The Neighborhood Atlas:
Linking Disparities-Aligned EXPOSOME to Brain Health through Data Democratization

February 6, 2023

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University of Wisconsin School of Medicine and Public Health

FUNDING DISCLOSURES

NIH/National Institute on Aging

NIH/National Institute on Minority Health and Health Disparities

Alzheimer's Association

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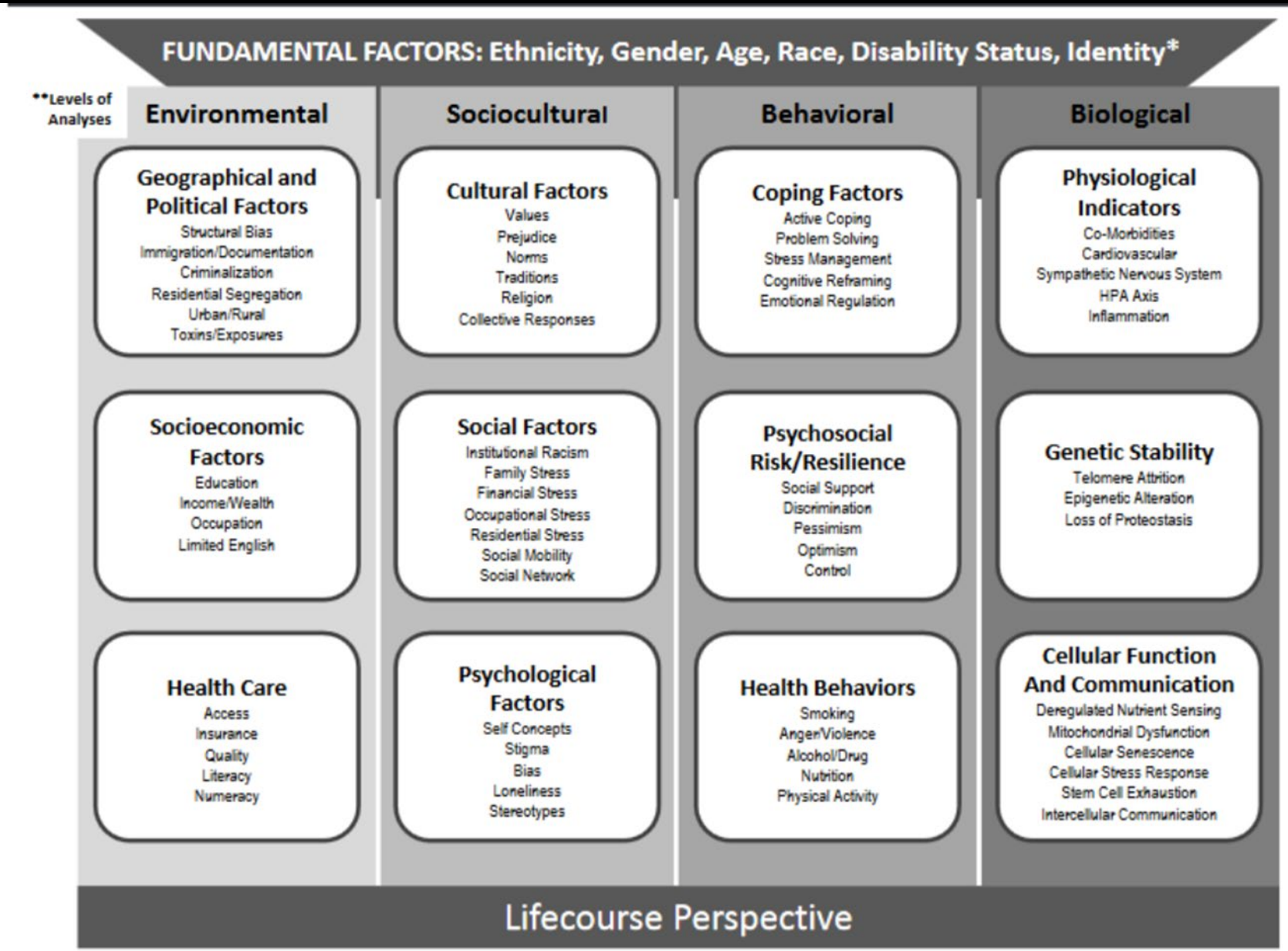
HEALTH IS NOT DISTRIBUTED EQUALLY

Solutions Needed

NIH MECHANISTIC HEALTH DISPARITIES FRAMEWORK



**Hill, Perez-Stable, Anderson and Bernard, *Ethnicity and Disease*, 2015

NIA HEALTH DISPARITIES FRAMEWORK

ENVIRONMENTAL

SOCIOCULTURAL

BEHAVIORAL

BIOLOGICAL

LIFE COURSE

**Hill, Perez-Stable, Anderson and Bernard, *Ethnicity and Disease*, 2015

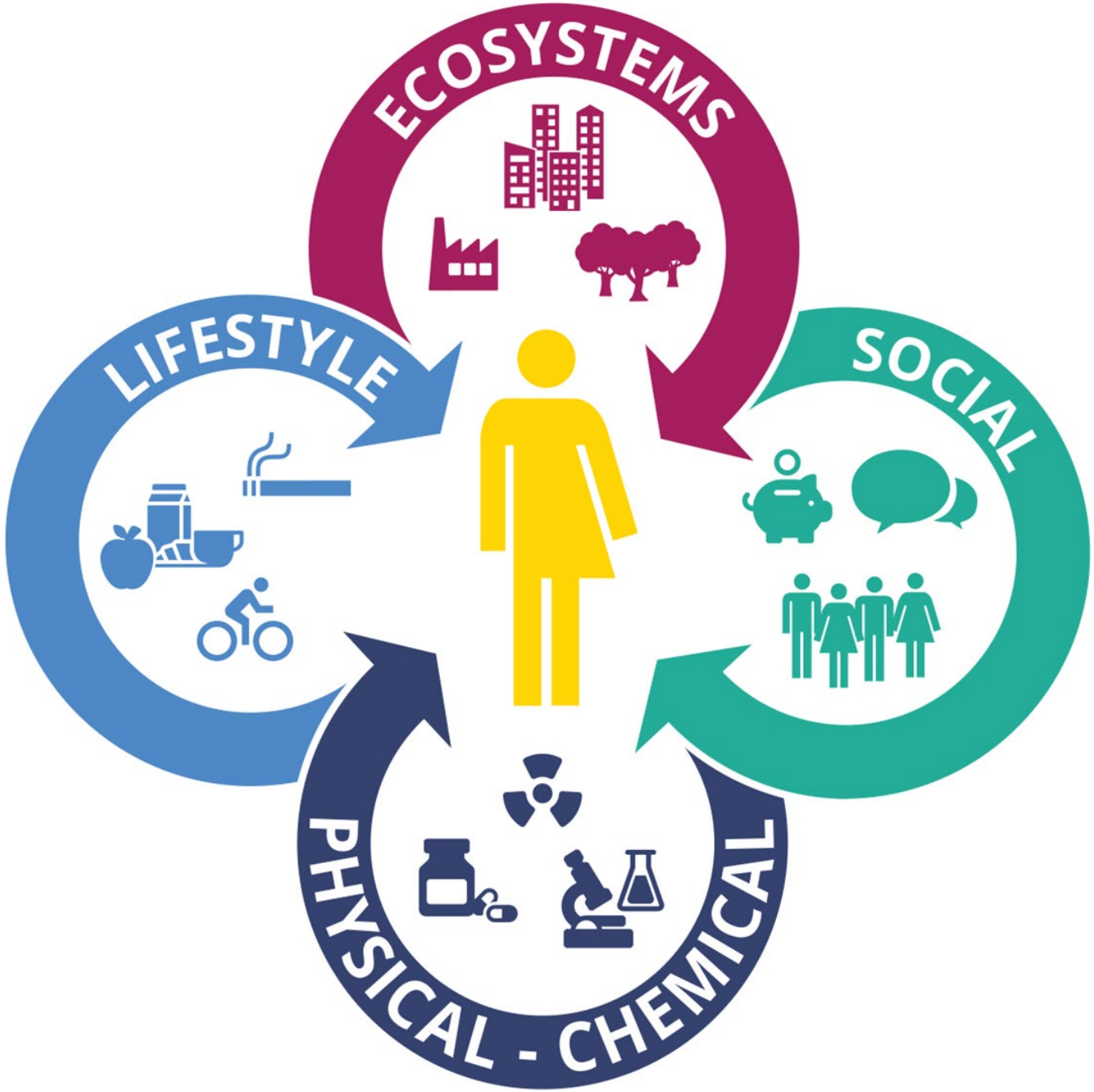
EXPOSOME

The measure of all the exposures of an individual in a lifetime and how those exposures relate to health*

*The National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC). https://www.cdc.gov/niosh/topics/exposome/default.html#:~:text=The%20exposome%20can%20be%20defined,from%20environmental%20and%20occupational%20sources.. Accessed 4/20/2021

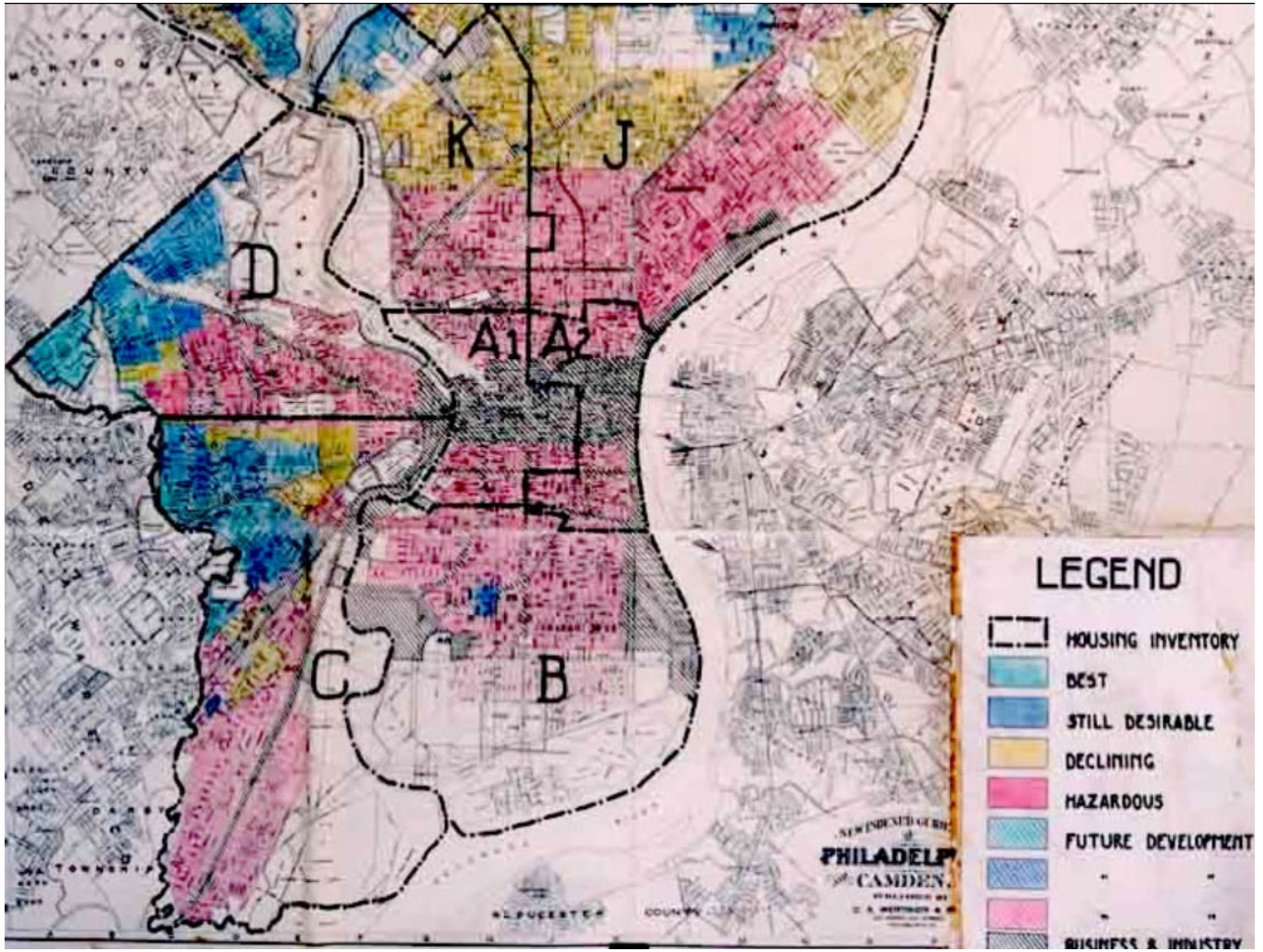
Exposome

- Factors external to the biological individual
- Diverse factors ranging from microbiome to structural inequity



Science. 2020. 367(6476): 392–396.

STRUCTURAL INEQUITIES



*The HOLC maps are part of the records of the FHLBB (RG195) at the National Archives II Archived 2016-10-11 at the Wayback Machine.

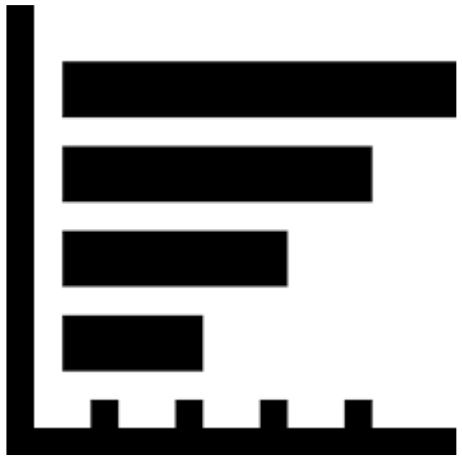
MOVING TO OPPORTUNITY STUDY

Individual Socioeconomics → **NO CHANGE**

Health → **IMPROVED**

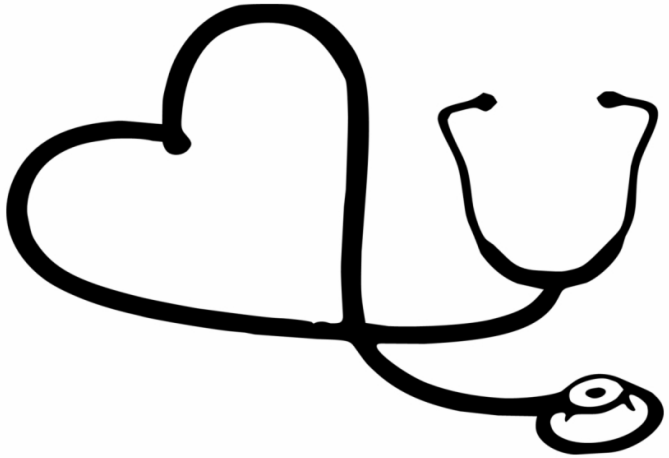
*Ludwig et al, New England Journal of Medicine, 2011; Ludwig et al, Science; Many others

EXAMINING THE EXPOSOME



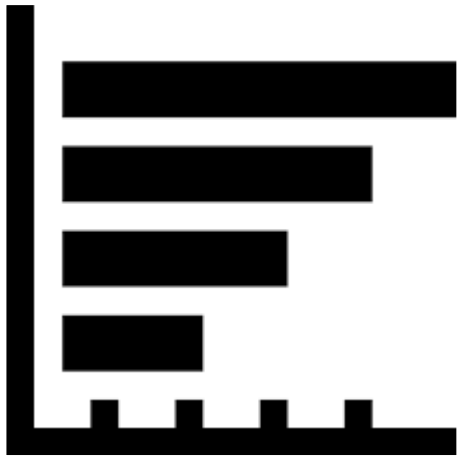
Quantifying Exposures

Linking Exposome to Biology



Research to Action

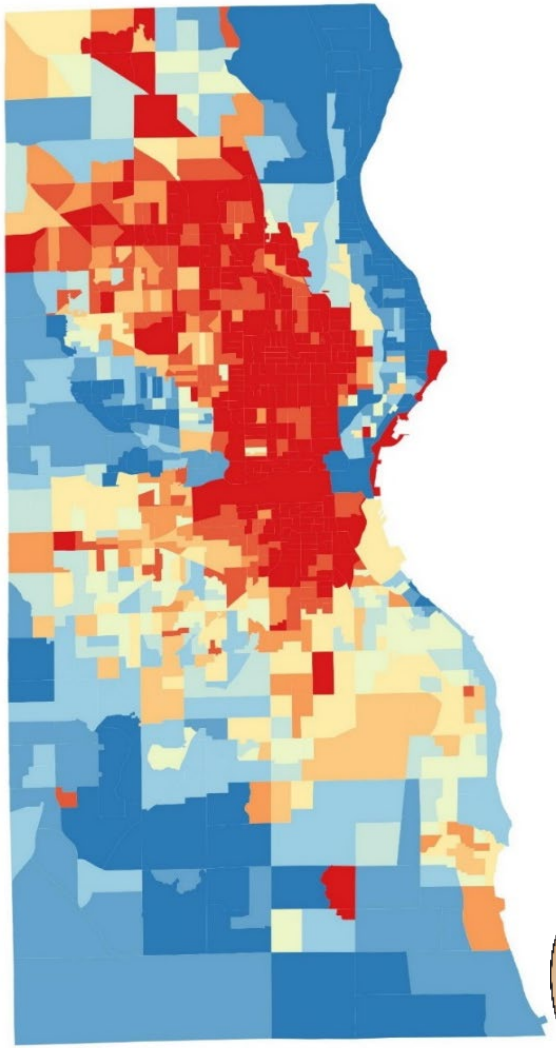
EXAMINING THE EXPOSOME



Quantifying Exposures

EXAMPLE: QUANTIFYING EXPOSOME USING THE AREA DEPRIVATION INDEX (ADI)*

- ADI construction
  - 17 measures of social determinants of health across small, population sensitive areas
  - Ranked score
  - Time concordant
- Current ADI measures for full US available through the Neighborhood Atlas®*
- Harmonizable metrics available internationally
- Disparities-aligned US exposome metric

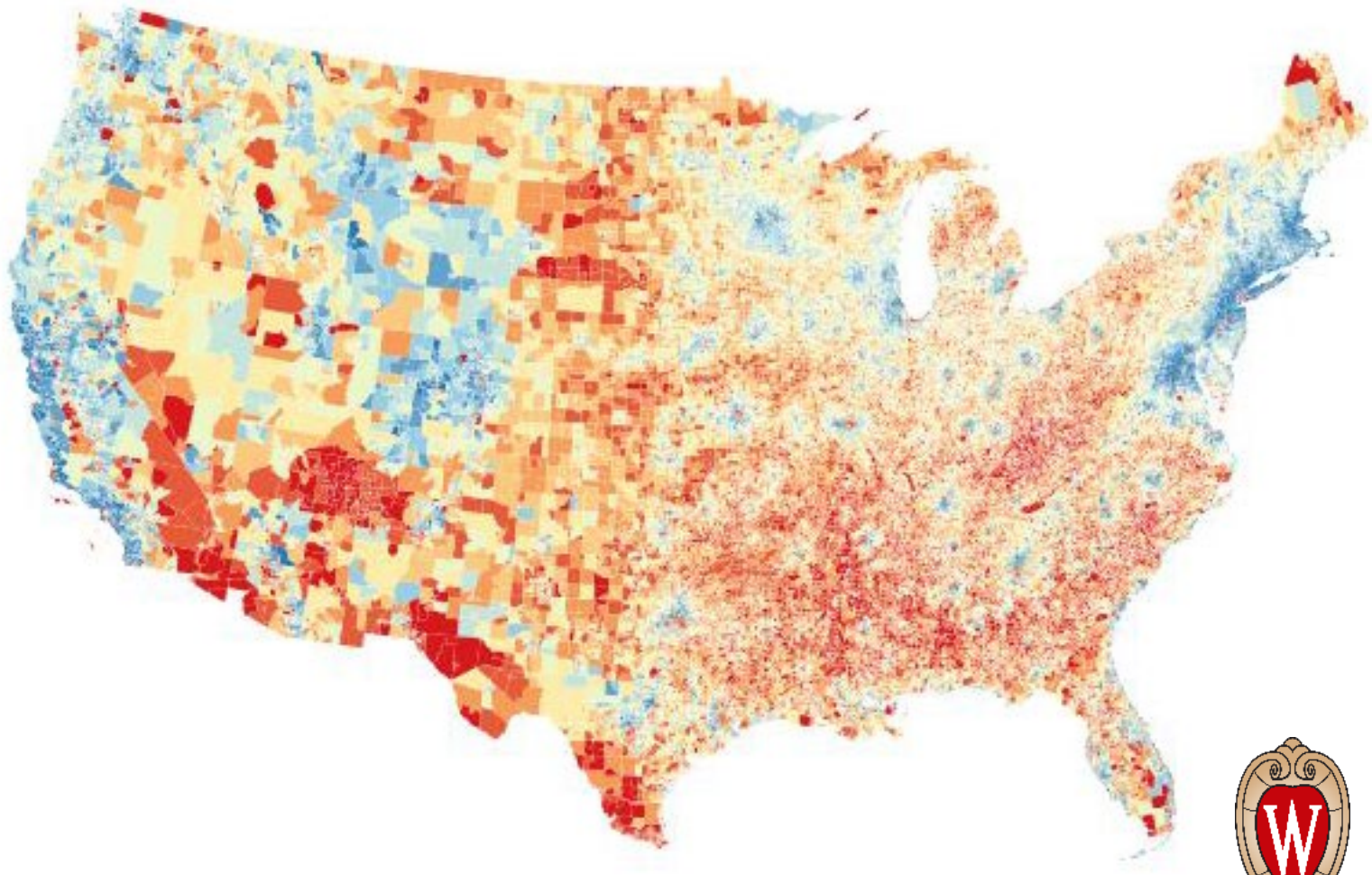


Milwaukee County

*Kind and Buckingham, *New England Journal of Medicine*, 2018

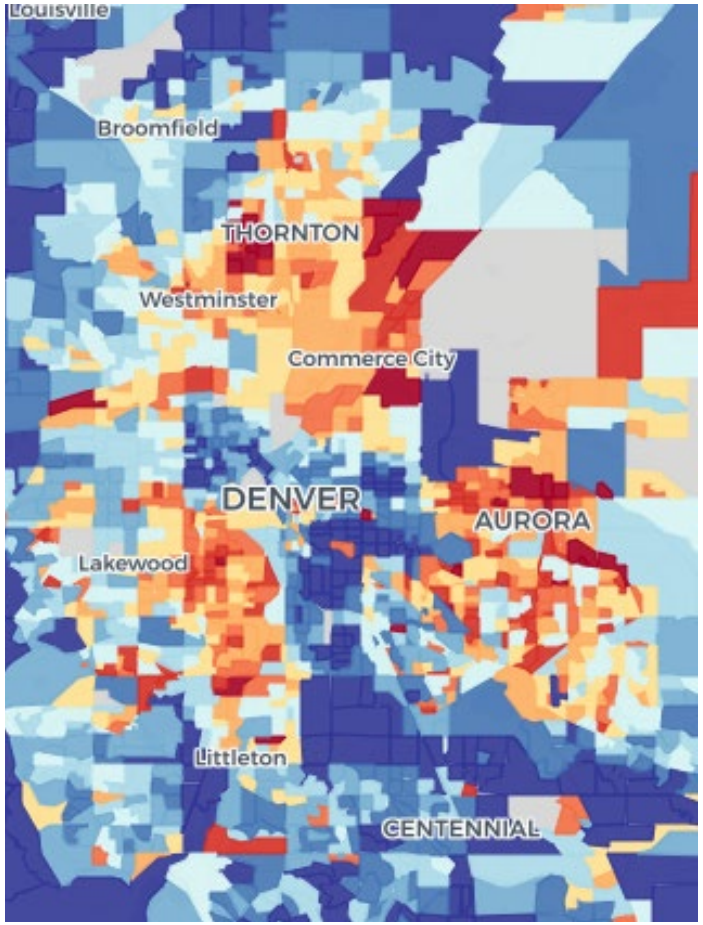
HIGHLY DISADVANTAGED NEIGHBORHOODS IN US

- More often in **urban core** and **rural** areas



*Kind et al, *Annals of Internal Medicine*, 2014; Kind and Buckingham, *New England Journal of Medicine,* 2018

RESIDING IN A HIGH ADI NEIGHBORHOOD IS LINKED TO:



- Epigenetic age acceleration (Lawrence et al, JAMA-Open, 2020)
- Rehospitalization and Cost (multiple)
- Later diagnoses and less comprehensive diagnostic evaluation (Tsoy et al, JAMA-Neurology, 2021; multiple)
- Increased risk of post-surgical complications (Arias et al, JAGS, 2021)
- Increased cardiovascular risk (Berman et al, JAMA-Cardiology, 2021; multiple)
- Decreased active-life expectancy (Gill et al, JAMA-IM, 2021)
- Many other factors

JAMA Network Open

Original Investigation | Surgery

Analysis of Delayed Surgical Treatment and Oncologic Outcomes in Clinical Stage I Non–Small Cell Lung Cancer

Brendan T. Heiden, MD; Daniel B. Eaton Jr, MPH; Kathryn E. Engelhardt, MD, MS; Su-Hsin Chang, PhD, SM; Yan Yan, MD, PhD; Mayank R. Patel, MD; Daniel Kreisel, MD, PhD; Ruben G. Nava, MD; Bryan F. Meyers, MD, MPH; Benjamin D. Kozower, MD, MPH; Varun Puri, MD, MSCI

Rachel Marsh[1] a

Area Deprivation Index Predicts Readmission Risk at an Urban Teaching Hospital

nd, Roee Gutman, Kristina Monteiro, William R. Buckingham,

DOI: 10.1377/hlthaff.2017.1509
HEALTH AFFAIRS 37,
NO. 7 (2018): –

American Journal of Transplantation | AST American Society of Transplantation | ASTS

ORIGINAL ARTICLE

Neighborhood socioeconomic deprivation is associated with worse patient and graft survival following pediatric liver transplantation

Sharad I. Wadhwani, Andrew F. Beck, John Bucuvalas, Laura Gottlieb, Uma Kotagal, Jennifer C. Lai

nuary 2020 | https://doi.org/10.1111/ajt.15786 | Citations: 4

SPECIAL ISSUE: HEA

Neighborhood

Annals

LATEST ISSUES

‹ PREV ARTICLE | THIS IS

ORIGINAL RESEARCH

Safety-Net Hospitals, Under Maryland's All-

Stephen F. Jencks, MD, MPH; Alyson Schu MSPH; Amy J.H. Kind, MD, PhD

Article, Author, and Disclosure Inform

JAMA Cardiology | Original Investigation

Association of Socioeconomic Disadvantage With Long-term Mortality After Myocardial Infarction

The Mass General Brigham YOUNG-MI Registry

Adam N. Berman, MD; David W. Biery, AB; Curtis Ginder, MD; Avinainder Singh, MBBS, MMSc; Jonggyu Baek, PhD; Rishi K. Wadhera, MD, MPP, MPhil; Wanda Y. Wu, BA; Sanjay Divakaran, MD; Ersilia M. DeFilippis, MD; Jon Hainer, BS; Christopher P. Cannon, MD; Jorge Plutzky, MD; Donna M. Polk, MD, MPH; Khurram Nasir, MD, MPH; Marcelo F. Di Carli, MD; Arlene S. Ash, PhD; Deepak L. Bhatt, MD, MPH; Ron Blankstein, MD

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Volume 45, O

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Brain connectivity and socioeconomic status at birth and externalizing symptoms at age 2 years

Bruce Ramphal [a], Diana J. Whalen [b], Jeanette K. Kenley [c], Qiongru Yu [b], Christopher D. Smyser [c, d, e], Cynthia E. Rogers [b, e], Chad M. Sylvester [b]

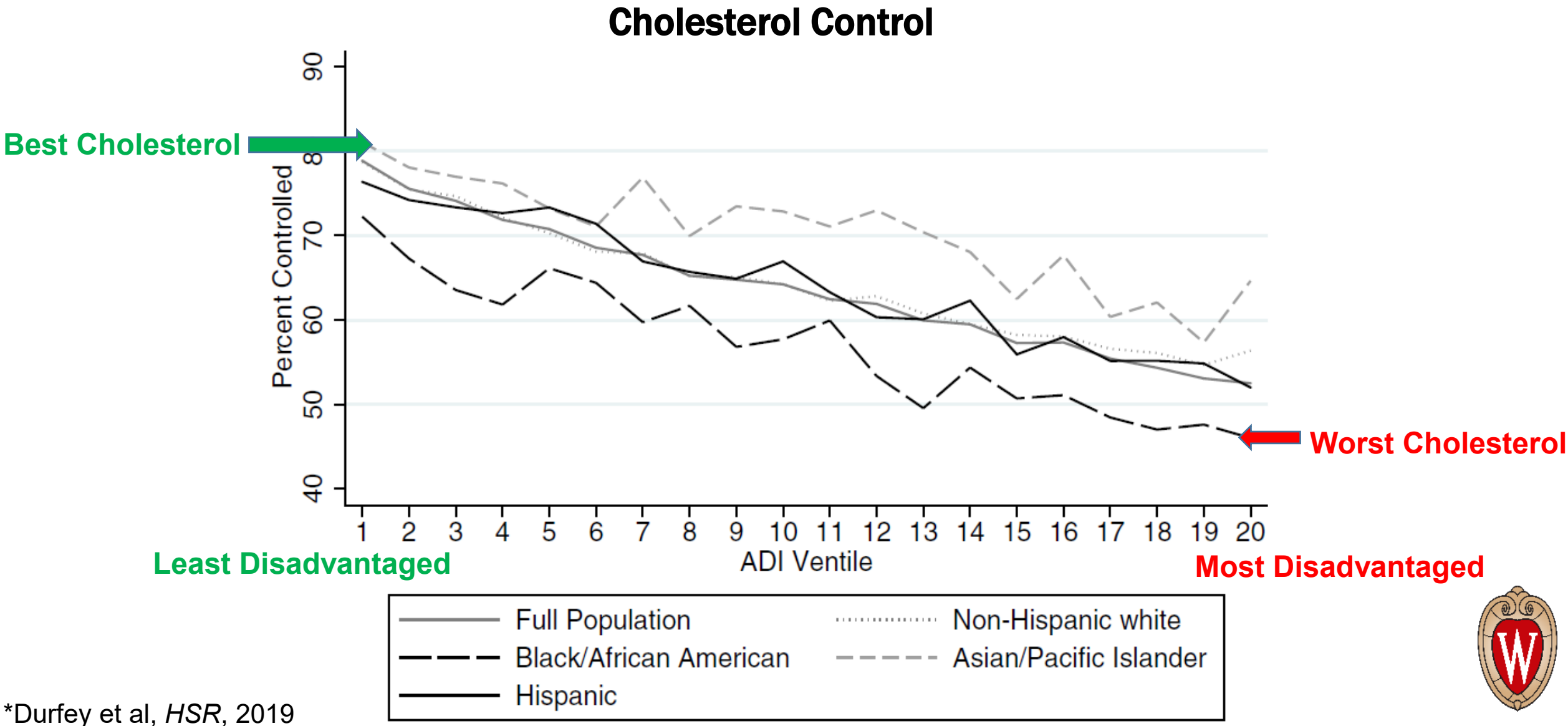
JAMA Network Open

Original Investigation | Infectious Diseases

Racial Disparities in Incidence and Outcomes Among Patients With COVID-19

L. Silvia Muñoz-Price, MD, PhD; Ann B. Nattinger, MD, MPH; Frida Rivera, MD, PhD; Ryan Hanson, MS; Cameron G. Gmehlin, BA; Adriana Perez, MS; Siddhartha Singh, MD, MS, MBA; Blake W. Buchan, PhD; Nathan A. Ledeboer, PhD; Liliana E. Pezzin, PhD, JD

NEIGHBORHOOD DISADVANTAGE AND CHOLESTEROL CONTROL



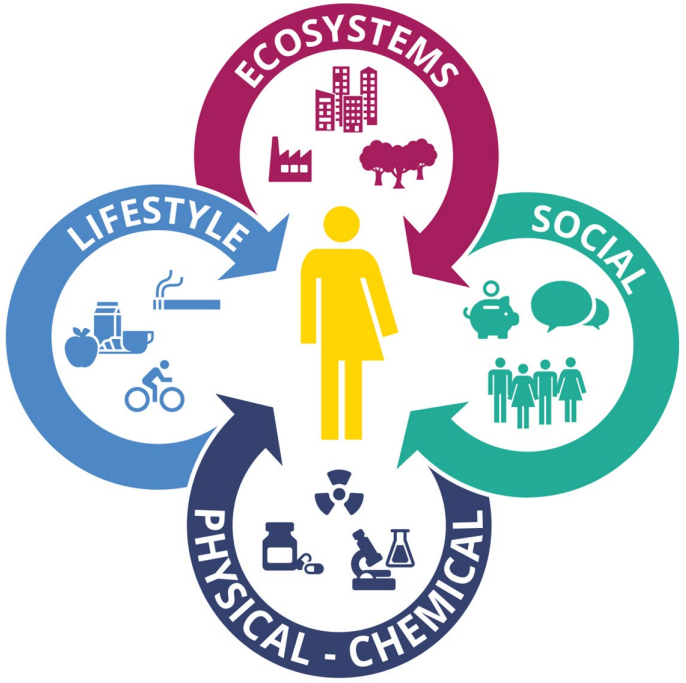
*Durfey et al, *HSR*, 2019

EXAMINING THE EXPOSOME

Linking Exposome to Biology

SOCIAL-BIOLOGICAL PHENOTYPING

- Link exposures to biological process
- Expand the potential of existing programs in completely new ways



Exposome

Science. 2020. 367(6476): 392–396.

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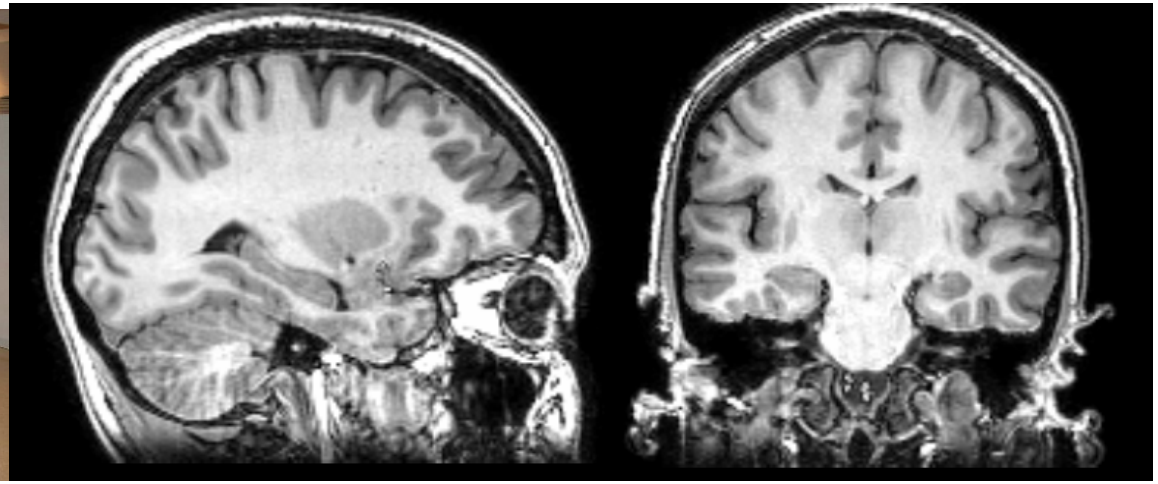
NEIGHBORHOOD DISADVANTAGE AND BRAIN STRUCTURE

- N=951 cognitively unimpaired research participants
- Residential address geocoded, linked to neighborhood disadvantage by ADI
- MRI measures of hippocampal and total brain tissue volume

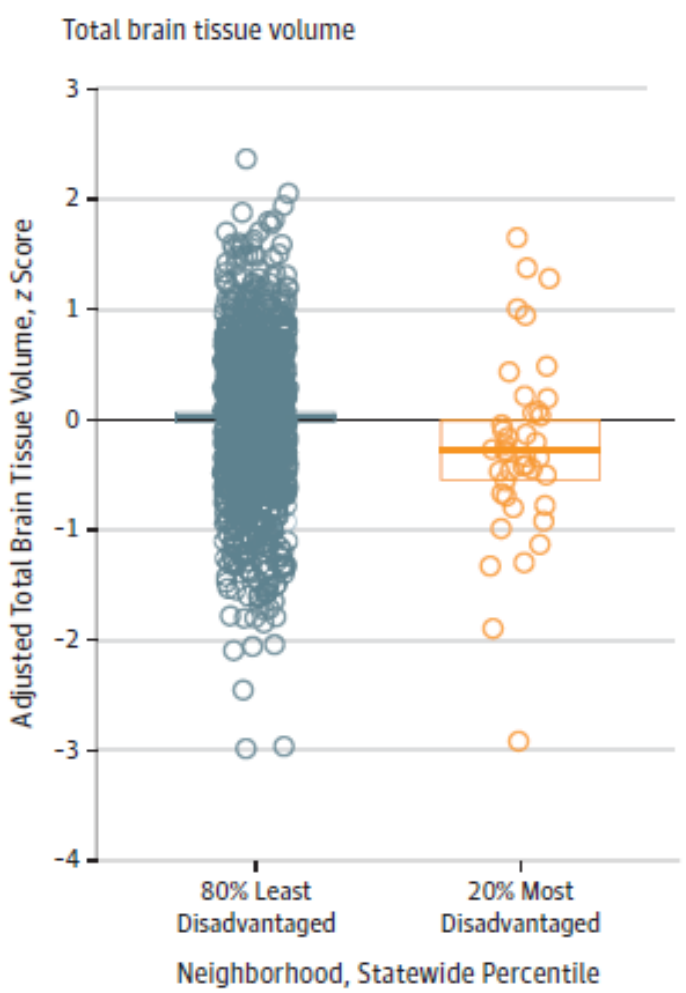


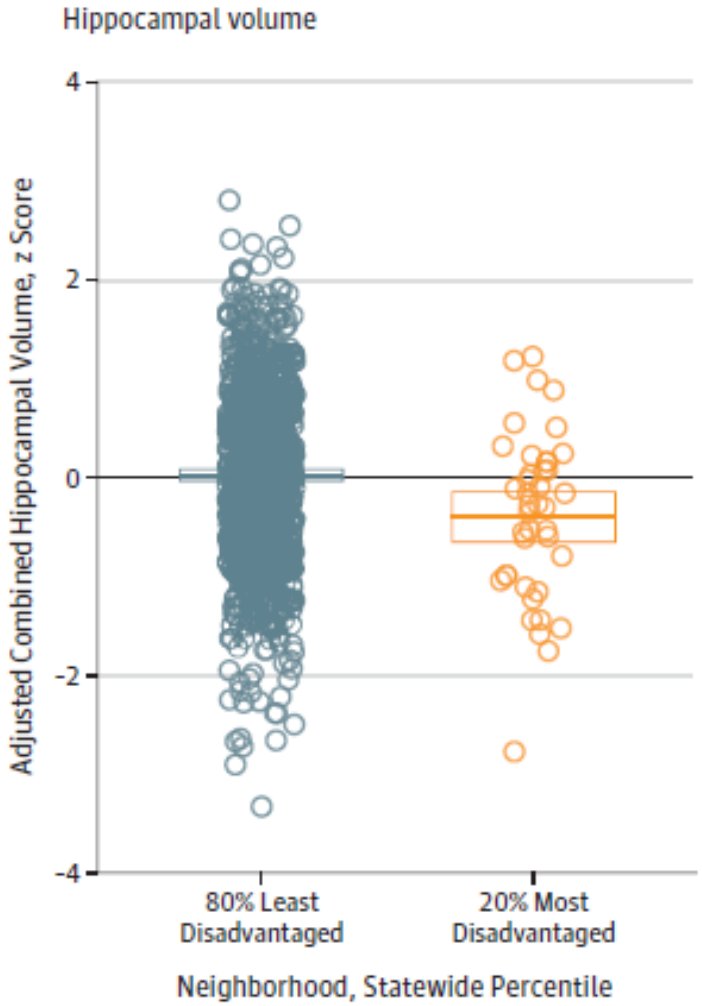
Hunt et al, JAMA-Neurology, 2020

JAMA Neurology | Original Investigation

Association of Neighborhood-Level Disadvantage With Cerebral and Hippocampal Volume

Jack F. V. Hunt, BA; William Buckingham, PhD; Alice J. Kim, BA; Jennifer Oh, BS; Nicholas M. Vogt, BA; Erin M. Jonaitis, MS, PhD; Tenah K. Hunt, MPH, PhD; Megan Zuelsdorff, PhD; Ryan Powell, PhD; Derek Norton, MS; Robert A. Rissman, PhD; Sanjay Asthana, MD; Ozioma C. Okonkwo, PhD; Sterling C. Johnson, PhD; Amy J. H. Kind, MD, PhD; Barbara B. Bendlin, PhD





Hunt et al, JAMA-Neurology, 2020

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April 14, 2021 ARTICLE

Association of Neighborhood Context, Cognitive Decline, and Cortical Change in an Unimpaired Cohort

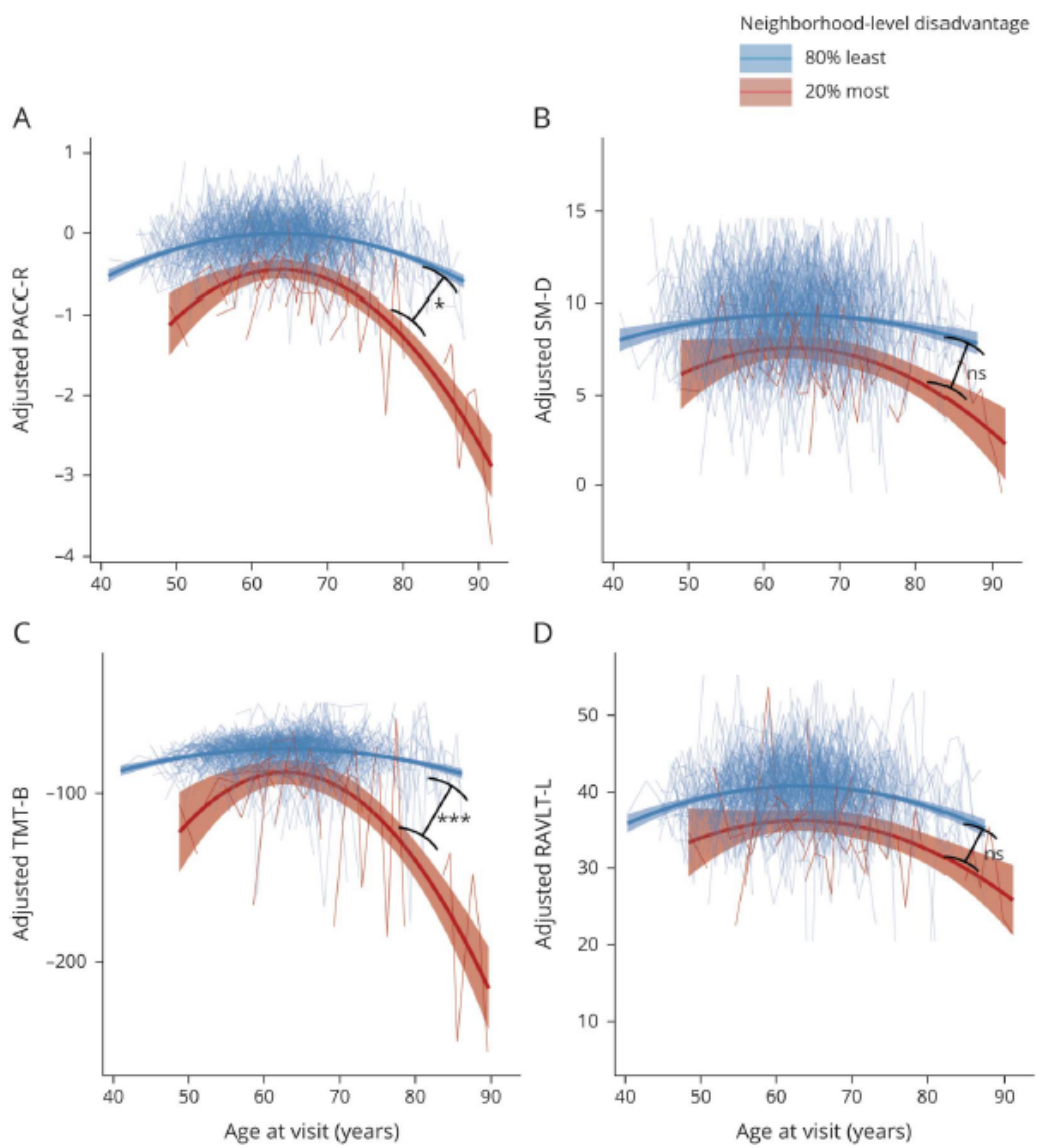
Jack F.V. Hunt, Nicholas M. Vogt, Erin M. Jonaitis, William R. Buckingham, Rebecca L. Koscik, Megan Zuelsdorff, Lindsay R. Clark, Carey E Gleason, Menggang Yu, Ozioma Okonkwo, Sterling C. Johnson, Sanjay Asthana, Barbara B. Bendlin, Amy J.H. Kind

First published April 14, 2021, DOI: https://doi.org/10.1212/WNL.0000000000011918

In this 10 year longitudinal study of cognitively unimpaired adults, living in the most highly disadvantaged neighborhoods was associated with accelerated degeneration (cortical thinning) in AD affected regions and more cognitive decline

Hunt et al, Neurology, 2021

Figure 2 Association Between Neighborhood-Level Disadvantage and Longitudinal Cognitive Trajectories



Plots depict performance on Preclinical Alzheimer's Cognitive Composite–Revised (PACC-R) composite (A) and component subtests (B–D) on the age on the x-axis. Higher scores equate to better performance on cognitive test (Trail-Making Test, part B [TMT-B] scores are multiplied by −1 fo consistency). Cognitive test scores are adjusted for sex, years of education, practice effects, and individual-level intercepts and slopes. Small lines plot) depict individual trajectories; large lines depict estimated quadratic slopes for participants with the 80% least neighborhood-level disadva lines, n = 582) and 20% most disadvantage (red lines, n = 19). Participants from the most highly disadvantaged neighborhoods exhibited significan decline in PACC-R and TMT-B than participants from less disadvantaged neighborhoods, but showed no difference in decline of Story Memory Delay (SM-D) or Rey Auditory Verbal Learning Test, total trials 1–5 (RAVLT-L). Unadjusted *p* values for age2:neighborhood disadvantage interaction terms are displayed on plots for each cognitive test: ns $p > 0.05$, *$p < 0.05$, ***$p < 0.001$.

ORIGINAL ARTICLE

Associations between Amygdala-Prefrontal Functional Connectivity and Age Depend on Neighborhood Socioeconomic Status

Bruce Ramphal[1], Mariah DeSerisy[2], David Pagliaccio[1], Elizabeth Raffanello[1], Virginia Rauh[3], Gregory Tau[1], Jonathan Posner[1], Rachel Marsh[1] and Amy E. Margolis[1]

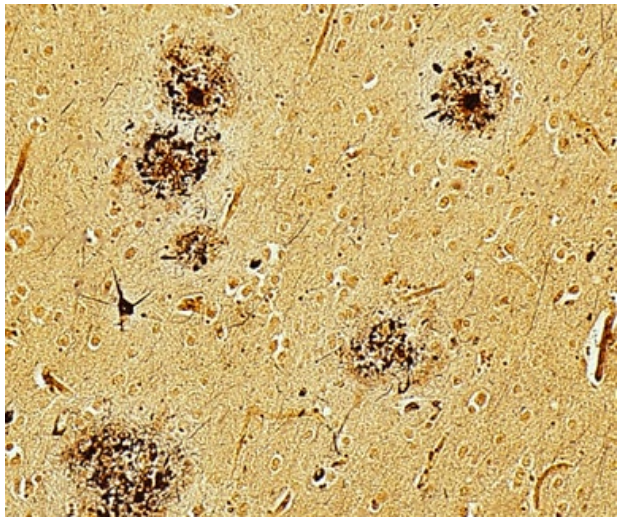
[1]New York State Psychiatric Institute and Department of Psychiatry, Vagelos College of Physicians and Surgeons, Columbia University, New York, NY 10032, USA, [2]Department of Psychology, Fordham University, Bronx, NY 10458, USA and [3]Department of Population and Family Health, Mailman School of Public Health, Columbia University, New York, NY 10032, USA

Address correspondence to Bruce Ramphal, 1051 Riverside Drive, Box 74/Room 2403, New York, NY 10032, USA. Email: bruce.ramphal@nyspi.columbia.edu.

Downloaded from https://academic.oup.com/cercorcomms/article/1/1

- Cross-sectional MRI study of 127 participants aged 5–25 years NYC area
- Reduced basolateral amygdala- prefrontal cortex functional connectivity at earlier ages in participants from more disadvantaged neighborhoods by ADI, independent of individual-level SES
- Reduced connectivity in more disadvantaged youth was associated with less anxiety

EXPOSOME AND NEUROPATHOLOGY



Source: www.Pixabay.com-- All images are released free of copyrights under Creative Commons CC0

- N=453 decedents who donated their brain to Wisconsin or University California San Diego ADRC brain banks, 1993-2016
- No social factor characterization available
- Residential address at death geocoded, linked to neighborhood disadvantage by ADI

Powell et al, JAMA-Open, 2020

JAMA Network Open

Original Investigation | Public Health

Association of Neighborhood-Level Disadvantage With Alzheimer Disease Neuropathology

W. Ryan Powell, PhD; William R. Buckingham, PhD; Jamie L. Larson, PhD; Leigha Vilen, BS; Menggang Yu, PhD; M. Shahriar Salamat, MD, PhD; Barbara B. Bendlin, PhD; Robert A. Rissman, PhD; Amy J. H. Kind, MD, PhD

Abstract

IMPORTANCE Social determinants of health, such as income, education, housing quality, and employment, are associated with disparities in Alzheimer disease and health generally, yet these determinants are rarely incorporated within neuropathology research.

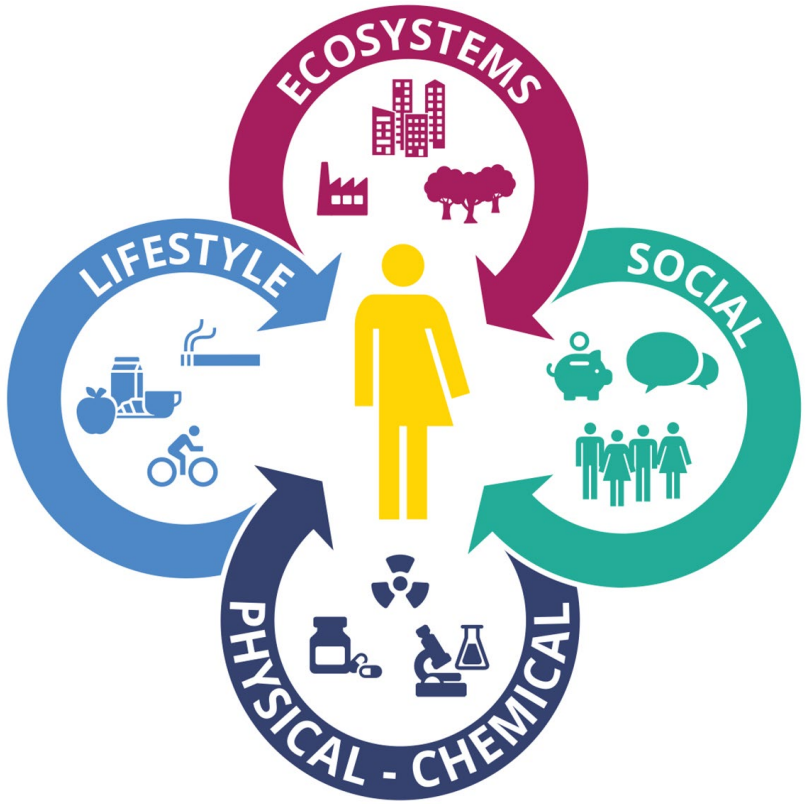
OBJECTIVE To establish the feasibility of linking neuropathology data to social determinants of health exposures using neighborhood disadvantage metrics (the validated Area Deprivation Index)

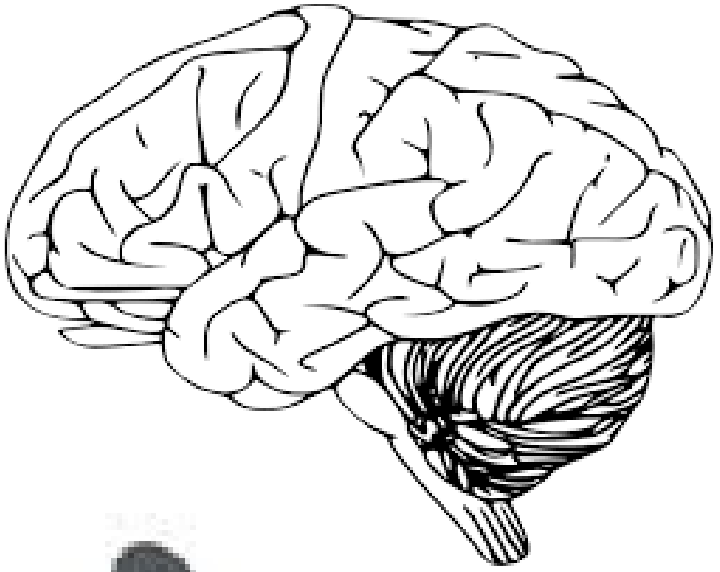
Key Points

Question Can neighborhood disadvantage, a social determinant of health, be incorporated into existing brain bank data to evaluate the risk of biological outcomes, such as Alzheimer disease neuropathology?

Living in the most disadvantaged neighborhood decile was associated with increased odds of AD neuropathology

June 11, 2020





Life-course

THE NEIGHBORHOODS STUDY

(R01AG070883; PI KIND, MPI BENDLIN)

Aim 1: Determine the impact of the **cumulative dose and timing** of neighborhood disadvantage exposure (indexed by ADI), on **cognitive function and change** over time

Aim 2: on AD-specific markers indexed by neuroimaging (**amyloid and tau PET**) and the secondary outcomes of vascular burden and volumetric MRI; and

Aim 3: on **neuropathologic tissue features and diagnosis**.

Aim 4: Using existing ADRC data and newly collected survey data, define the extent to which individual race/ethnicity, age, sex, income, education, comorbidity and health-behaviors mediate these relationships.

ACKNOWLEDGMENTS

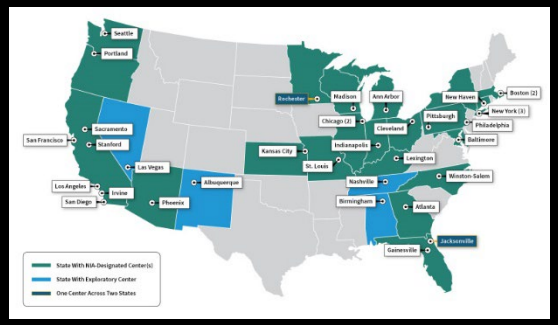
ADRC	Participating Components	Site PI(s)	Site Co-I(s)
University of Wisconsin	BB/CC	Amy Kind, Barbara Bendlin (MPI)	Vikas Singh, Menggang Yu
Banner Alzheimer's Institute	BB/CC	Eric Reiman, Thomas Beach	Kewei Chen
Boston University	BB/CC	Maureen K. O'Connor	Michael Alosco
Emory University	BB/CC	Felicia Goldstein	
Indiana University	BB/CC	Shannon Risacher	Andrew Saykin, Liana Apostolova
Johns Hopkins University	BB/CC	Corinne Pettigrew	
Mount Sinai School of Medicine	BB/CC	Mary Sano	Carolyn Zhu, Judith Neugroschl
New York University	BB/CC	Thomas Wisniewski, Joshua Chodosh	Karyn Marsh
Oregon Health & Science University	BB/CC	Aimee Pierce	Randall Woltjer, Raina Croff
Rush University	BB Only	Melissa Lamar	David Bennett, Lisa Barnes
Stanford University	BB/CC	Victor Henderson	Patricia Rodriguez Espinosa
UC–Davis	BB/CC	Oanh Meyer	Rachel Whitmer, Sarah Farias
UC–Irvine	BB/CC	David Sultzer	
UC–San Diego	BB/CC	Robert Rissman	James Brewer
UC–San Francisco	BB/CC	Serggio Lanata	
University of Kansas	BB/CC	Jonathan Mahnken	Jill Morris, Rebecca Lepping
University of Kentucky	BB Only	Erin Abner	Anna Kucharska-Newton
University of Michigan	BB/CC	Henry L. Paulson	Kelly Bakulski
University of Pittsburgh	BB/CC	Jennifer Lingler	Julia Kofler, Anthony Fabio
Wake Forest University	BB/CC	Suzanne Craft, Trey Bateman	Samuel Lockhart
Washington University in St. Louis	BB Only	Cyrus A. Raji	Richard Perrin
Yale University	BB/CC	Carmen Carrión	

Site	NACC	T1Weighted	Amyloid PET	Tau PET	Brain bank
Arizona Alzheimer's Center	328	328	214	177	390
Boston University	402	0	0	0	437
Emory University	455	250	30	10	333
Indiana University School of Medicine	480	262	119	143	436
Johns Hopkins University School of Medicine	295	215	0	0	683
Mount Sinai ADC	460	152	208	4	109
New York University	490	455	76	6	358
Oregon Health and Science University	318	81	23	9	920
Rush University Medical Center	0	0	0	0	1690
Stanford University	369	239	108	5	9
University of California, Davis	432	414	162	5	761
University of California, Irvine	319	94	40	10	153
University of California, San Diego	462	462	0	0	982
University of California, San Francisco	792	644	218	140	405
University of Kansas	341	175	76	0	47
University of Kentucky	0	0	0	0	971
University of Michigan ADC	468	268	300	300	205
University of Pittsburgh	639	495	110	31	699
Wake Forest University ADC	585	516	121	4	3
Washington University School of Medicine	0	0	0	0	296
Yale University ADRC	240	105	105	30	20
Total	**7875**	**5155**	**1910**	**874**	**9907**

UW Ns (ADRC only)
at time of submission:

Number with T1-weighted imaging: 803
Number with amyloid PET: 216
Number with tau PET: 129

Data sources



NACC
National Alzheimer's Coordinating Center
www.alz.washington.edu

Table 3. Sample Size, from 22 ADRCs

	n
Active participants with UDS reported to NACC (living cohort)*	9234
with T1-weighted imaging	5728
with amyloid PET	1995
with tau PET	958
Brain bank decedents with NACC neuropathology form	10469

*UDS: Uniform data set, standardized clinical data reported by all ADRCs to the National Alzheimer's Coordinating Center (NACC). MRI, Amyloid PET and Tau PET sample numbers are reflective of all available assessments across sites. Please see Neuroimaging Data section of this proposal for additional detail, including harmonization procedures.

Table 5. NACC and Survey Derived Data Elements

Health Behaviors:
Alcohol/Substance abuse[2,4]
Smoking[2]
Co-morbidities:
Cerebrovascular disease[2]
Heart disease[2,5]
Diabetes[2,5]
Hypertension[2,3,5]
Abnormal cholesterol[2,5]
Obesity[3]
Traumatic brain injury[2,4]
Individual Socioeconomic Position
Income[6]
Education[1,6]
Occupation[6]
Demographic Factors
Race/Ethnicity[1]
Age[1,6]
Gender[1]

Source: National Alzheimer's Coordinating Center (NACC) data-collection forms
Elements in database have been highly conserved across data form versions
[1]Form A1. Subject Demographics.
[2]Form A5: Subject Health History
[3]Form B1: Physical
[4]Form D1: Clinician Diagnosis
[5]Form D2: Clinician-Assessed Medical Conditions
[6]Collected in proposed survey

LIFE COURSE EXPOSOME CONSTRUCTION

Decedent Residential History: Geospatial targeting of exposure data across the life-course using publicly available data

- Participant addresses
- Public-data based construction (archival, genealogical and historical methods)
- 73% of all person years discoverable with considerable archival time investments

Living Cohort Residential History: Geospatial targeting of exposure data across the life-course

- Participant addresses
- Validated survey, standard approach
- Option for public data tracing

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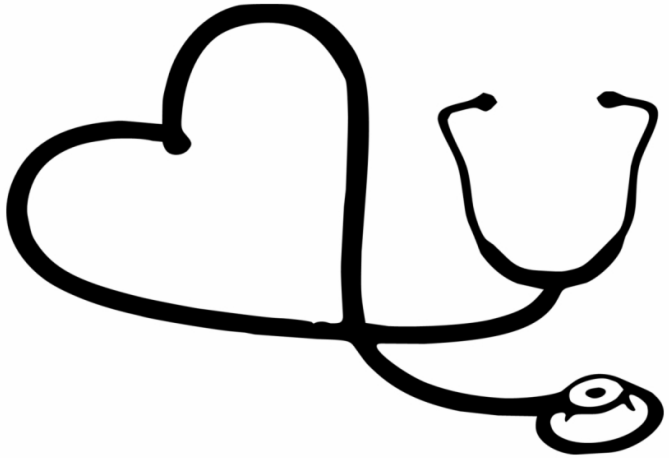
LIFE COURSE EXPOSOME CONSTRUCTION: CHALLENGES

- Technical considerations
  - Historical geocoding
  - Residential history construction on decedents
- Linking to Protected Health Information (PHI)
- Responsible and ethical sharing
- Data democratization considerations

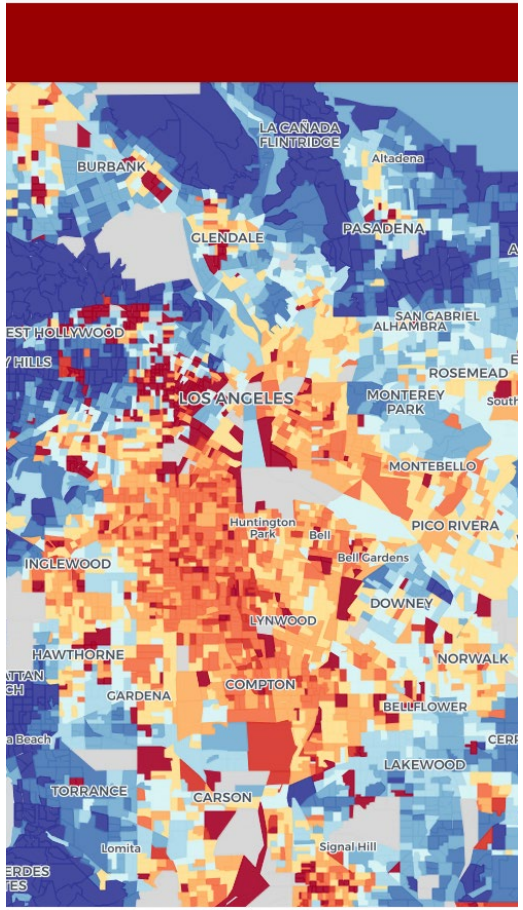
EXAMINING THE EXPOSOME



Research to Action

THE NEIGHBORHOOD ATLAS

www.neighborhoodatlas.medicine.wisc.edu

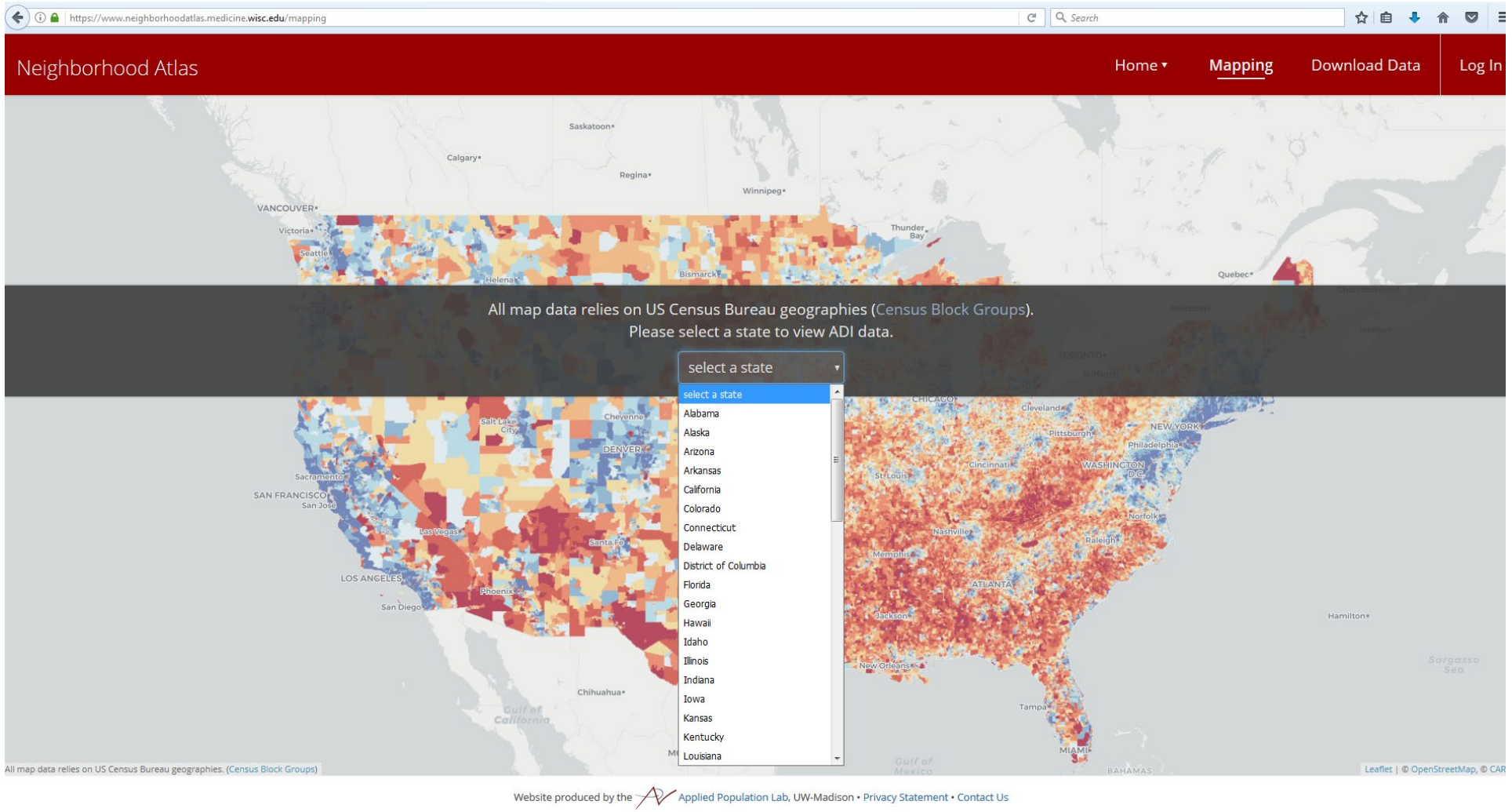


- Data democratization and open science tool for the ADI
- Customized mapping; Free, open to all
- Data downloaded tens of thousands of times by research, governmental, community, and industry groups.

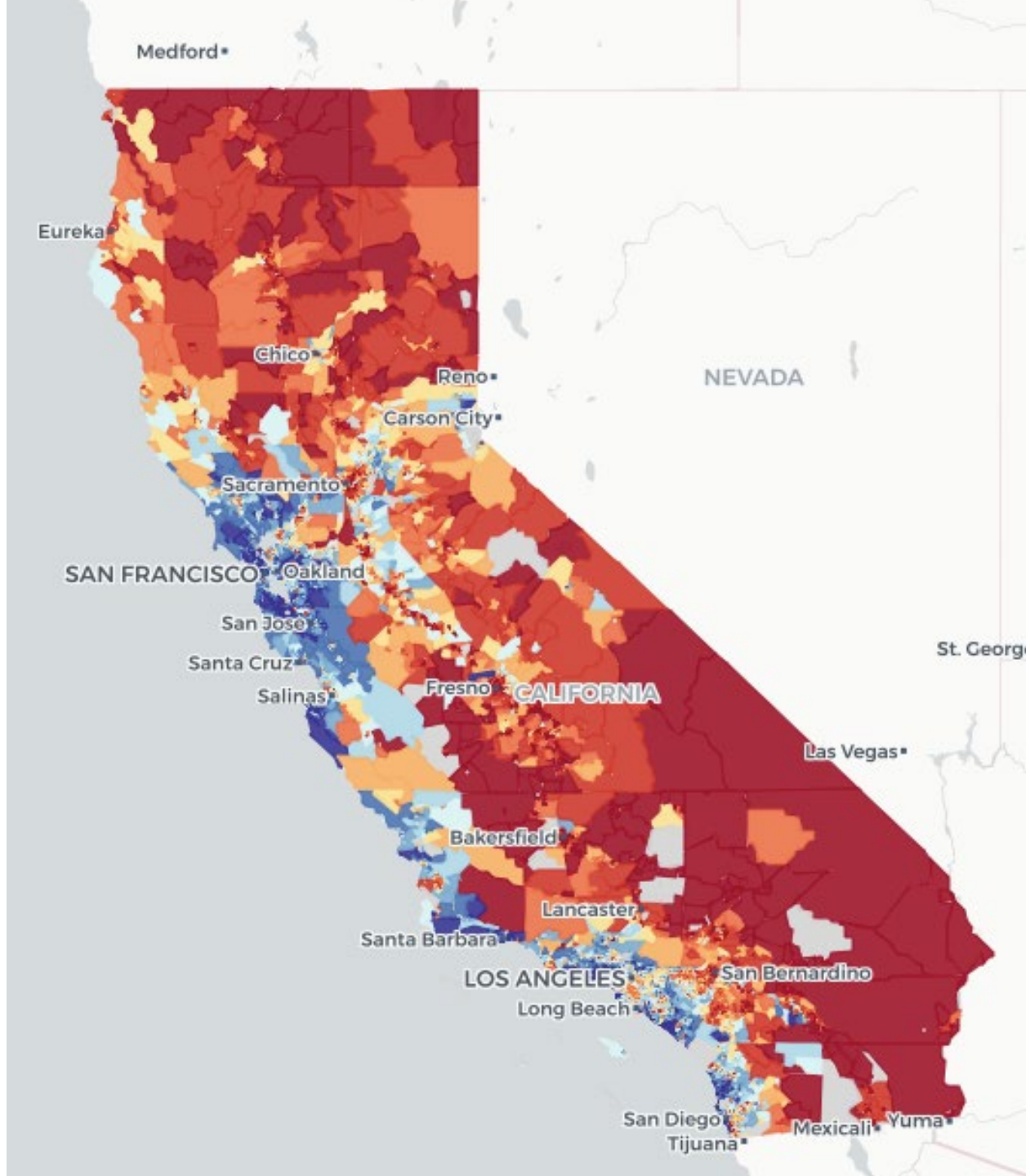
*Kind NEJM 2018

THE NEIGHBORHOOD ATLAS

www.neighborhoodatlas.medicine.wisc.edu



*Kind NEJM 2018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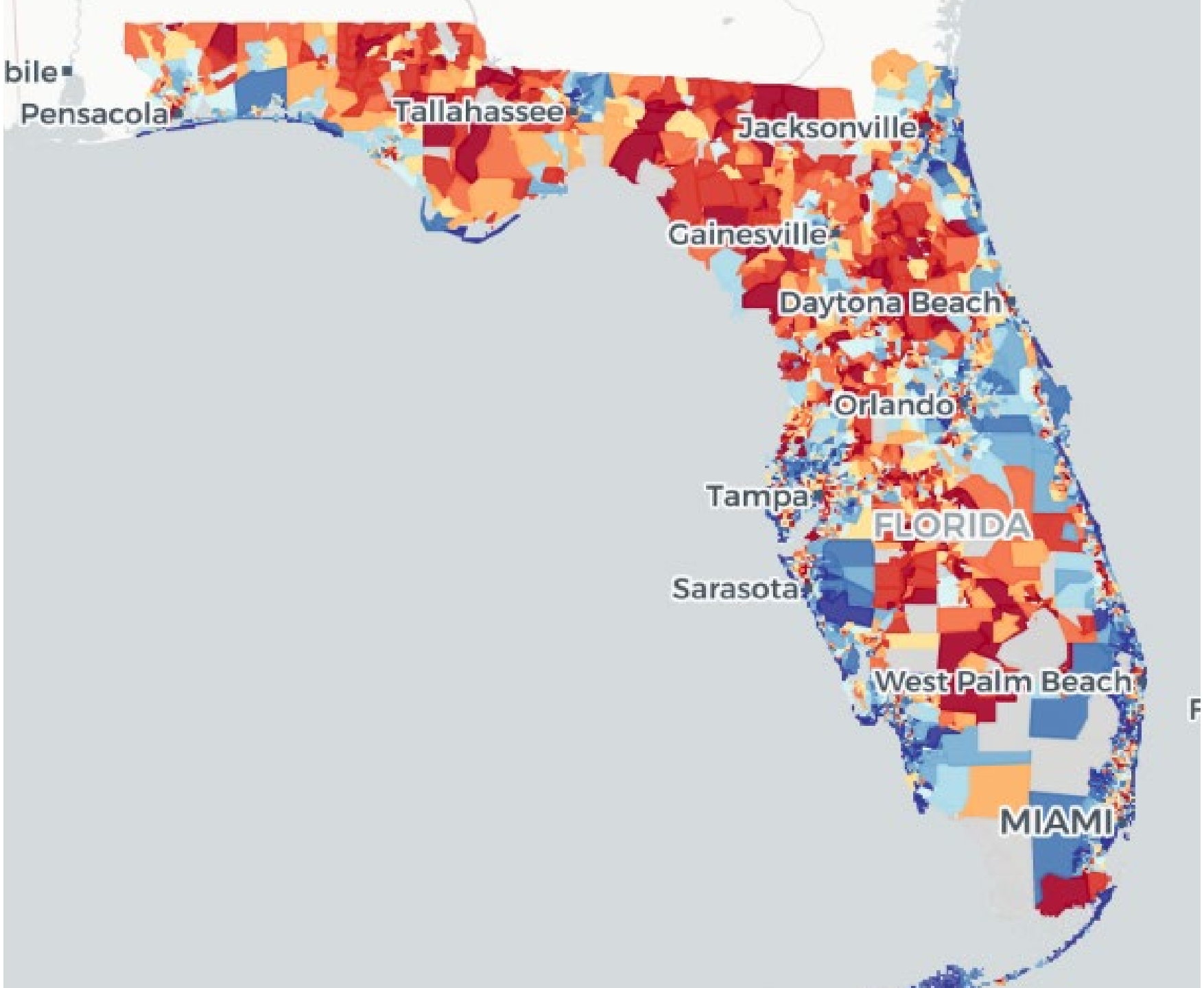
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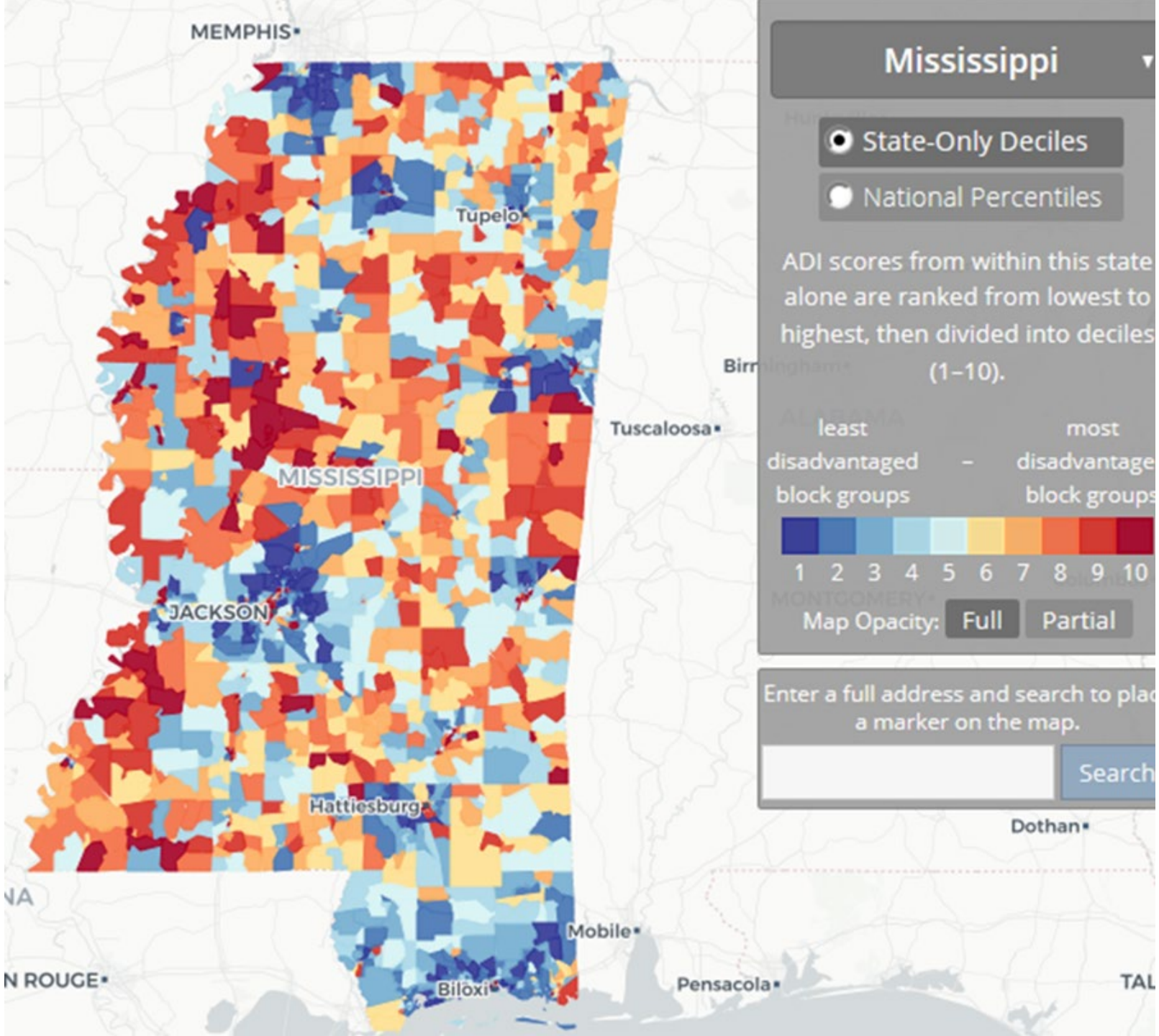
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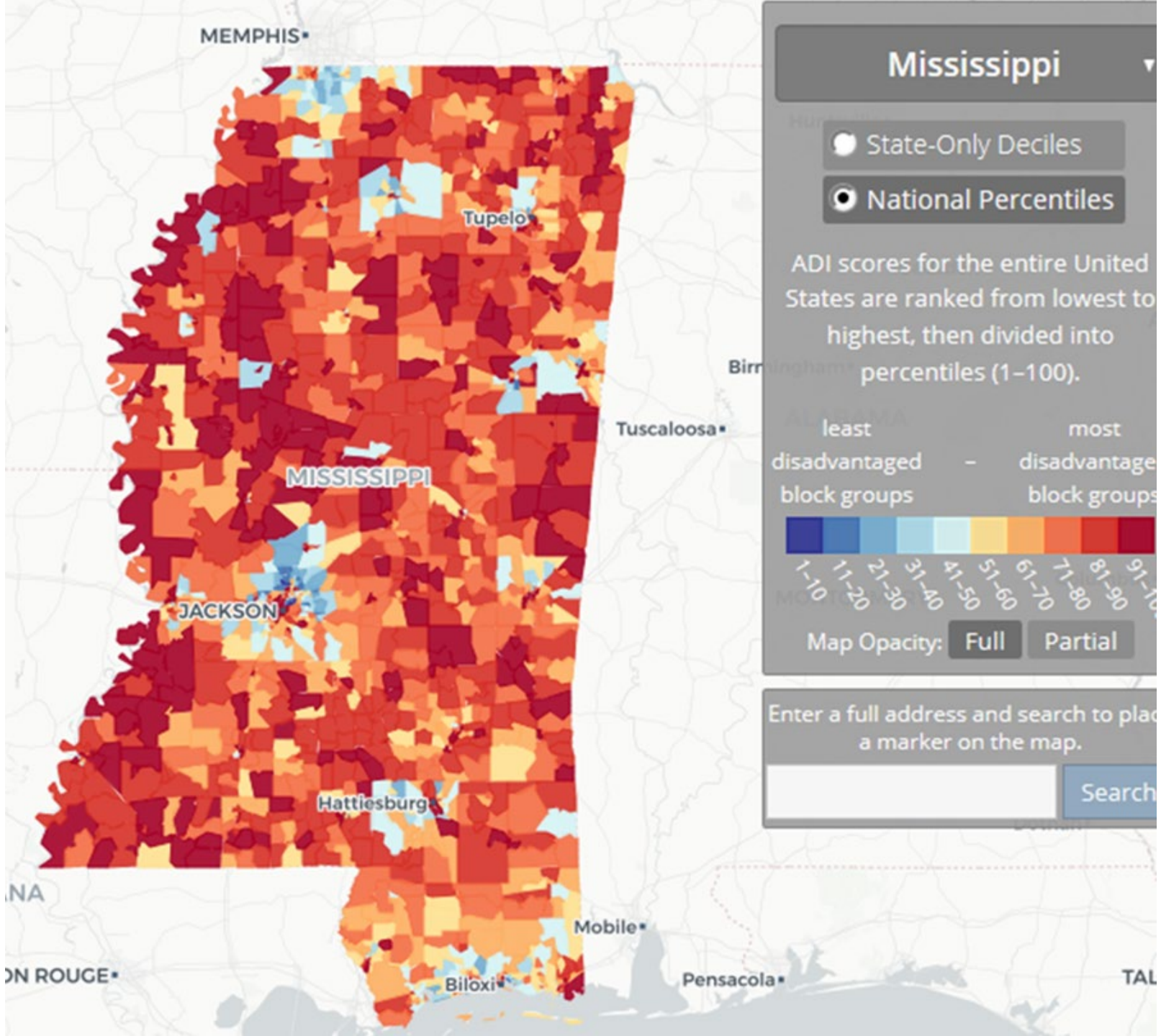
Mobile
Biloxi
Pensacola
Dothan
Mississippi
State-Only Deciles
National Percentiles
ADI scores from within this state alone are ranked from lowest to highest, then divided into deciles (1–10).
least disadvantaged block groups
most disadvantaged block groups
1 2 3 4 5 6 7 8 9 10
Map Opacity: Full Partial
Enter a full address and search to place a marker on the map.
Search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MISSISSIPPI
JACKSON
Hattiesburg
Mobile
Biloxi
Pensacola
Mississippi
State-Only Deciles
National Percentiles
ADI scores for the entire United States are ranked from lowest to highest, then divided into percentiles (1–100).
least disadvantaged block groups
most disadvantaged block groups
1–10
11–20
21–30
31–40
41–50
51–60
61–70
71–80
81–90
Map Opacity:
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Enter a full address and search to place a marker on the map.
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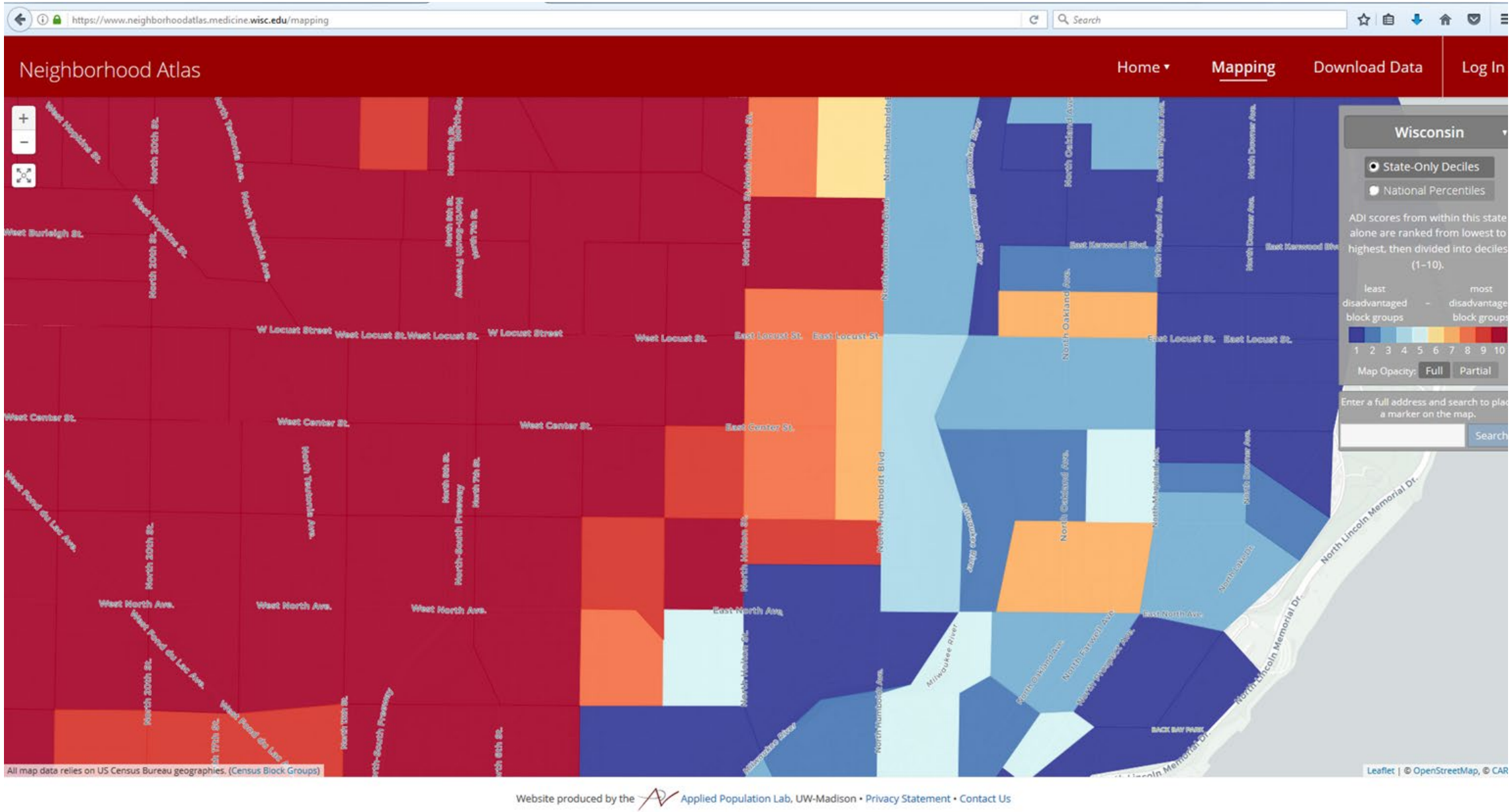

https://www.neighborhoodatlas.medicine.wisc.edu/

CENTER FOR MEDICARE AND MEDICAID INNOVATION (CMMI)

CMS
CENTERS for MEDICARE & MEDICAID SERVICES

2023 Accountable Care Organization – Realizing Equity, Access and Community Health (ACO-REACH)

- **Goal: Advance Health Equity to Bring the Benefits of Accountable Care to Underserved Communities.**
  - ACO REACH will test an innovative payment approach to better support care delivery and coordination for patients in underserved communities and will require that all model participants develop and implement a robust health equity plan to identify underserved communities and implement initiatives to measurably reduce health disparities within their beneficiary populations.

*Text taken from CMS.gov official ACO-REACH materials at https://innovation.cms.gov/innovation-models/aco-reach

Health Equity Benchmark Adjustment

ACO REACH includes a benchmark adjustment that increases benchmarks for ACOs serving higher proportions of underserved beneficiaries

CMS will stratify all beneficiaries aligned to ACO REACH using a composite measure of underservice that incorporates a combination of[1]:

Area Deprivation Index	Dual Medicaid Status
*Area-level measure of **local socioeconomic factors** correlated with medical disparities and underservice*	*Beneficiary-level measure of economic challenges affecting individuals' ability to access high quality care*
Percentile Score from 1-100	**25 Point Adjustment for Full or Partial Dual Eligibility**

91st – 100th Percentile (Top Decile)	***+$30 PBPM Adjustment***
51st – 90th Percentile (Middle 4 Deciles)	*No Adjustment*
1st – 50th Percentile (Bottom 5 Deciles)	*-$6 PBPM Adjustment*

1. CMS may explore other variables to include in this assessment and will notify applicants prior to the start of PY2023 if any other variables are included.

*2023 ACO Realizing Equity, Access, and Community Health (REACH) Model [https://innovation.cms.gov/media/document/aco-reach-fin-meth-webinar-slides}

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ADI USE IS WIDESPREAD, INCLUDING IN US FEDERAL POLICY

- NIH Dissemination of the ADI
- Industry Partnerships
- Professional Medical Societies
- Private Insurers
- State Medicaid Programs
- US Center for Medicare and Medicaid Services ACO-REACH Program

Examples:

TIPS TO REMEMBER

- The ADI is an extensively validated measure of the social exposome which links to a wide array of biological metrics and health outcomes.
- Individual-level social factors and exposome-level social factors are independently related to health outcomes. Both are important.
- Metrics of neighborhood disadvantage often reflect structural inequities– highly disadvantaged neighborhoods are not distributed equally.
- The Neighborhood Atlas is a freely available data democratization tool that provides customizable geographic images of block-group level ADI for anywhere within the US.

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Banner Alzheimer's Institute	BB/CC	Eric Reiman, Thomas Beach	Kewei Chen
Boston University	BB/CC	Maureen K. O'Connor	Michael Alosco
Emory University	BB/CC	Felicia Goldstein	
Indiana University	BB/CC	Shannon Risacher	Andrew Saykin, Liana Apostolova
Johns Hopkins University	BB/CC	Corinne Pettigrew	
Mount Sinai School of Medicine	BB/CC	Mary Sano	Carolyn Zhu, Judith Neugroschl
New York University	BB/CC	Thomas Wisniewski, Joshua Chodosh	Karyn Marsh
Oregon Health & Science University	BB/CC	Aimee Pierce	Randall Woltjer, Raina Croff
Rush University	BB Only	Melissa Lamar	David Bennett, Lisa Barnes
Stanford University	BB/CC	Victor Henderson	Patricia Rodriguez Espinosa
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UC–Irvine	BB/CC	David Sultzer	
UC–San Diego	BB/CC	Robert Rissman	James Brewer
UC–San Francisco	BB/CC	Serggio Lanata	
University of Kansas	BB/CC	Jonathan Mahnken	Jill Morris, Rebecca Lepping
University of Kentucky	BB Only	Erin Abner	Anna Kucharska-Newton
University of Michigan	BB/CC	Henry L. Paulson	Kelly Bakulski
University of Pittsburgh	BB/CC	Jennifer Lingler	Julia Kofler, Anthony Fabio
Wake Forest University	BB/CC	Suzanne Craft, Trey Bateman	Samuel Lockhart
Washington University in St. Louis	BB Only	Cyrus A. Raji	Richard Perrin
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UNIVERSITY OF WISCONSIN
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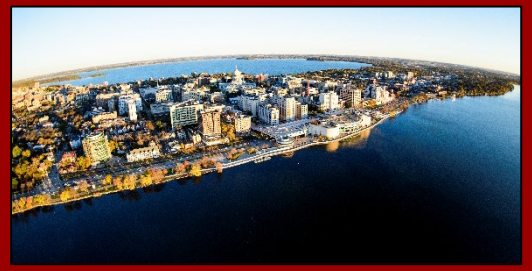












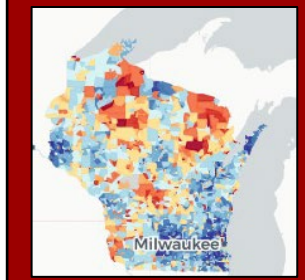

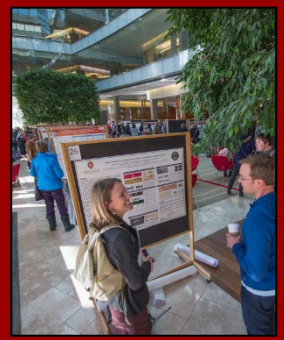








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