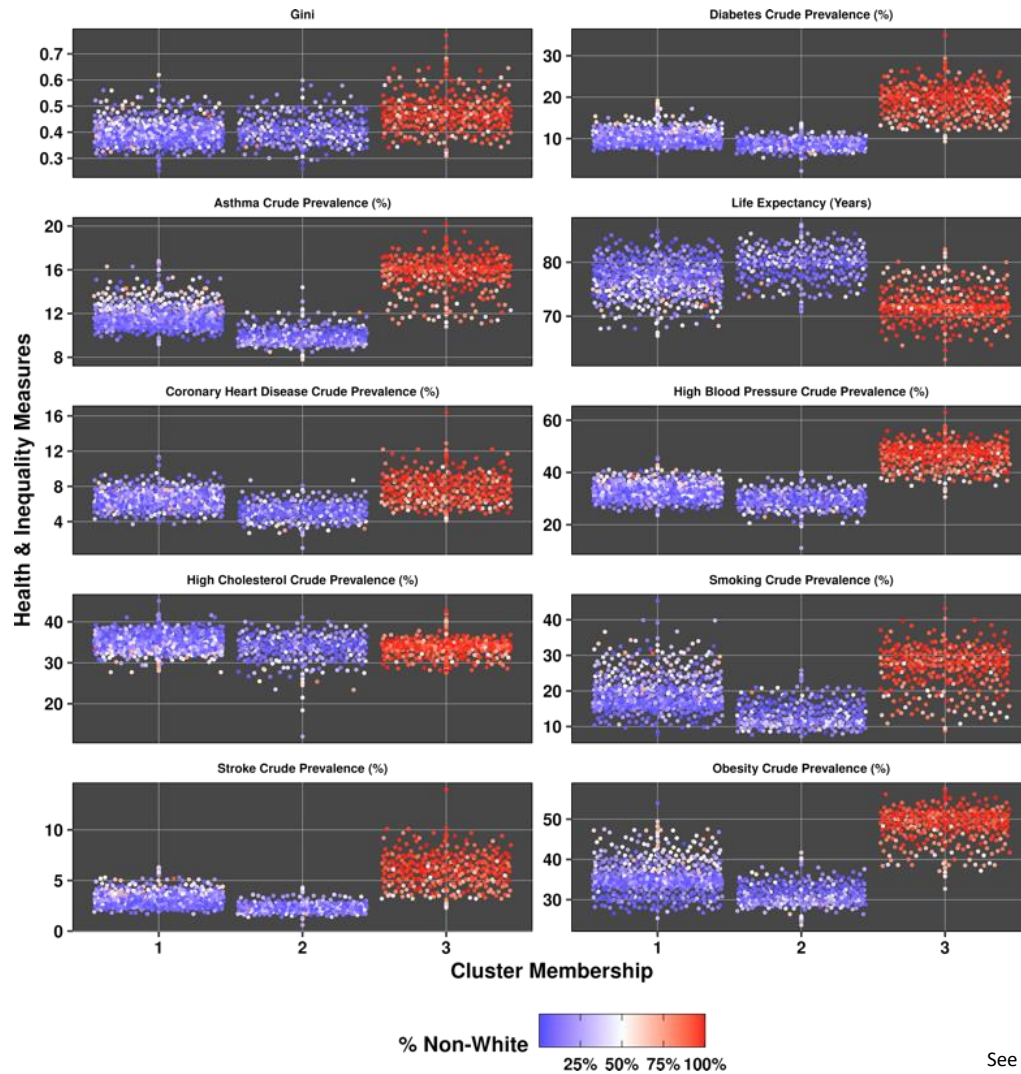
Unsupervised Machine Learning

1. Determine relationships among **1151** census tracts.
2. Reduce **33** dimensions to **2** via **Uniform Manifold Approximation and Projection (UMAP)** and assess data similarities via **Partitioning Around Medoids (PAM)** clustering.





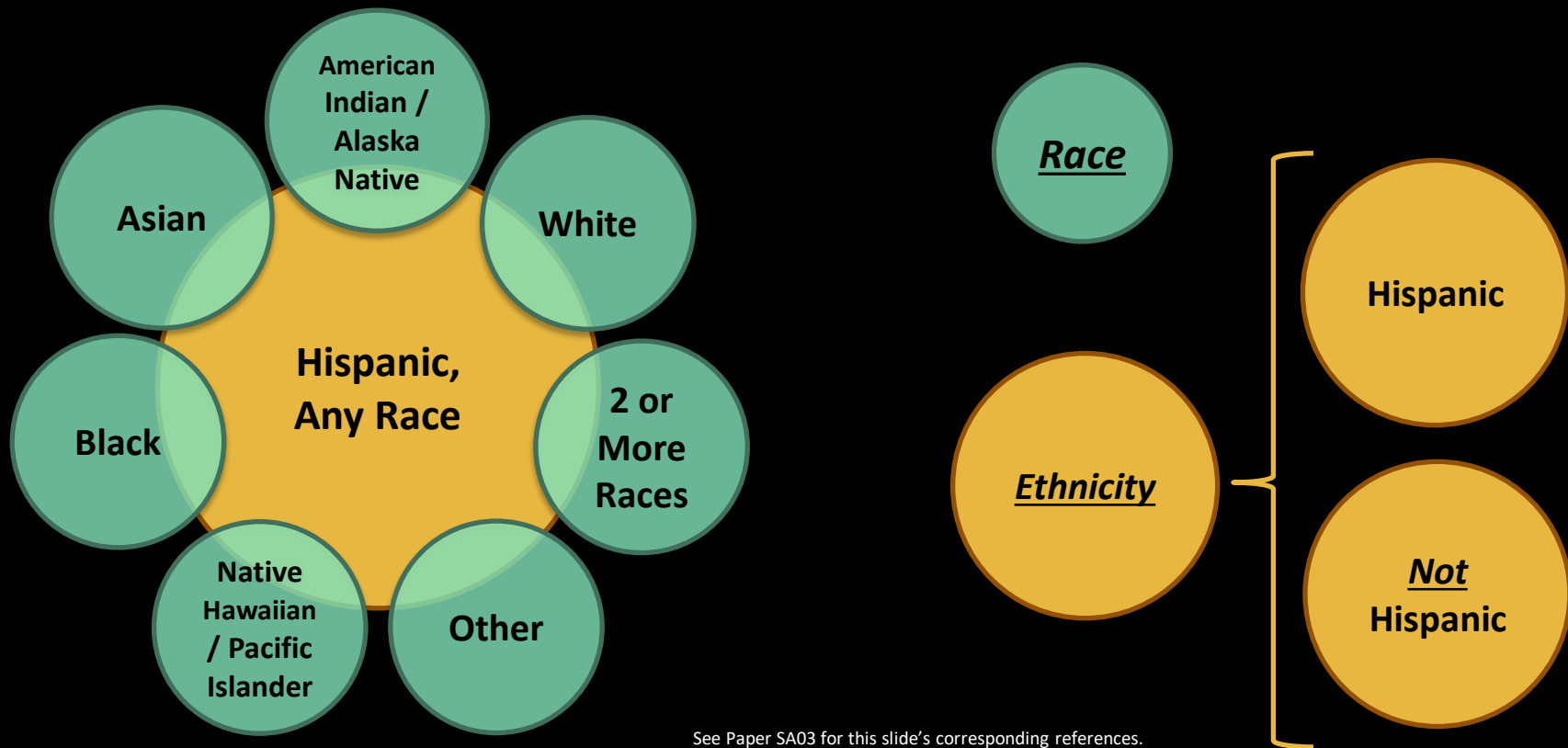
See Paper SA03 for this figure's corresponding references.



See Paper SA03 for this figure's corresponding references.

“5,000 Foot Views” of Race / Ethnicity in Detroit (1 of 2)

- Use race / ethnicity estimates from the American Community Survey (ACS) provided by the US Census via the R package **tidycensus**.

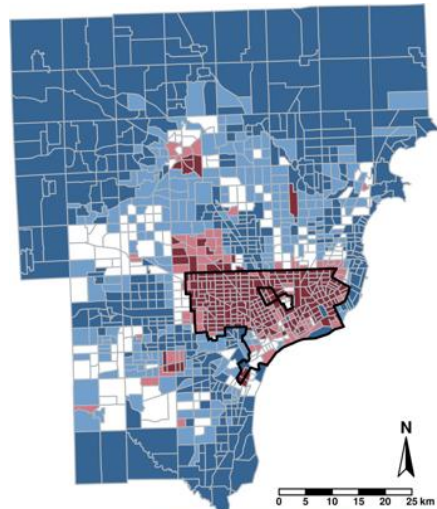


“5,000 Foot Views” of Race / Ethnicity in Detroit (2 of 2)

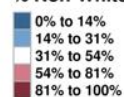
- **Gini-Simpson Diversity Index:** *Probability estimate of encountering 2 people of different races within the same census tract.*
- Examples:

M&Ms	Gini-Simpson Diversity Index, G_s
	0
	0.5
	0.83

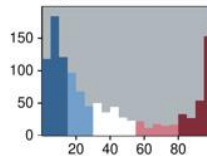
$0 \leq G_s < 1$



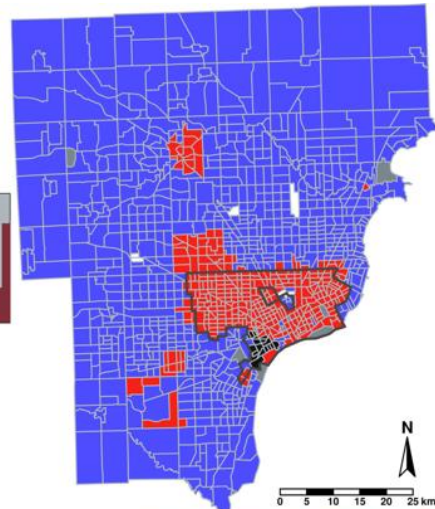
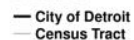
% Non-White



Corresponding Histogram



Borders

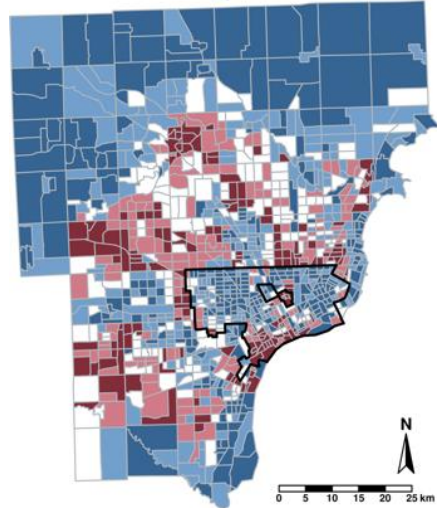
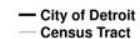


Majority

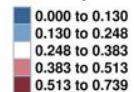
Race / Ethnicity



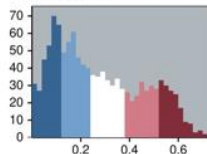
Borders



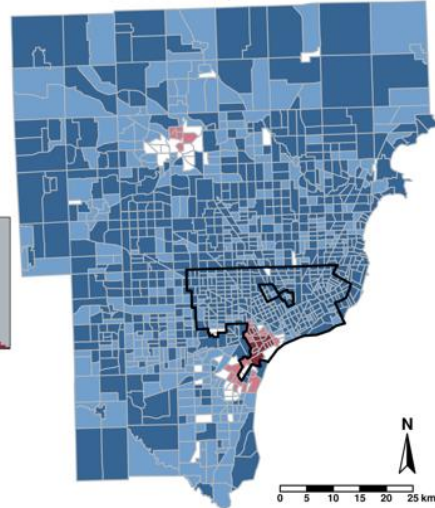
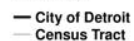
Gini-Simpson Diversity Index



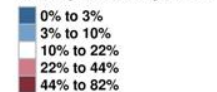
Corresponding Histogram



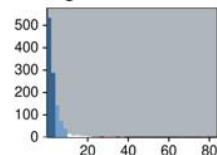
Borders



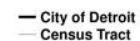
% Hispanic, Any Race

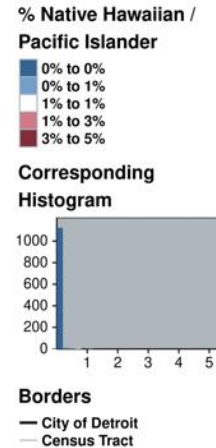
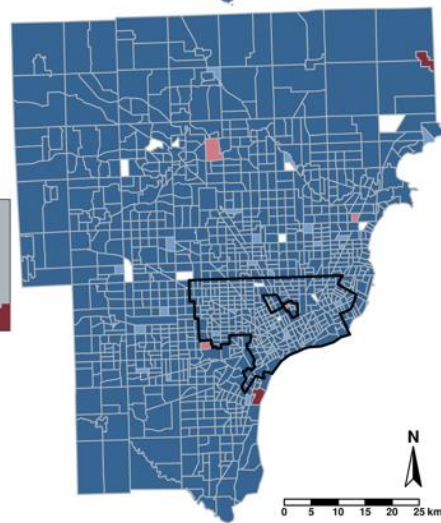
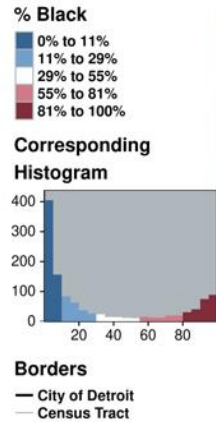
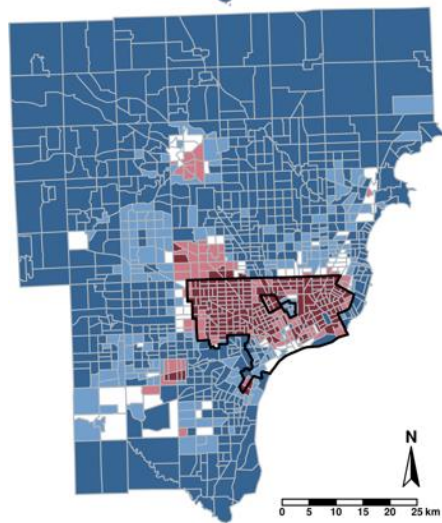
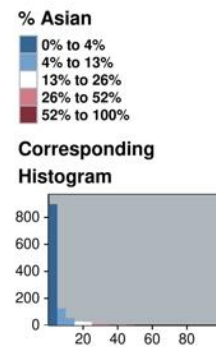
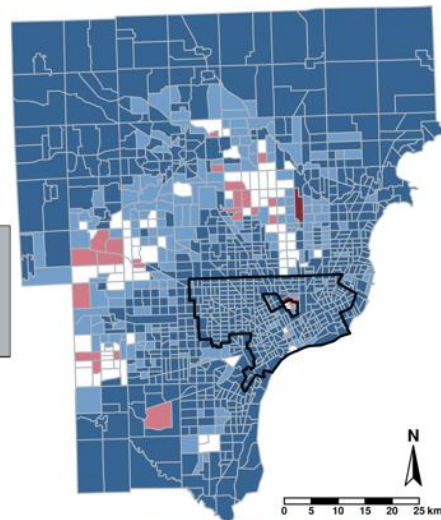
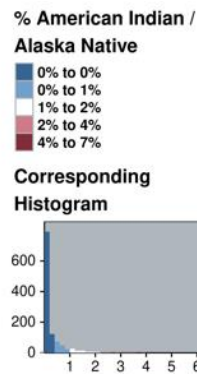
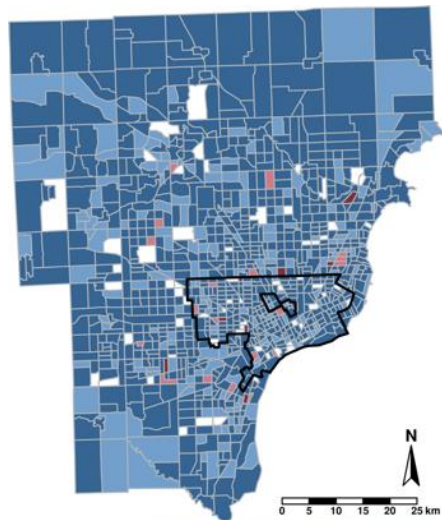


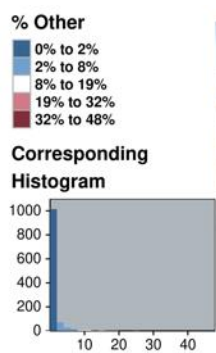
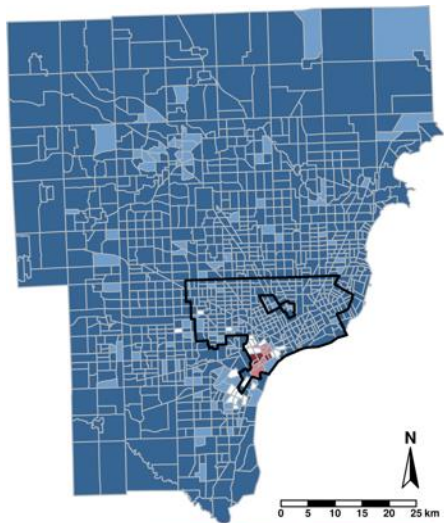
Corresponding Histogram



Borders

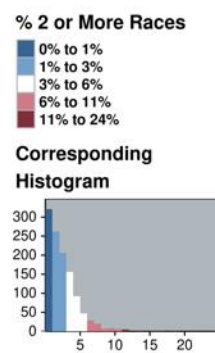
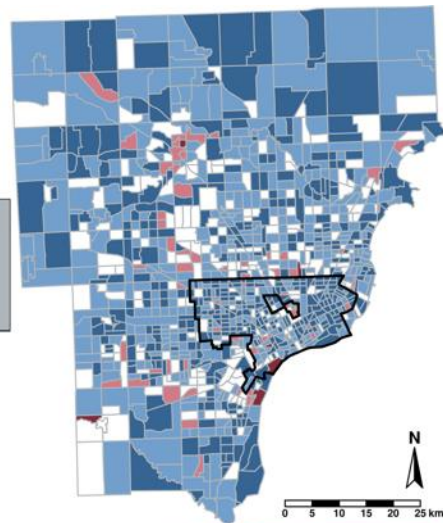






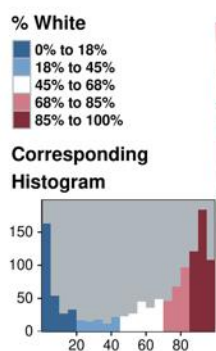
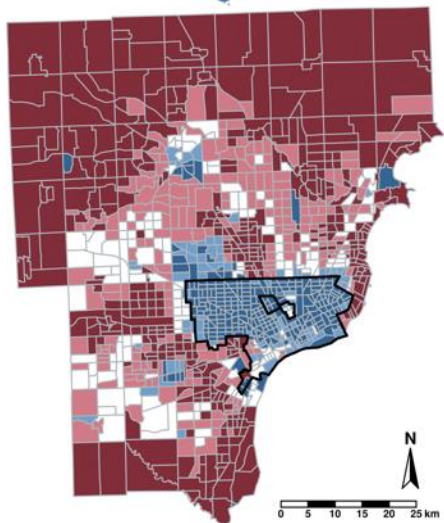
Borders

- City of Detroit
- Census Tract



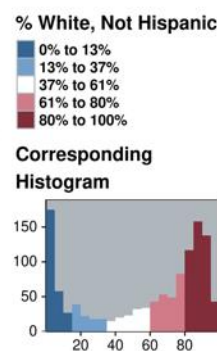
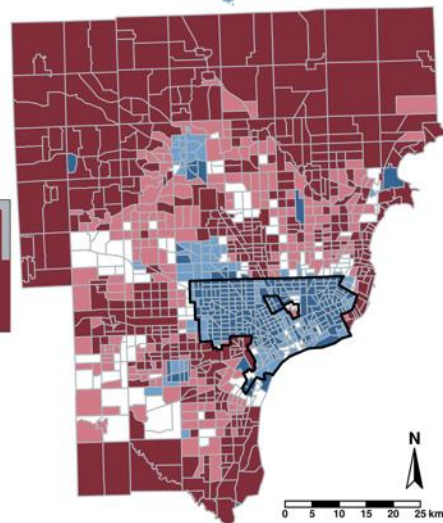
Borders

- City of Detroit
- Census Tract



Borders

- City of Detroit
- Census Tract



Borders

- City of Detroit
- Census Tract

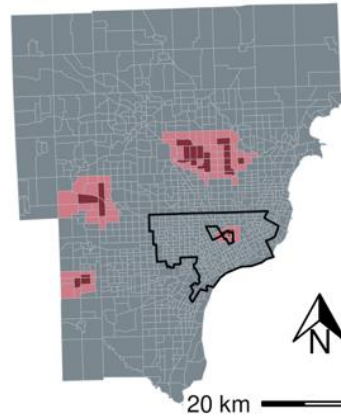
Apply Geospatial Statistics to Race / Ethnicity Data

- **First Law of Geography:** “Everything is related to everything else, but near things are more related than distant things.”
—Waldo Tobler, *Professor of Geography & Statistics & GIS Trailblazer*
https://en.wikipedia.org/wiki/Waldo_R._Tobler
- “This first law is the foundation of the fundamental concepts of **spatial dependence** and **spatial autocorrelation**.”
—https://en.wikipedia.org/wiki/Tobler%27s_first_law_of_geography
- **Local Getis-Ord G** Indicator:
 - Geospatial statistic that functions as a **local indicator of spatial association (LISA)**. https://en.wikipedia.org/wiki/Indicators_of_spatial_association
 - Use this statistic to locate **local areas of interest** for different races / ethnicities. → Use to find “**hot spots**”.

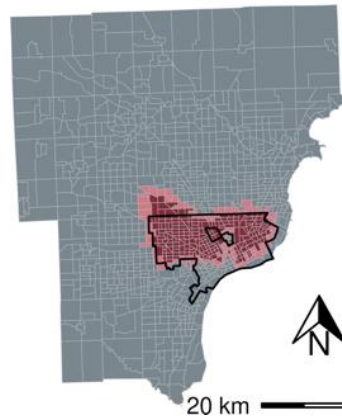
**American Indian /
Alaska Native**



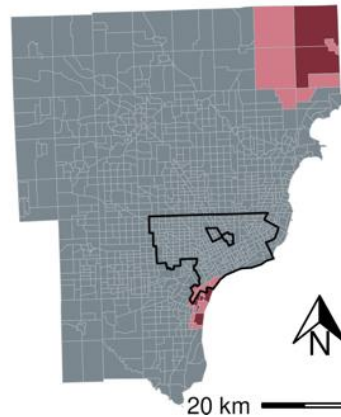
Asian



Black



**Native Hawaiian /
Pacific Islander**



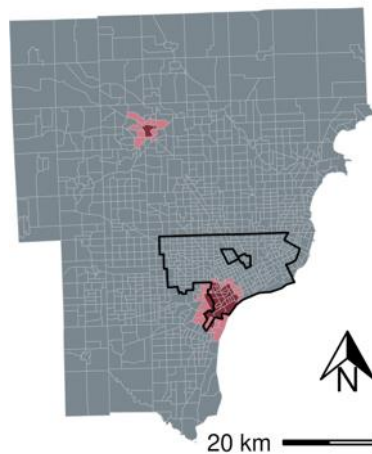
Boundaries

- Census Tract
- City of Detroit

Local Getis-Ord's G Status
for Census Tract

- Hot Spot
- Neighbor of Hot Spot
- Not Significant

Hispanic, Any Race



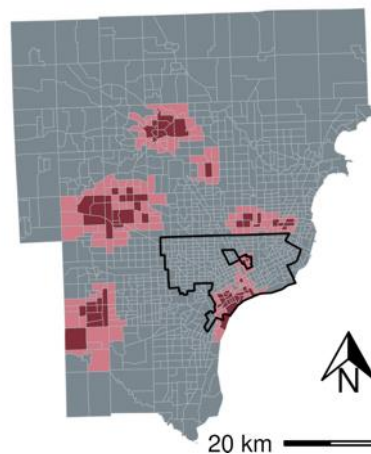
Other



Two or More



Gini-Simpson Index



Boundaries

Census Tract

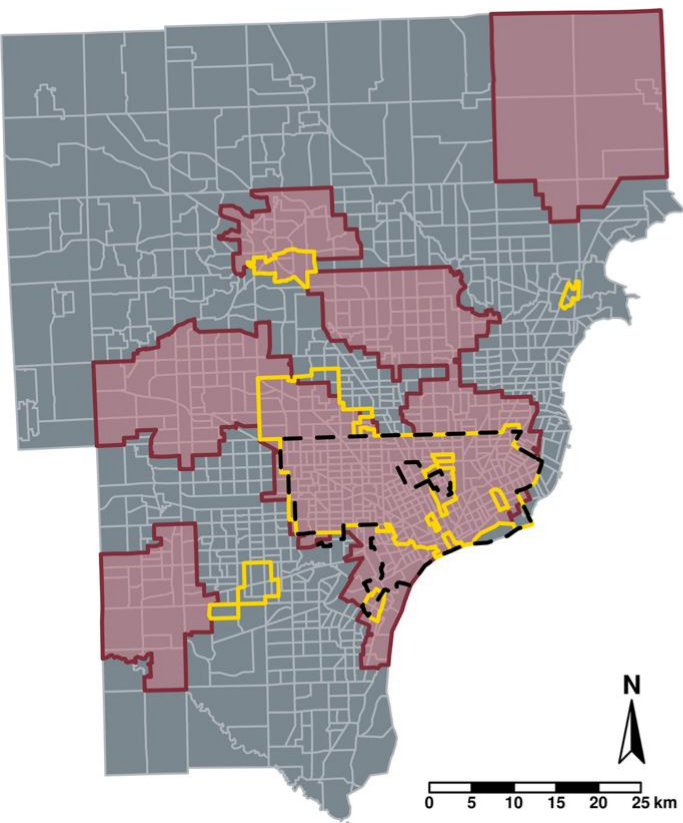
City of Detroit

**Local Getis-Ord's G Status
for Census Tract**

Hot Spot

Neighbor of Hot Spot

Not Significant

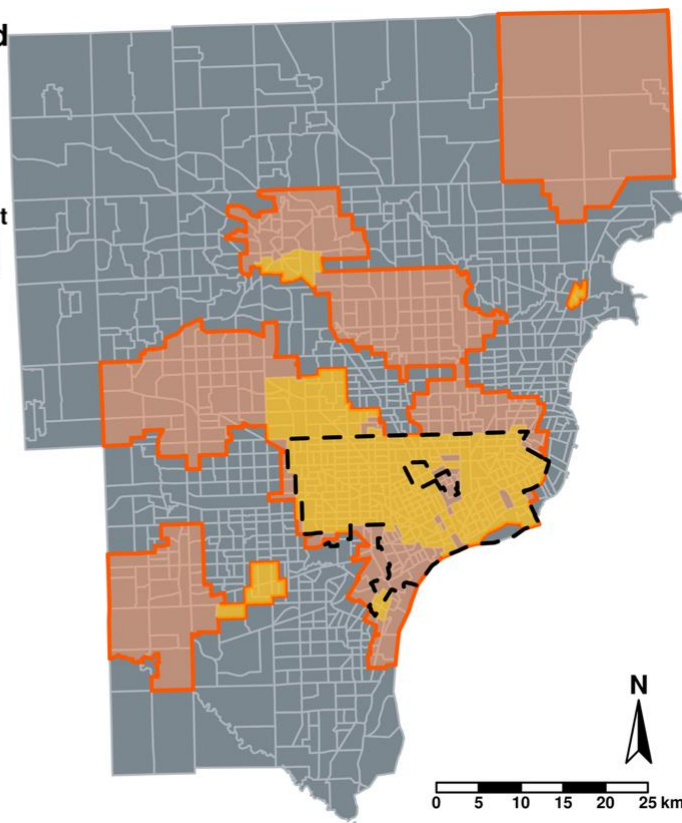


Consolidated Hot Spots



Borders

- City of Detroit
- Cluster No. 3
- Census Tract



Consolidated Hot Spots & Cluster No. 3



Health Disparities Focus Area (Cluster No. 3)

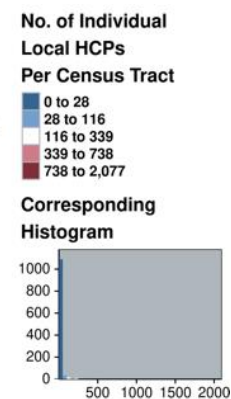
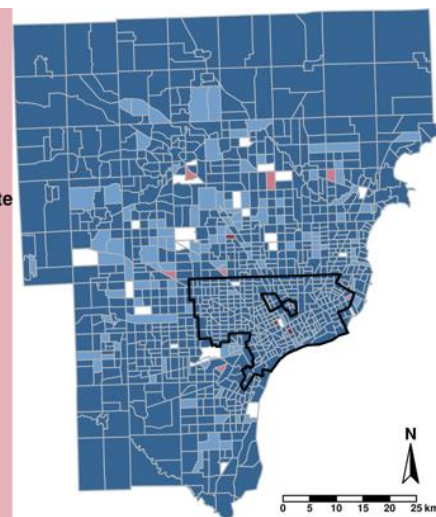
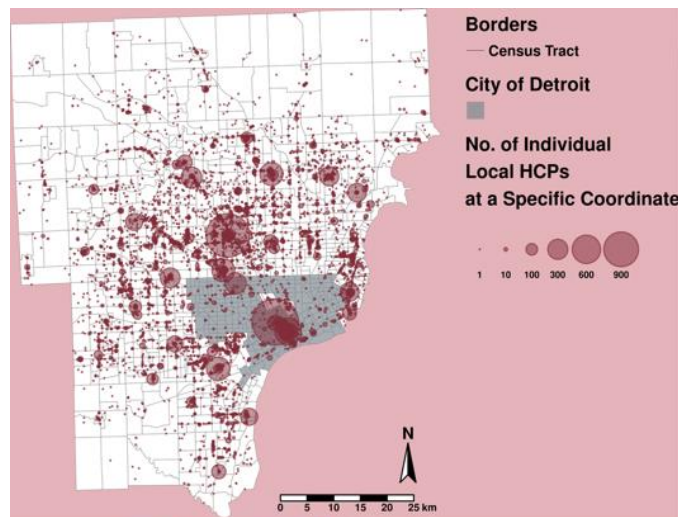


Borders

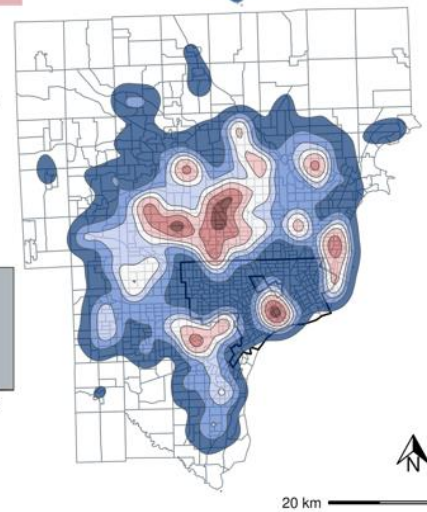
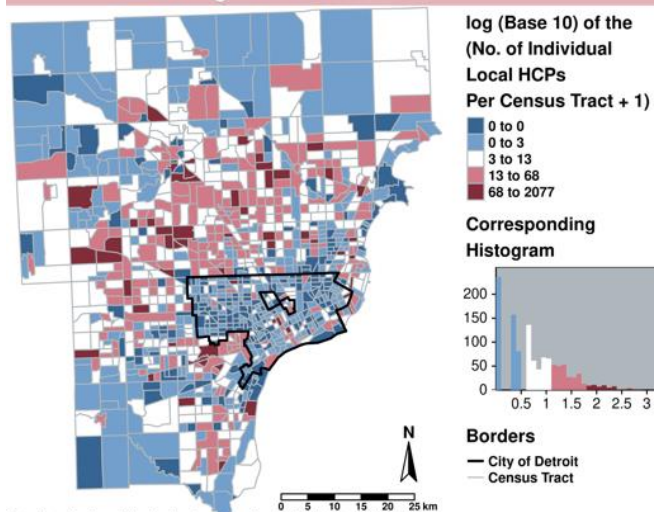
- City of Detroit
- Census Tract

Locate **Local HCPs** and Non-Traditional DCT Sites

- **National Plan and Provider Enumeration System (NPPES) Registry:**
 1. **US provider data**—including street addresses, type of medicine practiced, etc.
 2. Either access the corresponding API via the **npi** R package or download the data.
 3. Identify relevant Providers by ZIP code using the **zipcodeR** R package.
 4. Geolocate the Providers via the **tidygeocoder** R package.
- **Google Maps API:**
 1. Access via the **googleway** R package.
 2. Geolocate non-traditional DCT sites (*e.g. places of worship*).



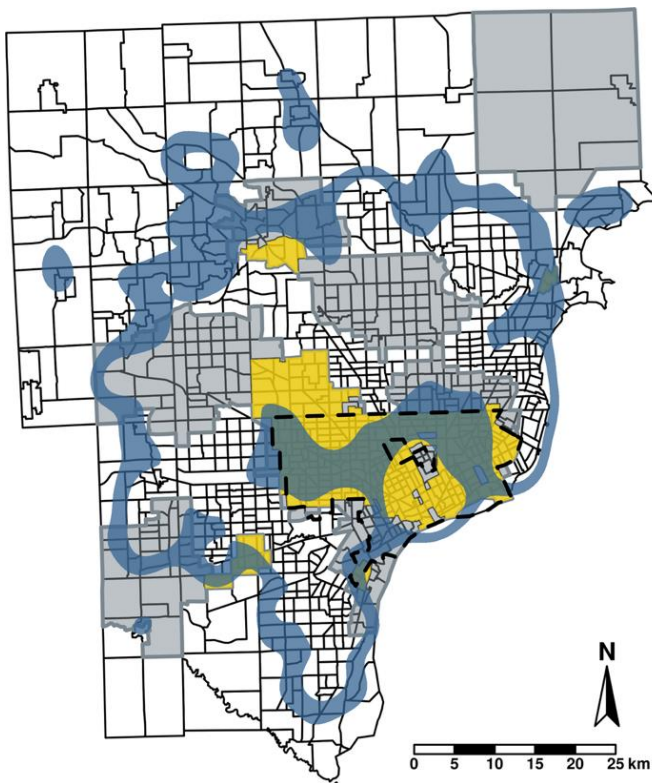
Borders
— City of Detroit
— Census Tract



Boundaries
□ City of Detroit
□ Census Tract

Note: The color legend breaks have been transformed back to the original scale.

See Paper SA03 for this figure's corresponding references.



**Consolidated
Hot Spots &
Cluster No. 3**



**Health Disparities
Focus Area
(Cluster No. 3)**



**Low
Individual HCP
Density**

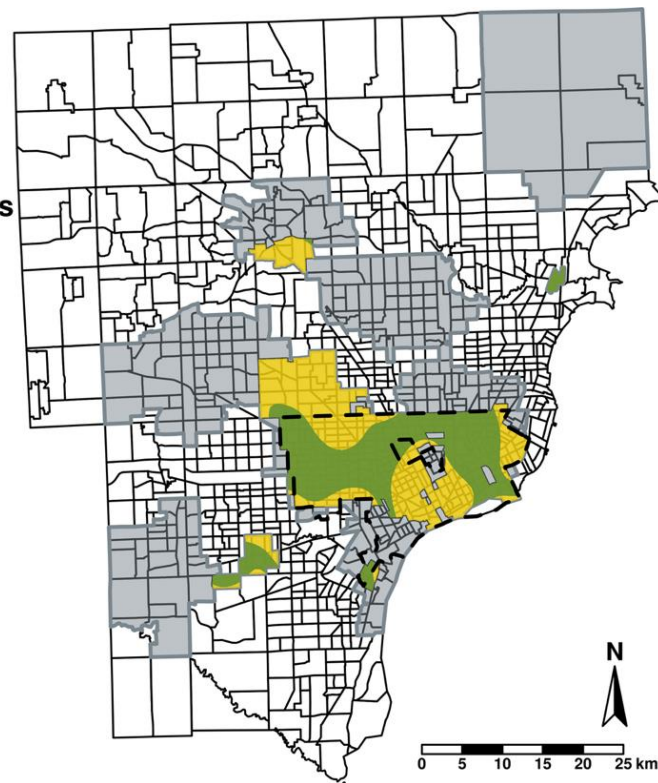


Borders

— City of Detroit
— Census Tract



0 5 10 15 20 25 km



**Consolidated
Hot Spots &
Cluster No. 3**



**Health Disparities
Focus Area
(Cluster No. 3)**



**Health Disparities /
Low Individual HCP
Density Focus Area**

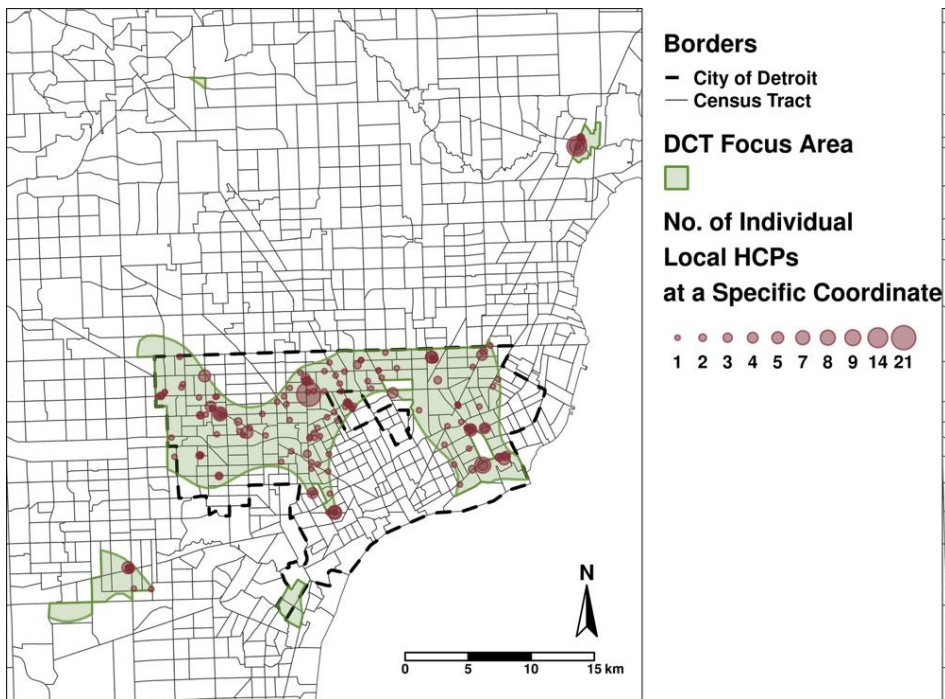


Borders

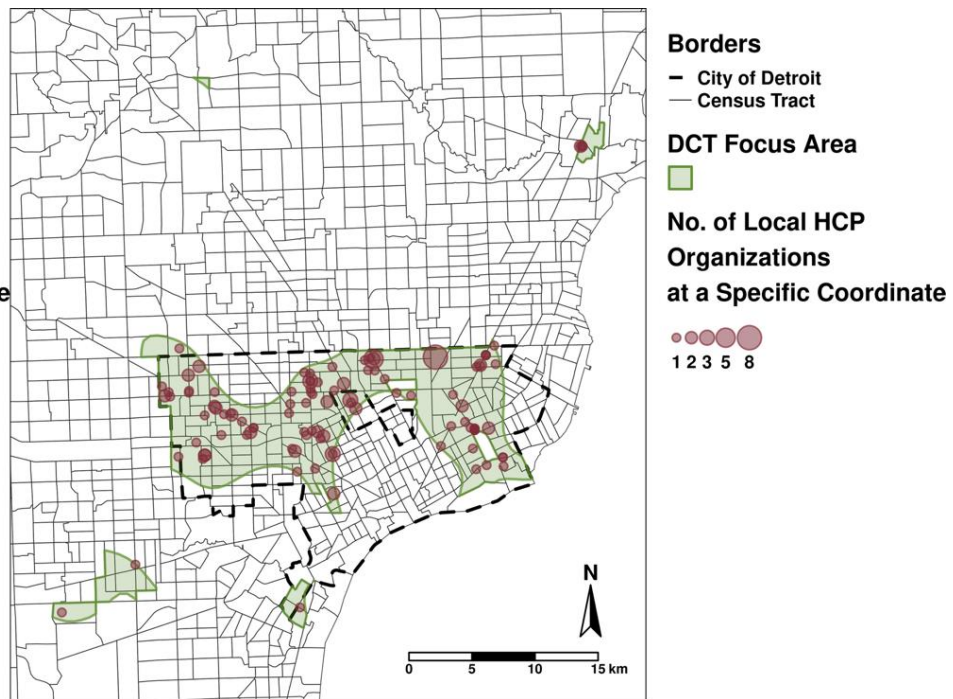
— City of Detroit
— Census Tract



0 5 10 15 20 25 km



Geocoded locations of **303 individual** local HCPs.

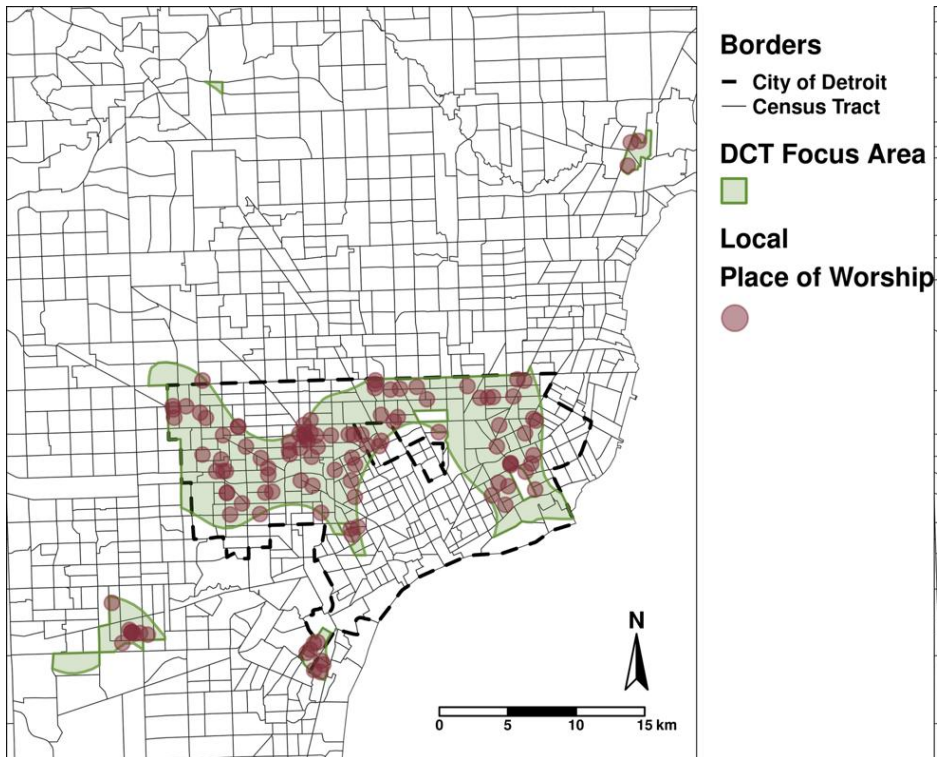


Geocoded locations of **143 local HCP organizations**.

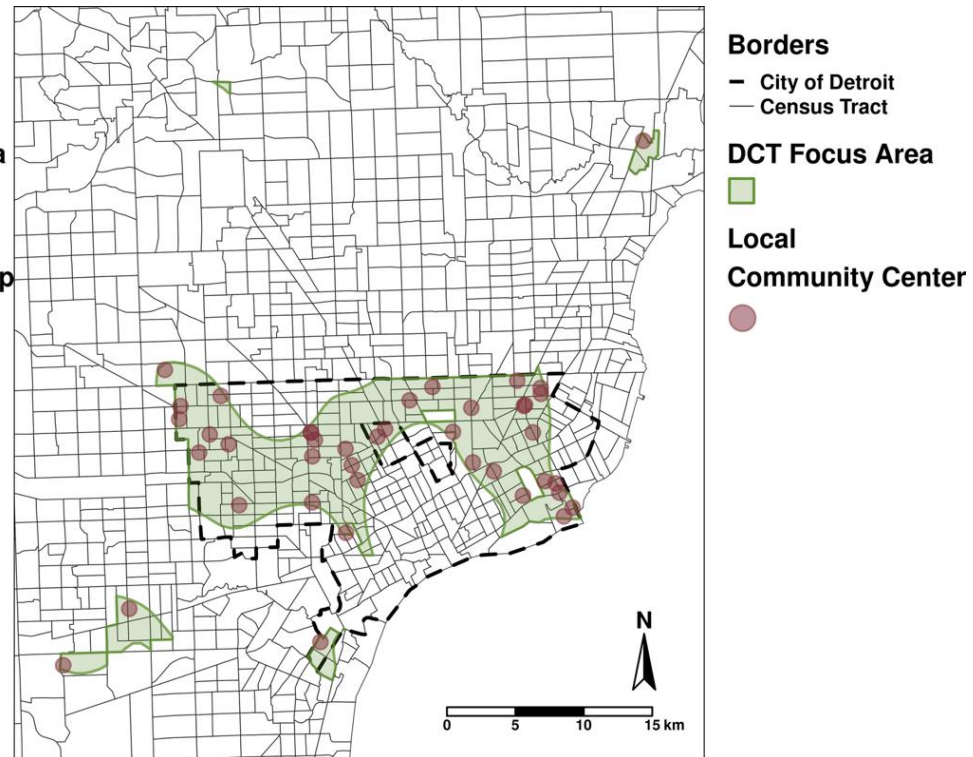
Why Use Non-Traditional Sites for DCTs?

- Healthcare survey commissioned by **Sanofi** of **11,500** people from across the **U.S.**, **France**, the **U.K.**, **Japan**, and **Brazil**.
- “The results are worrying. In the U.S., **77%** of people with **disabilities**, **69%** of people from **ethnic minority groups**, and **70%** of people from the **LGBTQ+ community** say they have had experiences that **damaged their trust in the healthcare system**.
- The survey also showed the **compounding effect of marginalization**: *People who fell into more than one of these groups were significantly more likely to have had a bad experience while seeking care.* For example, in the U.S., **80%** of people who have **disabilities and identify as LGBTQ+** reported losing trust in the healthcare system due to their personal experience, compared with **56%** of people **without** those backgrounds.”

—**Paul Hudson** (Sanofi CEO) and **Michelle A. Williams** (Harvard SPH Dean)



Geocoded locations of **113 places of worship**.



Geocoded locations of **41 community centers**.

Detroit, Michigan: A Case Study for DEI via Decentralized Clinical Trials (DCTs)

- Employ **R** as a **Geographic Information Systems (GIS) software tool** that uses **open access data** to find prospective patients and local HCPs + DCT sites for clinical trials **outside of the US**:
 - **Brazil**
 - **geobr**: *Download Official Spatial Data Sets of Brazil*
 - **Canada**
 - **cancensus**: *Access, Retrieve, and Work with Canadian Census Data and Geography*
 - **cansim**: *Accessing Statistics Canada Data Table and Vectors*
 - **cmhc**: *Access, Retrieve, and Work with CMHC Data*
 - **tongfen**: *Make Data Based on Different Geographies Comparable*
 - **Europe**
 - **eurostat**: *Tools for Eurostat Open Data*
 - **France**
 - **insee**: *Tools to Easily Download Data from INSEE BDM Database*
 - **International**
 - **idbr**: *R Interface to the US Census Bureau International Data Base API*
 - **ipumsr**: *An R Interface for Downloading, Reading, and Handling IPUMS Data*
 - **Kenya**
 - **rKenyaCensus**: *The goal of rKenyaCensus is to provide tidy datasets obtained from the Kenya Population and Housing Census results.*
 - **Mexico**
 - **mxmaps**: *Mexico Choropleths*
 - **inegiR**: *Integrate INEGI's (Mexican Stats Office) API with R*
 - **United Kingdom**
 - **nomisr**: *Access 'Nomis' UK Labour Market Data*

Questions? Questions? Questions?

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Back-Up Slides

