Early-Stage Investigator Lecture

Structural and Social Determinants of Brain Health and Alzheimer's Disease and Related Dementias

Presented by:
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University of Miami Miller School of Medicine

NIH National Institutes of Health
Office of Disease Prevention

My background

Education

- PhD City and Regional Planning
- Master of Science in Public Health
  - Epidemiology
  - Environmental and Occupational Health
- Bachelor of Science in Biology

My research program:

- Influence of built and social environments on health throughout the life course, brain health, and risk for Alzheimer's disease and related dementias

Why I study brain health

- Curiosity about the complexity of the brain and how it functions
- UW's National Alzheimer's Coordinating Center for almost 8 years prior to academic appointment
- Paternal grandmother had dementia, lived to 92
- Maternal grandmother was healthy, lived to 104, community dwelling in Philippines

Presentation outline

Key concepts – Dementia, Alzheimer's disease and related dementias (ADRD), brain health, social/structural determinants of health (S/SDOH)

Conceptual framework linking S/SDOH, brain health, and ADRD

Evidence linking S/SDOH and brain health/ADRD

Future directions

S/SDOH = Social/structural determinants of health
ADRD = Alzheimer's disease and related dementias

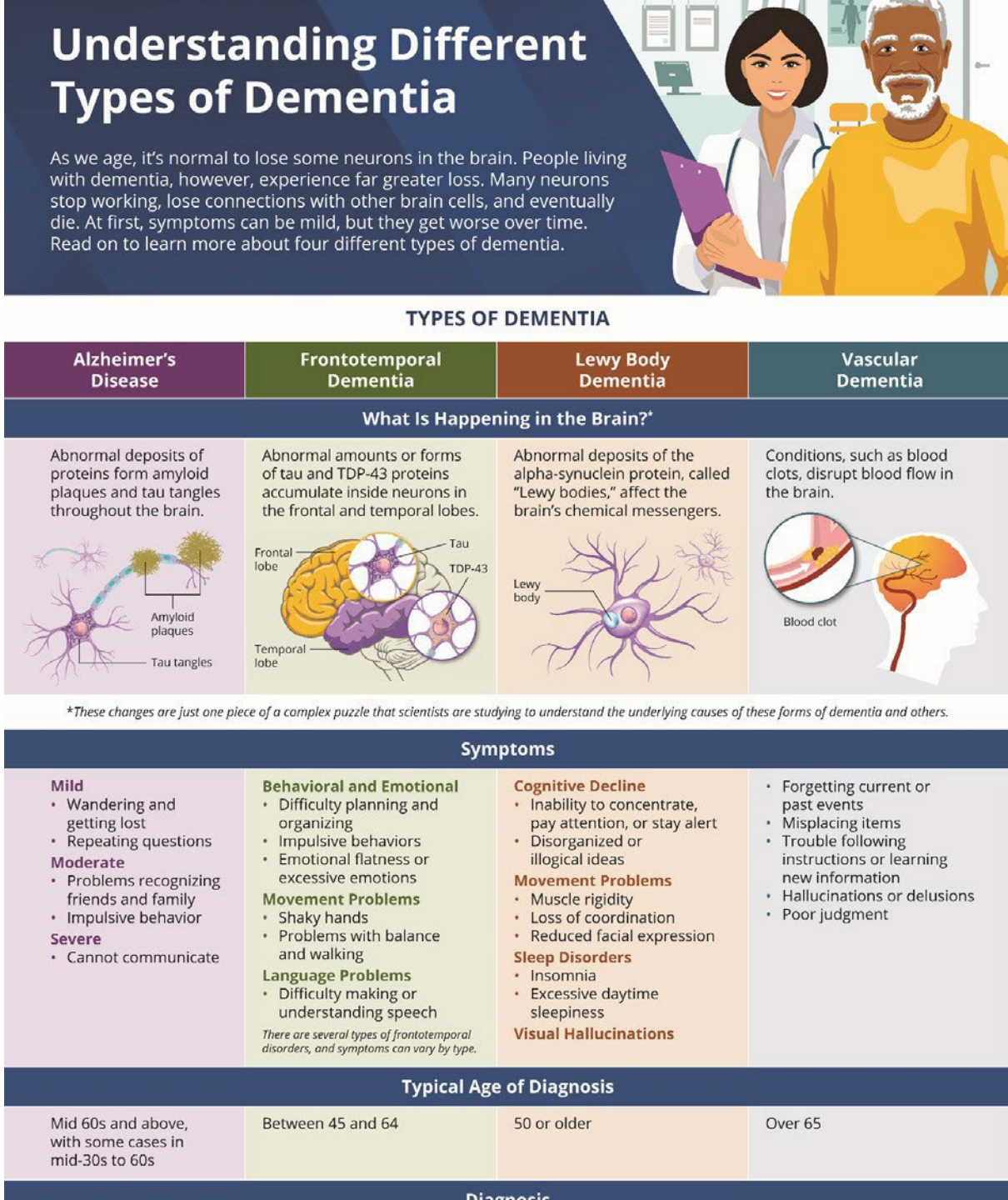
Key concepts

Dementia

Loss of cognitive functioning — thinking, remembering, and reasoning — to such extent that interferes with person's daily life and activities

Different etiologies, varying age of onsets, presentations, and risk factors:

- Alzheimer's disease – most common cause
- Frontotemporal dementia
- Lewy body dementia
- Vascular dementia



Understanding Different Types of Dementia

As we age, it's normal to lose some neurons in the brain. People living with dementia, however, experience far greater loss. Many neurons stop working, lose connections with other brain cells, and eventually die. At first, symptoms can be mild, but they get worse over time. Read on to learn more about four different types of dementia.

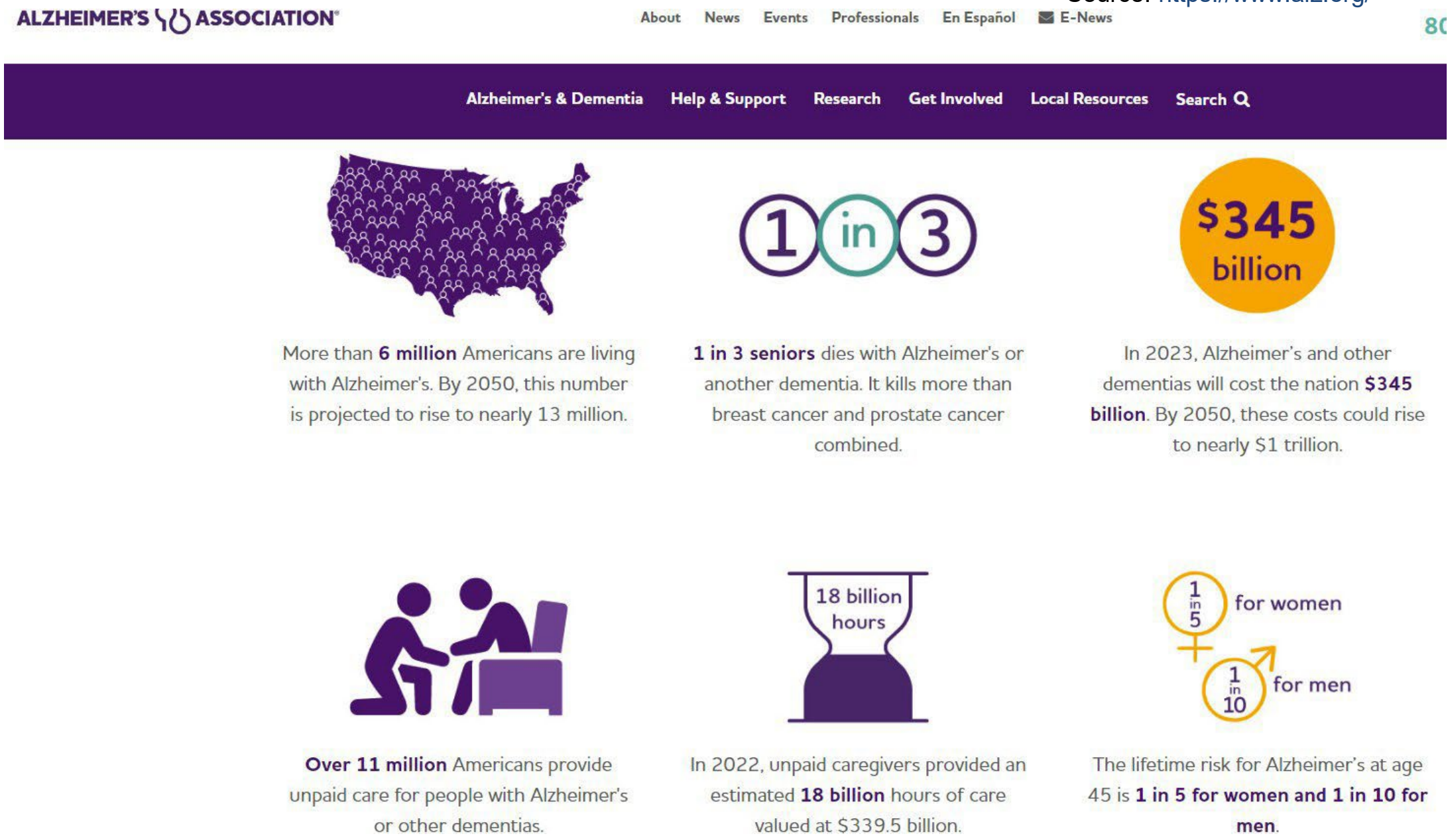
TYPES OF DEMENTIA

	Alzheimer's Disease	Frontotemporal Dementia	Lewy Body Dementia	Vascular Dementia
What Is Happening in the Brain?*	Abnormal deposits of proteins form amyloid plaques and tau tangles throughout the brain.	Abnormal amounts or forms of tau and TDP-43 proteins accumulate inside neurons in the frontal and temporal lobes.	Abnormal deposits of the alpha-synuclein protein, called "Lewy bodies," affect the brain's chemical messengers.	Conditions, such as blood clots, disrupt blood flow in the brain.
Symptoms	**Mild** • Wandering and getting lost • Repeating questions **Moderate** • Problems recognizing friends and family • Impulsive behavior **Severe** • Cannot communicate	**Behavioral and Emotional** • Difficulty planning and organizing • Impulsive behaviors • Emotional flatness or excessive emotions **Movement Problems** • Shaky hands • Problems with balance and walking **Language Problems** • Difficulty making or understanding speech *There are several types of frontotemporal disorders, and symptoms can vary by type.*	**Cognitive Decline** • Inability to concentrate, pay attention, or stay alert • Disorganized or illogical ideas **Movement Problems** • Muscle rigidity • Loss of coordination • Reduced facial expression **Sleep Disorders** • Insomnia • Excessive daytime sleepiness **Visual Hallucinations**	• Forgetting current or past events • Misplacing items • Trouble following instructions or learning new information • Hallucinations or delusions • Poor judgment
Typical Age of Diagnosis	Mid 60s and above, with some cases in mid-30s to 60s	Between 45 and 64	50 or older	Over 65

*These changes are just one piece of a complex puzzle that scientists are studying to understand the underlying causes of these forms of dementia and others.

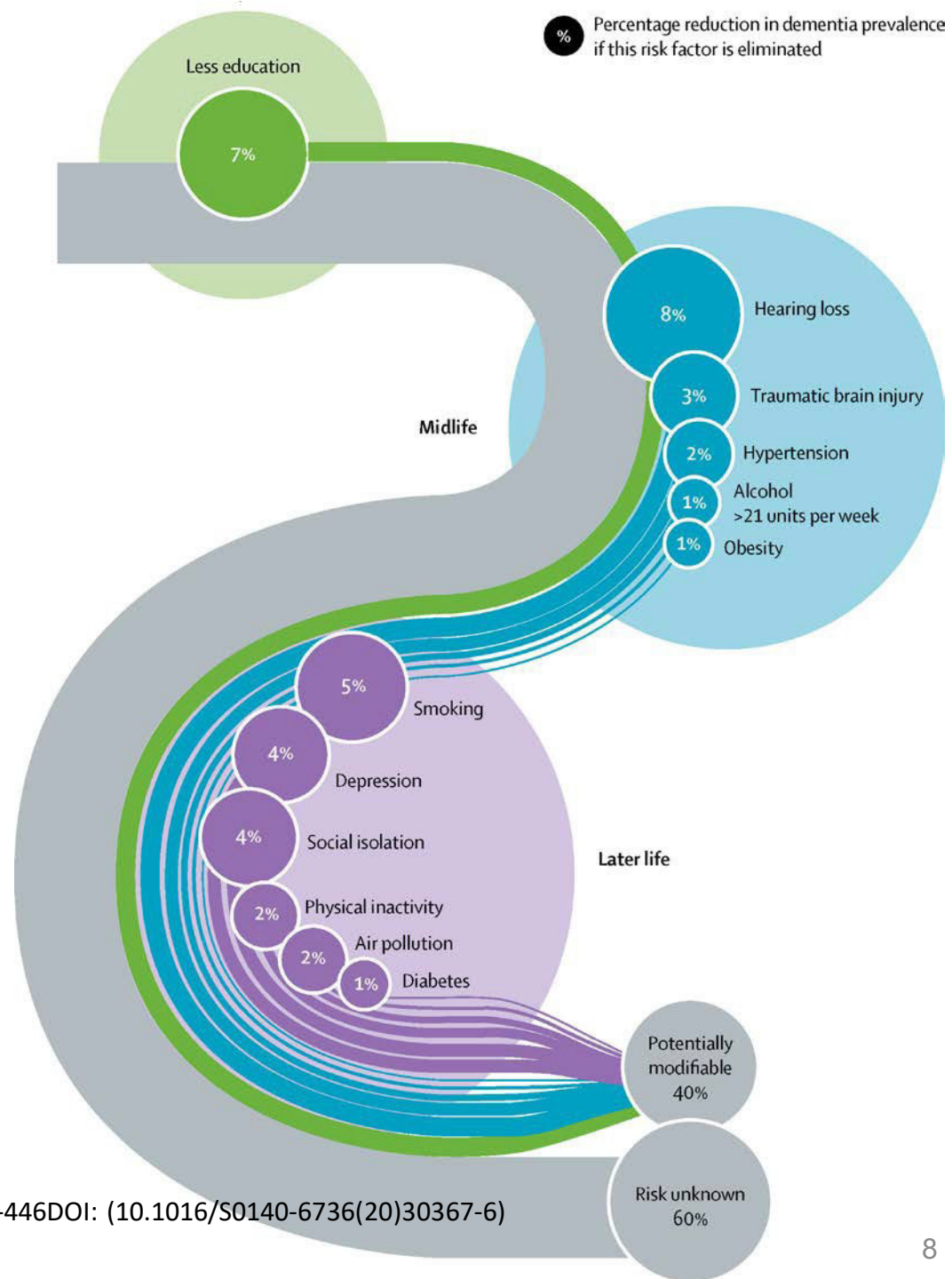
Burden of ADRD

Source: https://www.alz.org/



Risk factors for Alzheimer's disease

- Older age biggest risk factor
  - 5% of 65-74 year olds
  - 13.1% of 75-84 year olds
  - 33.3% of 85+ year olds
- Small subset of individuals develop Alzheimer's disease earlier in life
  - Familial genetic mutation
  - Symptoms can begin in 30s
- APOE ε4: greater risk of developing Alzheimer's disease in later life
  - 1 ε4 allele, 3x risk
  - 2 ε4 alleles, 8-12x risk
- Modifiable risk factors (e.g., education, social engagement)

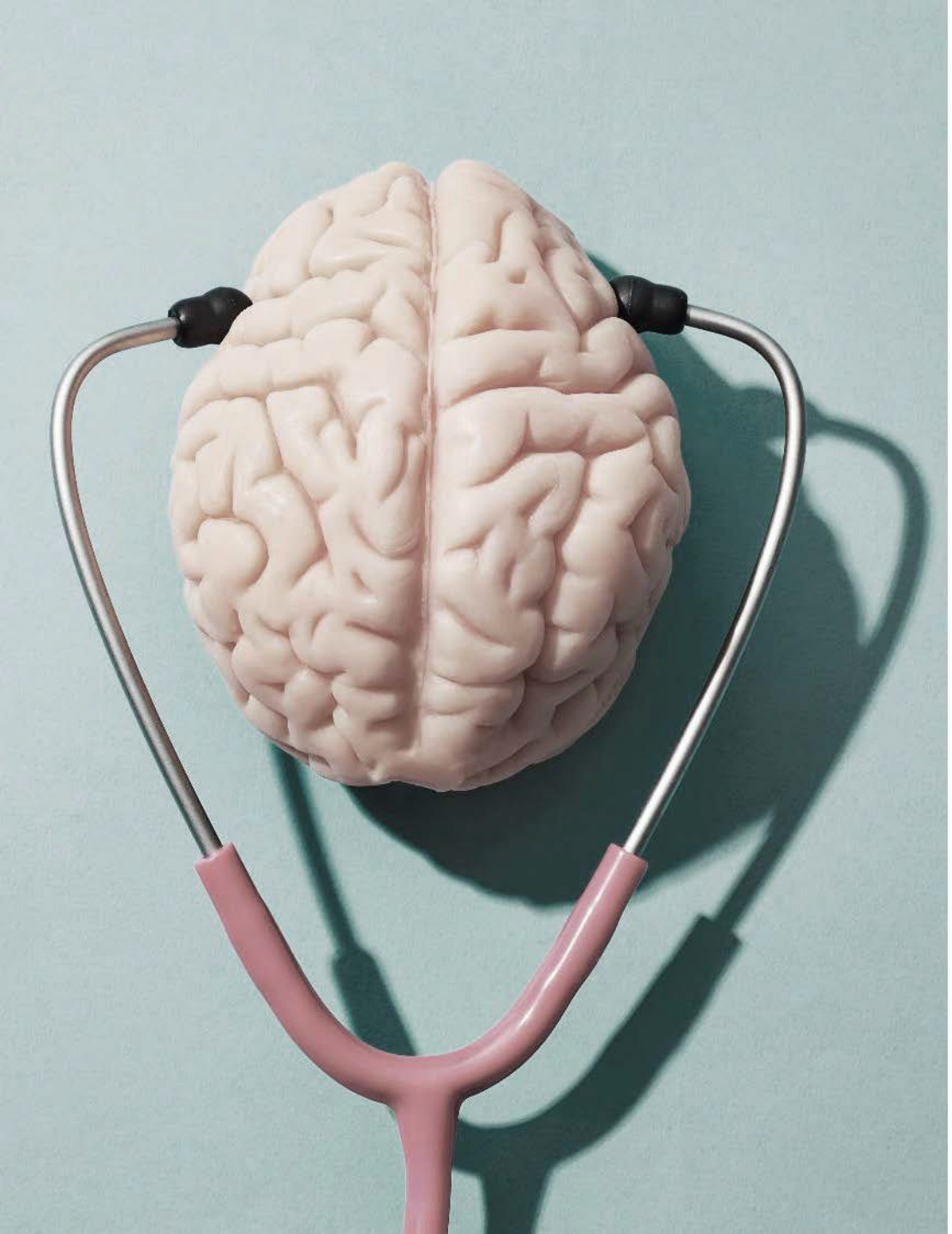


The Lancet 2020 396413-446DOI: (10.1016/S0140-6736(20)30367-6)

Health Disparities in ADRD and cognitive outcomes

Characteristic	Disparities
Race/ethnicity	Alzheimer's dementia prevalence in ≥65 year olds: Black - 19%; Hispanic - 14%; White - 10% (Rajan et al, 2021)
Sex	Lifetime risk for Alzheimer's dementia: Women - 21%; Men - 12% (Chene et al, 2015)
Individual-level SES	AD dementia risk greatest if low education and low lifetime occupational attainment (RR, 2.87; 95% CI, 1.32-3.84) (Stern et al, 1994)
Neighborhood SES	Greater neighborhood/area deprivation associated with significantly higher risk of cognitive dysfunction (OR: 1.40, 95% CI: 1.05-1.87) (McCann et al, 2018)

SES = socioeconomic status



Flip the perspective: Brain health

- Brain has at least three levels of functions that affect all aspects of daily lives:
  - Interpretation of senses and movement
  - Cognitive, mental, and emotional processes
  - Normal behavior and social cognition
- Brain health: “preservation of optimal brain integrity and mental and cognitive function at a given age in the absence of overt brain diseases that affect normal brain function”
- *Focus: Resilience and prevention*

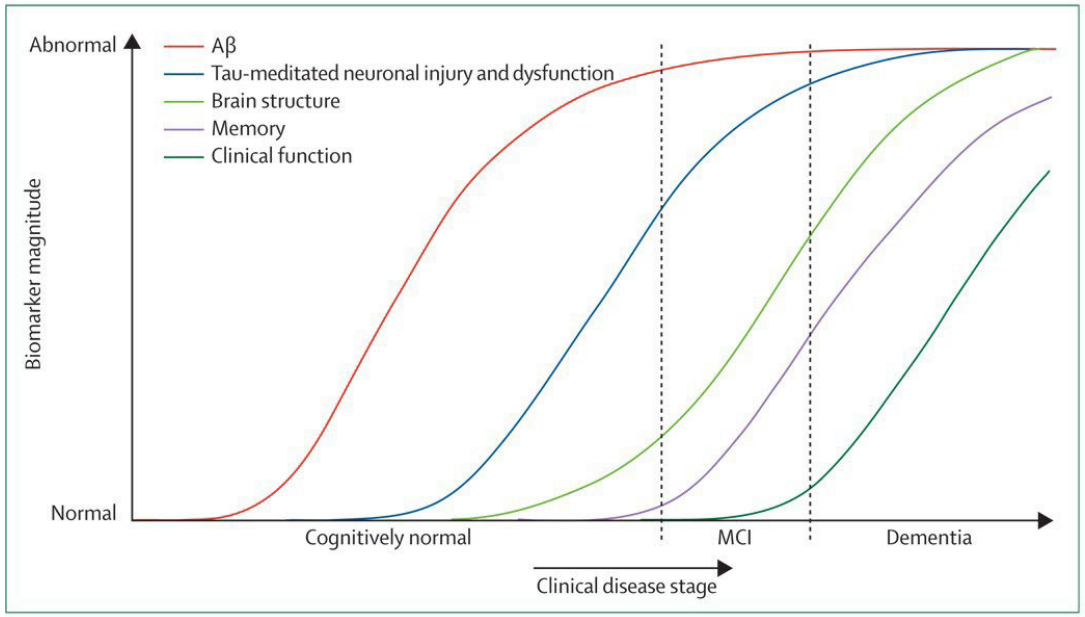
Measuring brain health

- **Cognitive tests** measure brain functioning with respect to memory, language, attention, and other cognitive functions
- **Brain imaging** (example: magnetic resonance imaging-MRI): can assess brain structure and function
- Other biomarkers (EEG, cerebrospinal fluid, etc.)
- Self-reported cognitive difficulties

- These measures can detect problems but can also confirm normal brain structure and functioning for one'sage

Promotion of brain health

- Fixed risk factors related to increased dementia risk cannot be changed:
  - Age, sex, genetics (for the most part)
- **Prevention efforts to target modifiable risk factors:**
  - Educational attainment
  - Hypertension, diabetes, depression, obesity
  - Lifestyle factors (e.g., physical activity, social contact, alcohol, smoking)
  - Environmental exposures (smoking, air pollution)
  - Hearing loss
  - Traumatic brain injury
- Preclinical phase can be ≥20 years prior to symptoms
  - **Primary prevention needs to start in midlife**



Jack CR Jr, Knopman DS, Jagust WJ, Shaw LM, Aisen PS, Weiner MW, Petersen RC, Trojanowski JQ. Hypothetical model of dynamic biomarkers of the Alzheimer's pathological cascade. Lancet Neurol. 2010 Jan;9(1):119-28.

Social determinants of health:

- "*Conditions in the environments* where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks." (Healthy People 2030)

Structural determinants of health:

- "*Social and political mechanisms that generate … stratification and social class divisions* in society and that define individual socioeconomic position within hierarchies of power, prestige and access to resources" (WHO)

Structural determinants of health

Social determinants of health

- **S/SDOH - major causes of poorer health outcomes/disparities among** historically underserved and minoritized individuals and communities (Gomez, 2021)

Recent and rapid increase in studies on S/SDOH and brain health and ADRD

- Research beyond drug and medical interventions for dementia
- Shifting beyond modifiable risk factors for dementia to their upstream causes

Topic	Author (year)
Food access & environment	McMichael et al (2021); Tani et al (2019)
Pollution	Weuve et al (2021); Fuller et al (2022)
Greenspace	Besser et al (2021); Zagnoli et al (2022)
Recreation	Buettner & Langrish (2020); Stephen et al (2017)
Transportation	Toepper & Falkenstein (2019); Babulal et al (2018)
Housing	Coley et al (2013); Okoye et al (2023); Wang (2021)
Poverty	Kalaria et al (2008); Trani et al (2022)
Policing and incarceration	Kaske et al (2021); Cox & Wallace (2022)
Neighborhood deprivation	Kind & Buckingham (2018); Powell et al (2020)
Workplace/occupation	Huang et al (2020); Parker et al (2021)
Income	Marden et al (2017); Yaffe et al (2013)
School literacy	Arce et al (2019); Sisco et al (2015)
Education	Eng et al (2021); Koboyashi et al (2019)
Health care	Yi et al (2021); Sekhon et al (2021)
Social networks, isolation, loneliness	Perry et al (2022); Yu & Ng (in press)

Conceptual frameworks

National Institute on Minority Health and Health Disparities Research Framework

Socio-ecological model:
Multiple, interacting levels of influence on health

		Levels of Influence			
		Individual	**Interpersonal**	**Community**	**Societal**
Domains of Influence *(Over the Lifecourse)*	**Biological**	Biological Vulnerability and Mechanisms	Caregiver–Child Interaction Family Microbiome	Community Illness Exposure Herd Immunity	Sanitation Immunization Pathogen Exposure
	Behavioral	Health Behaviors Coping Strategies	Family Functioning School/Work Functioning	Community Functioning	Policies and Laws
	Physical/Built Environment	Personal Environment	Household Environment School/Work Environment	Community Environment Community Resources	Societal Structure
	Sociocultural Environment	Sociodemographics Limited English Cultural Identity Response to Discrimination	Social Networks Family/Peer Norms Interpersonal Discrimination	Community Norms Local Structural Discrimination	Social Norms Societal Structural Discrimination
	Health Care System	Insurance Coverage Health Literacy Treatment Preferences	Patient–Clinician Relationship Medical Decision-Making	Availability of Services Safety Net Services	Quality of Care Health Care Policies
Health Outcomes		**Individual Health**	**Family/ Organizational Health**	**Community Health**	**Population Health**

Alzheimer's Association
Diversity and Disparities Professional Interest Area (PIA):

Social/Structural Determinants of Health (S/SDOH) Work Group

Co-chairs		
		
Dr. Adkins-Jackson Columbia University Research: Structural racism and policing	Dr. George UC Davis Research: Vascular risk factors and health disparities	Dr. Besser University of Miami Research: Neighborhood environments including greenspaces

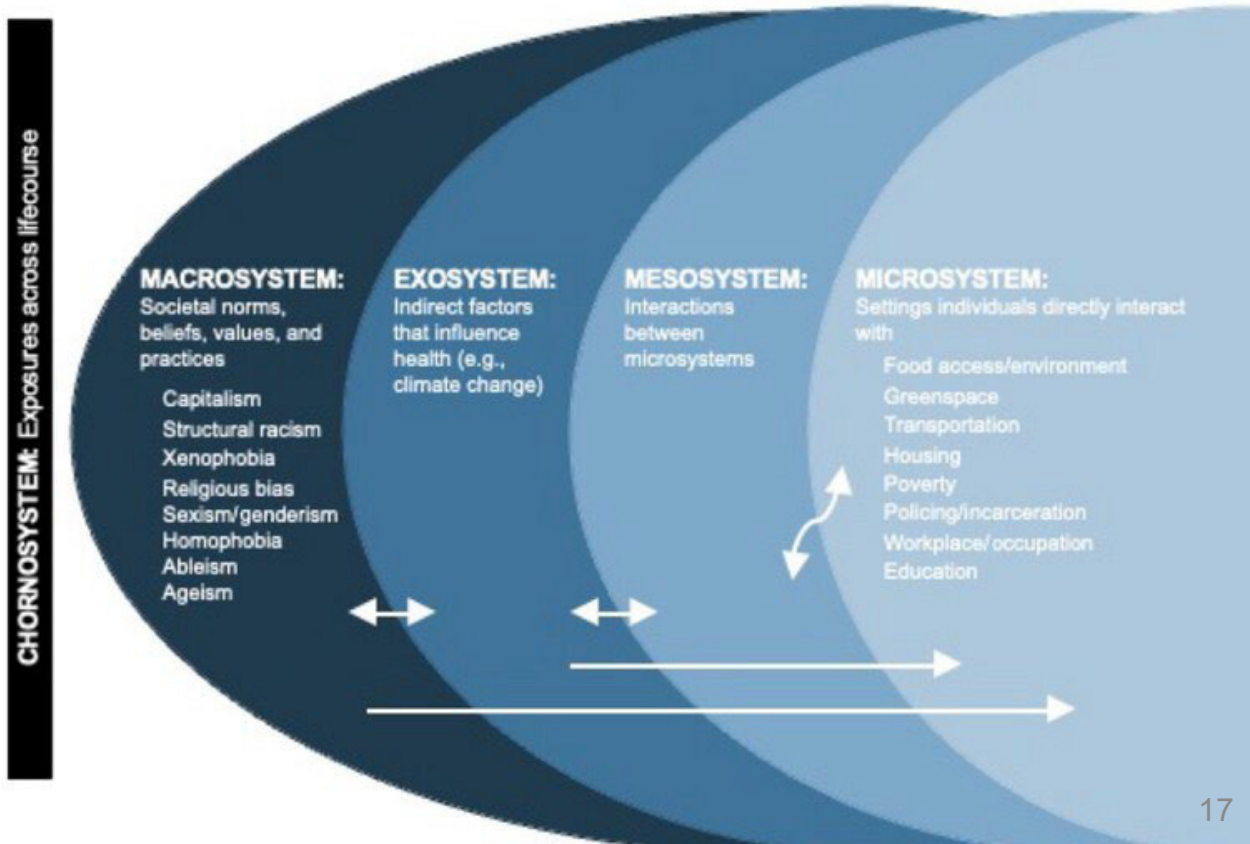
REVIEW ARTICLE

Alzheimer's & Dementia®
THE JOURNAL OF THE ALZHEIMER'S ASSOCIATION

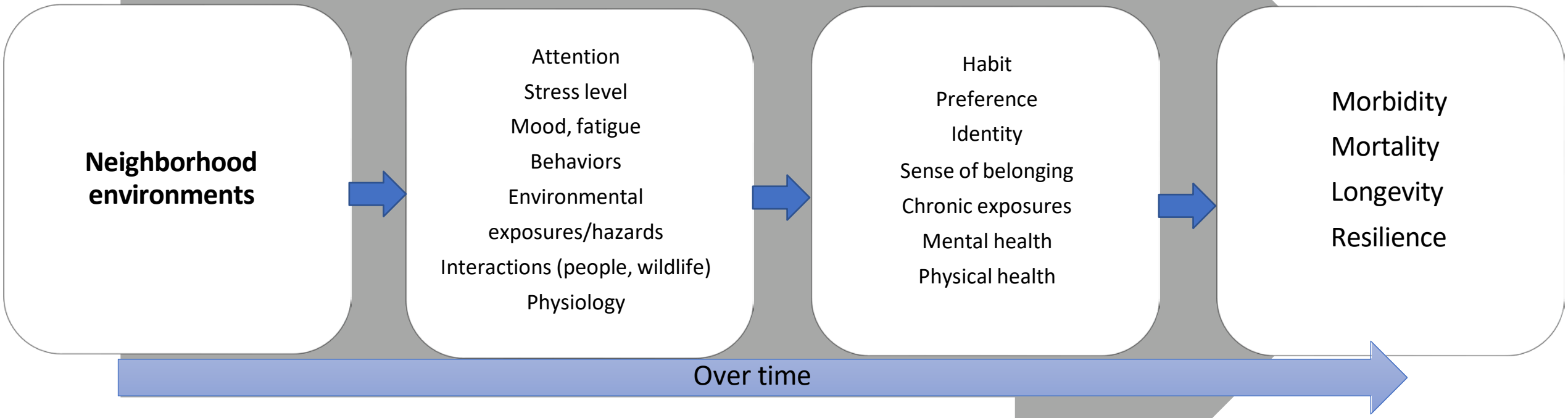
The structural and social determinants of Alzheimer's disease related dementias

Paris B. Adkins-Jackson[1] | Kristen M. George[2] | Lilah M. Besser[3] | Jinshil Hyun[4] | Melissa Lamar[5] | Tanisha G. Hill-Jarrett[6] | Omonigho M. Bubu[7] | Jason D. Flatt[8] | Patricia C. Heyn[9] | Ethan C. Cicero[10] | A. Zarina Kraal[11] | Preeti Pushpalata Zanwar[12,13] | Rachel Peterson[14] | Boeun Kim[15] | Robert W. Turner II[16] | Jaya Viswanathan[17] | Erin R. Kulick[18] | Megan Zuelsdorff[19] | Shana D. Stites[20] | Miguel Arce Rentería[21] | Elena Tsoy[22] | Dominika Seblova[23] | Ted K.S. Ng[24,25] | Jennifer J. Manly[26] | Ganesh Babulal[27,28,29,30]

Framework: **Bronfenbrenner's Ecological Systems Theory**

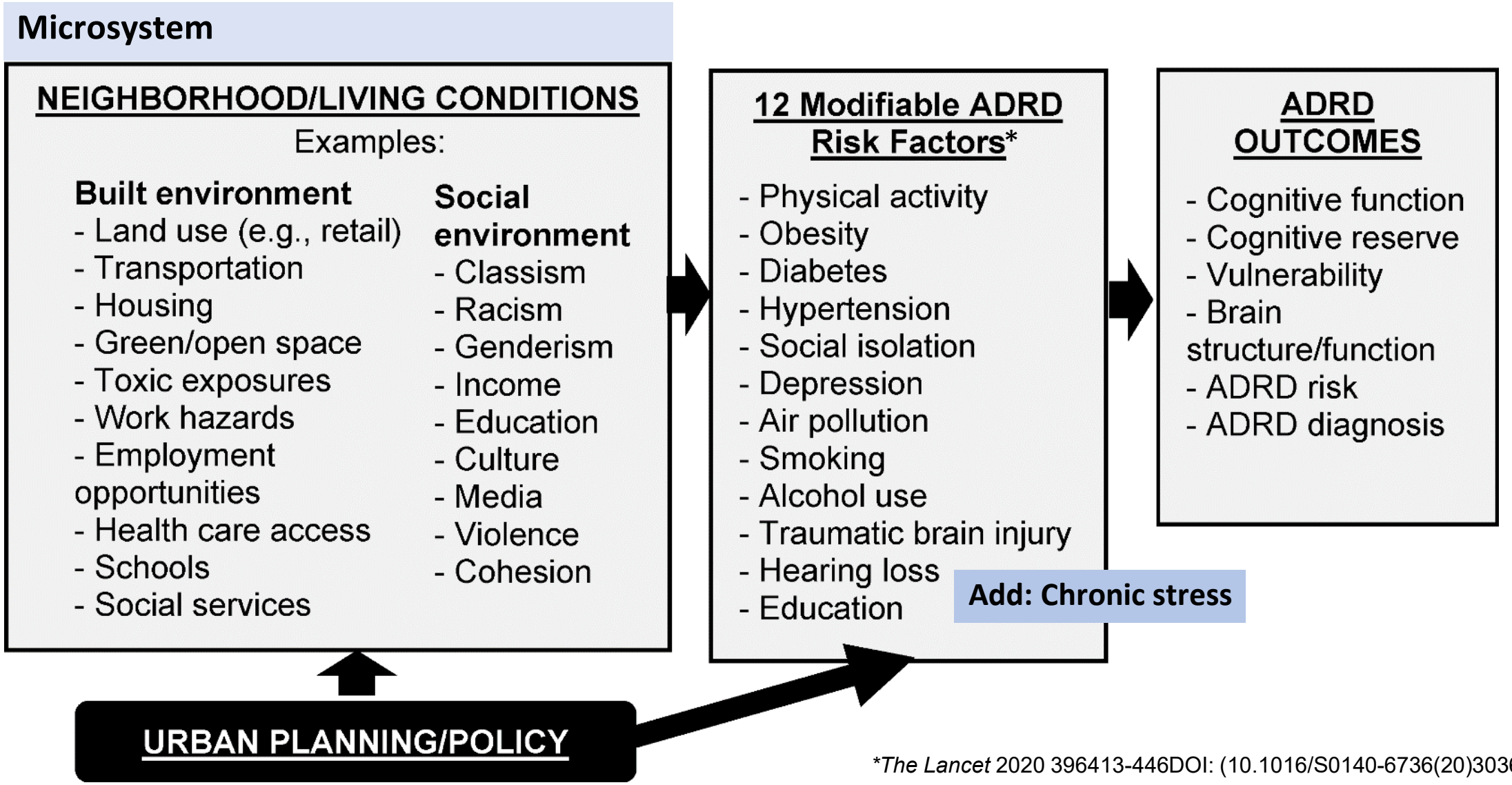


Why neighborhoods are important



- Multi-factorial elements and direct consequences of neighborhood environments influence multiple long-term health outcomes
  - Opportunities for population-level prevention and intervention efforts to simultaneously reduce cardiovascular disease, risk for dementia, etc.

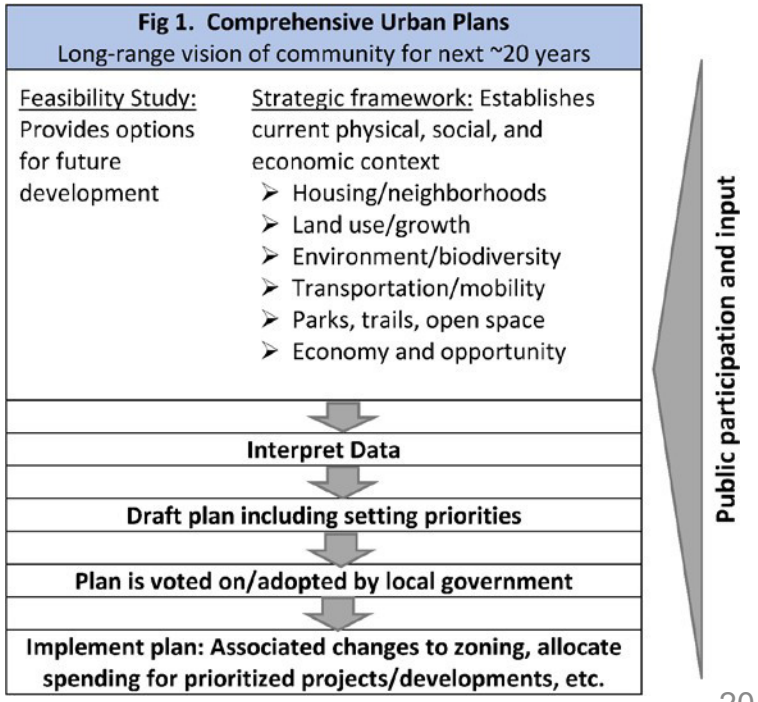
Linking neighborhoods to ADRD outcomes via modifiable risk factors



**The Lancet* 2020 396413-446DOI: (10.1016/S0140-6736(20)30367-6)

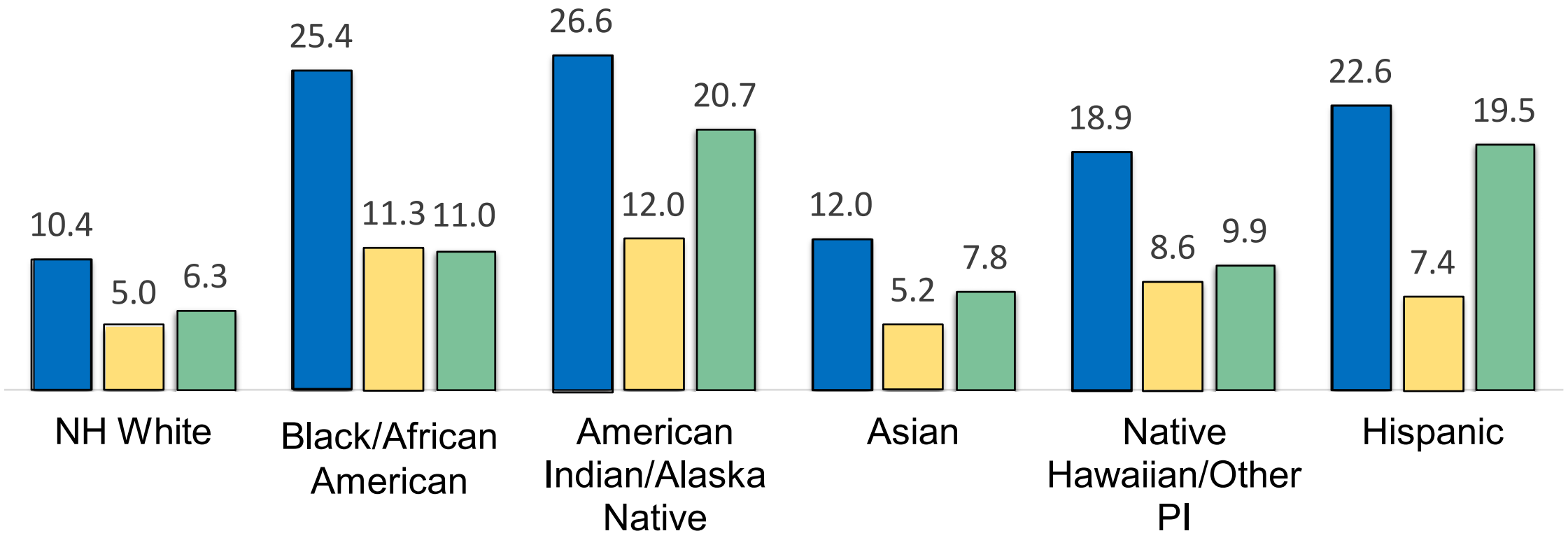
Urban planning

- Urban plans and policies structure communities by:
  - Setting long-term development and infrastructure priorities
  - Plans for land use
  - Prioritization of capital spending
- Planners work closely with stakeholders - architects, public, and government officials and decisionmakers
- Social and built environments resulting from urban planning can have long-lasting effects to human health and wellbeing
  - By influencing modifiable risk factors over the life course, can impact one's risk for Alzheimer's disease and related dementias



Evidence

Singh et al (2017), Social Determinants of Health in the United States: Addressing Major Health Inequality Trends for the Nation



Source: Singh et al, 2017; Data: 2015 American Community Survey

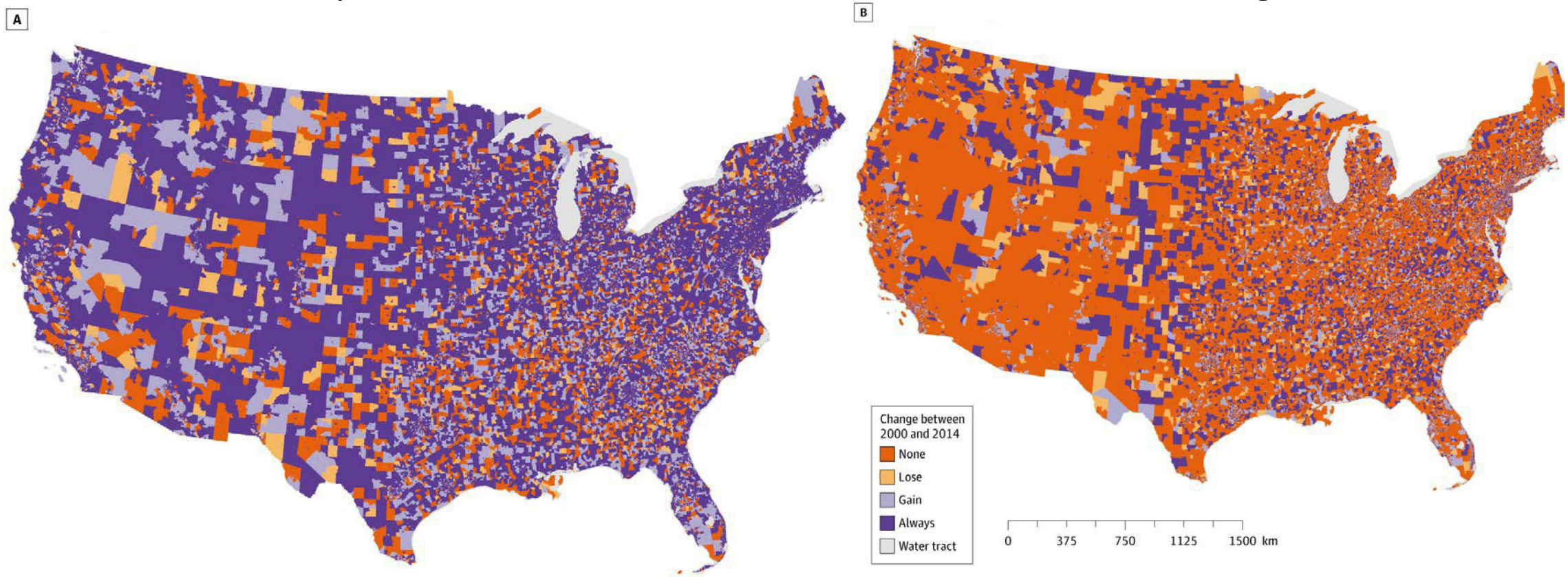
In 2015, **life expectancy** highest for Asian/Pacific Islander (87.7 years), lowest for Black (75.7 years) persons

Patterns in Geographic Access to Health Care Facilities Across Neighborhoods in the United States Based on Data From the National Establishment Time-Series Between 2000 and 2014

Tsui et al. JAMA Netw Open. 2020;3(5):e205105. doi:10.1001/jamanetworkopen.2020.5105

Ambulatory care facilities

Pharmacies/drug stores



Larson et al (2009)

Neighborhood Environments: Disparities in Access to Healthy Foods in the U.S.

"National and local studies across the U.S. suggest that residents of low-income, minority, and rural neighborhoods are most often affected by poor access to supermarkets and healthful food"

Author	Finding
Zenk (2008)	In US, compared to schools in low-income tracts, those in middle-income and high-income tracts had fewer convenience stores within ½ mile (22% fewer and 50% fewer respectively)
Galvez (2007)	In East Harlem, 76% of predominantly Black blocks had no food stores, vs 15% of predominantly Latino blocks and 40% of racially mixed blocks (predominant: >75%)
Moore (2006)	• In NC, MD, and NY, predominantly (>60%) Black and racially mixed neighborhoods (tracts), >twice as many grocery stores but fewer supermarkets than predominantly White neighborhoods • Low-income and nonwhite neighborhoods often fewer fruit/vegetable markets and natural food stores

Focus of my work and remainder of talk

- Neighborhood built environments
- Neighborhood greenspaces
- Neighborhood racial/ethnic segregation

What are built environments?

- Manmade physical environments in which we live, work, play, and learn: Roads, buildings, pedestrian infrastructure, parks/greenspaces, community spaces, etc.

- **Street features:** Grid streets, block sizes, crosswalks and signals
- **Design:** Building heights and set backs, condition of spaces
- **Density:** Housing density and types, population density
- **Land use:** Park area and green/open space, retail and commercial use
- **Transport/access:** Sidewalks & bike paths, transit availability

Intersection Density

Ease of navigation and distance to destinations affects desire and ability to walk places in neighborhood

Street Maps at the Same Scale

Source: Allan B. Jacobs, *Great Streets*, MIT Press, Cambridge, MA, 1993, pp. 221, 225, 249. Reprinted in Reid Ewing, *Pedestrian and Transit-Friendly Design: A Primer for Smart Growth,* Smart Growth Network, August 1999, p. 4 <http://www.epa.gov/dced/pdf/ptfd_primer.pdf>

Brief Reports

Commute Time and Social Capital in the U.S.

Lilah M. Besser, MSPH, Michele Marcus, PhD, Howard Frumkin, MD, DrPH

Background: The suggested declining trend in social capital among Americans could be due, in part, to long commute times associated with urban sprawl.

Methods: In 2007, the 2001 National Household Travel Survey (NHTS) was used to determine the association between commute time and socially-oriented trips, a proxy measure of social capital, while controlling for individual-level and regional-level characteristics. Socially-oriented trips were those taken to: attend school/religious activities; attend social/recreational activities; visit friends/relatives; go out for entertainment; attend funerals/weddings/social events; exercise/play sports; attend to family/personal obligations; participate in organizational meetings; or transport someone. Odds ratios and 95% CIs were calculated for the association between commute time and socially-oriented trips for full-time working adults (N=54,747).

Results: Higher commute time (>20 minutes) was significantly associated with no socially-oriented trips (adjusted OR=1.17, 95% CI=1.09–1.25). The strongest association was among 90+ minute commuters (adjusted OR=1.50, 95% CI=1.16–1.94).

Conclusions: This study suggests that individuals with longer commutes have less access to social capital, as indicated by fewer socially-oriented trips.

(Am J Prev Med 2008;34(3):207–211)

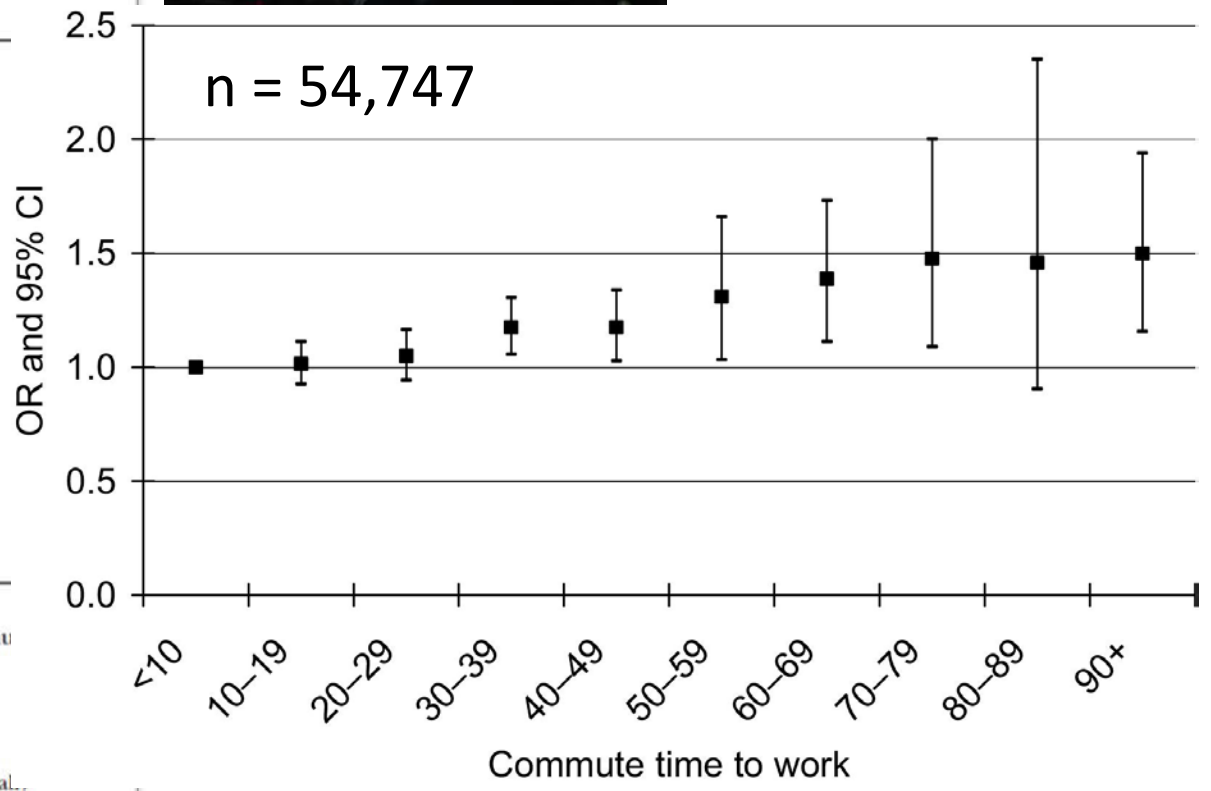
Introduction

Social capital—the "connectedness" of a group as reflected in attitudes (e.g., trust) and behaviors (e.g., civic participation)—has attracted growing interest among health professionals[1–4] and social scientists.[5–8] Whether measured on the individual or community level (debate exists about the merits of each approach),[9] higher levels of social capital have been associated with healthier behaviors,[10,11] better self-rated health,[12] and fewer negative outcomes such as

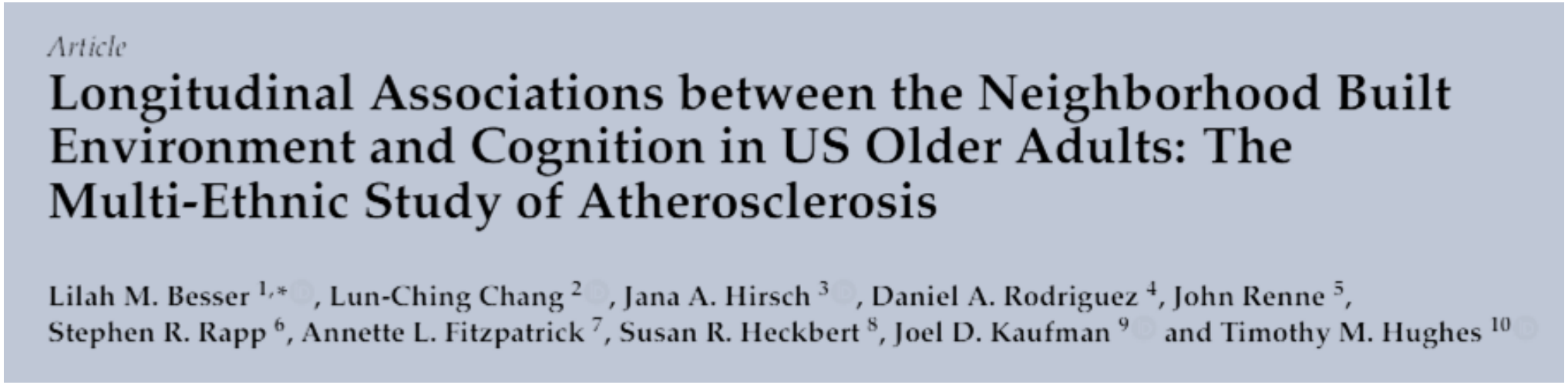
oriented trips—the hypothesis was tested that commu
time is negatively associated with social capital.

Methods

In 2007, the association between commute time and social
oriented trips was examined using 2001 NHTS data. The
NHTS is a cross-sectional, telephone-based survey of U.S.
households in all 50 states and the District of Columbia. For
participating households, interviewers collected data on each
trip during an assigned travel day, including mode, distance,



↑ commute time, more likely to have no socially-oriented on a given day



Article

Longitudinal Associations between the Neighborhood Built Environment and Cognition in US Older Adults: The Multi-Ethnic Study of Atherosclerosis

Lilah M. Besser [1,*], Lun-Ching Chang [2], Jana A. Hirsch [3], Daniel A. Rodriguez [4], John Renne [5], Stephen R. Rapp [6], Annette L. Fitzpatrick [7], Susan R. Heckbert [8], Joel D. Kaufman [9] and Timothy M. Hughes [10]

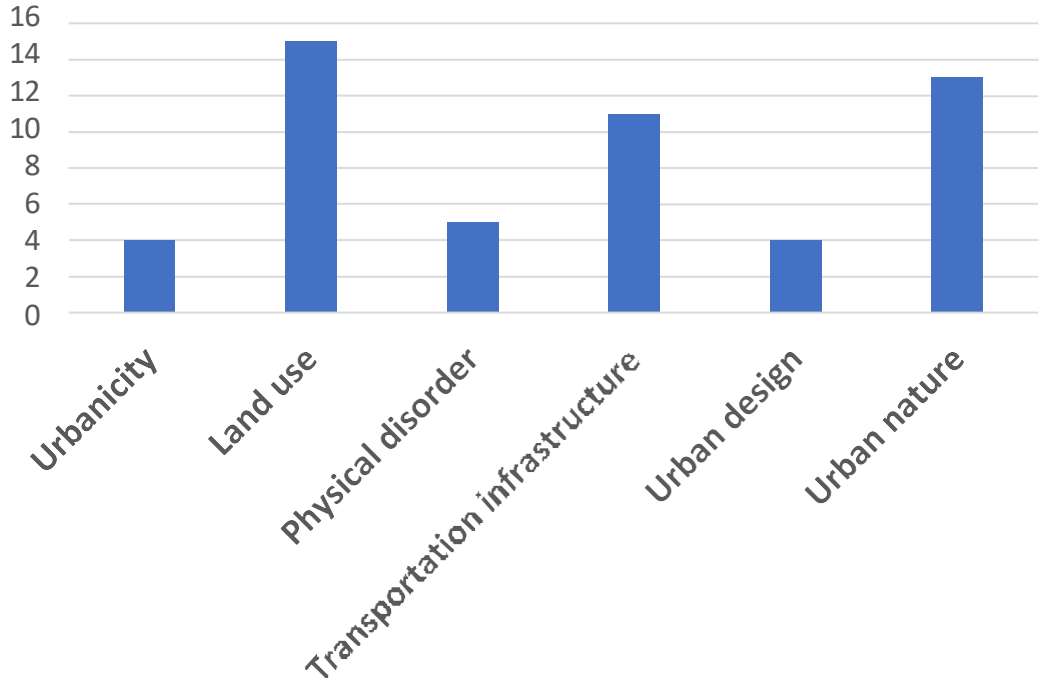
- n=1,816, mean age=67 years, 11% Chinese, 29% Black, 17% Hispanic, 44% White
- Built environment: Neighborhood walking destination density
  - Post office, bank, drug store, pharmacy, non-beverage food stores (e.g., grocery), non-beverage dining places (e.g., fast food), and non-alcoholic drinking places
- Outcomes, 6-year change in:
  - Cognitive Abilities Screening Instrument (global cognition)
  - Digit Symbol Coding (processing speed)
- **Greater neighborhood walking destination density associated with slower decline on processing speed:** OR: 1.24; 95% Confidence interval: 1.03-1.45

Besser LM et al. Longitudinal Associations between the Neighborhood Built Environment and Cognition in US Older Adults: The Multi-Ethnic Study of Atherosclerosis. Int J Environ Res Public Health. 2021 Jul 28;18(15):7973.

Extant evidence for associations between built environments and dementia/cognition

Chen et al (2022) systematic review:

- 37 published studies as of 2020
- **Neighborhood land use/resources** (e.g., library, post office, food store, community centers, churches) and **greenspace most often linked to cognitive outcomes**
- Physical activity mediates associations



More recent papers, examples:

Tani Y, Hanazato M, Fujiwara T, Suzuki N, Kondo K. Neighborhood Sidewalk Environment and Incidence of Dementia in Older Japanese Adults. Am J Epidemiol. 2021 Jul 1;190(7):1270-1280.

Finlay J, Esposito M, Langa KM, Judd S, Clarke P. Cognability: An Ecological Theory of neighborhoods and cognitive aging. Soc Sci Med. 2022 Sep;309:115220.

Bagheri N, Mavoa S, Tabatabaei-Jafari H, Knibbs LD, Coffee NT, Salvador-Carulla L, Anstey KJ. The Impact of Built and Social Environmental Characteristics on Diagnosed and Estimated Future Risk of Dementia. J Alzheimers Dis. 2021;84(2):621-632.

Chen X, Lee C, Huang H. Neighborhood built environment associated with cognition and dementia risk among older adults: A systematic literature review. Soc Sci Med. 2022 Jan;292:114560.

Tradeoffs between urban and suburban/rural built environments: traffic/noise, air pollution, greenspace, access to destinations/resources, social engagement opportunities, walkability, etc.

How can we optimize our community environments for health?

What are greenspaces?

- **Areas with natural / green vegetation:**
  - Grass
  - Trees and forests
  - Shrubs
  - Flowers and other plants
  - Farmland
- **Publicly owned areas:**
  - Parks, trails, open spaces, street plantings and street trees
- **Privately owned areas:**
  - Private gardens, lawns, yards, trails, forests, farms

People have intrinsic connection with nature, evidence building for health benefits of nature contact

Parks and greenspaces differ by neighborhood

Access differs by place

- Residents within 10-minute walk of park
- Boca Raton, FL: 51.5%; Miami: 87.2%

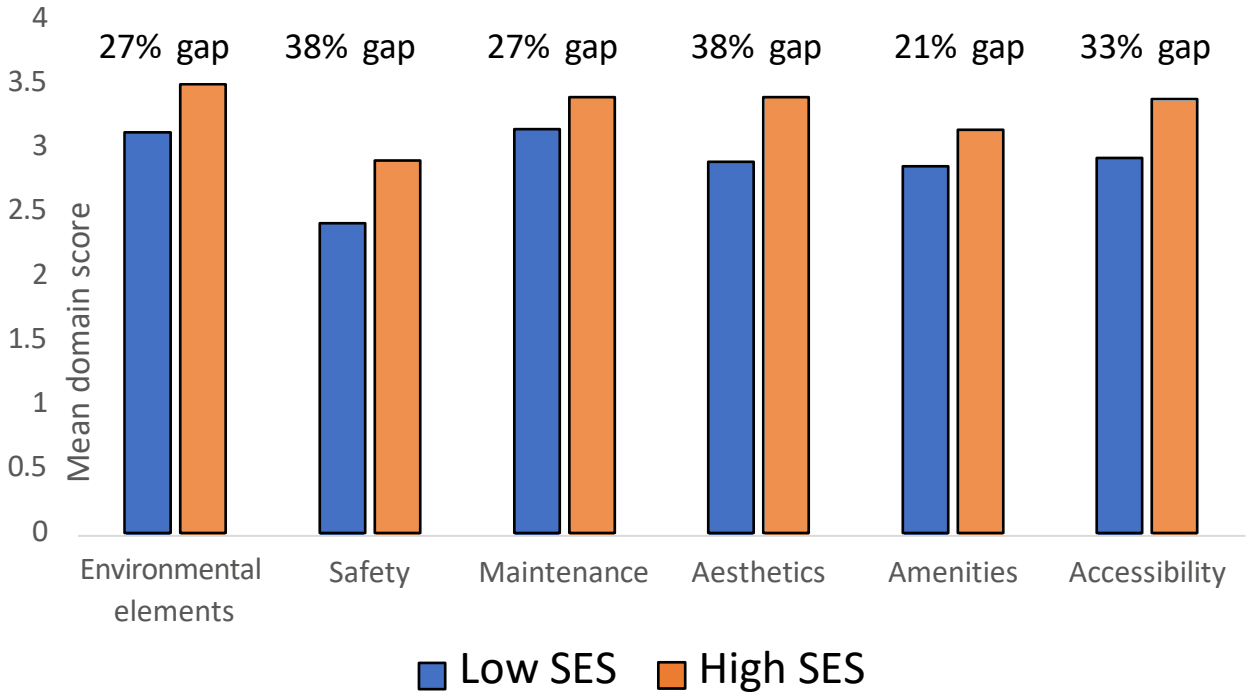
Access differs by neighborhood racial/ethnic composition:

- In New York City, the average park size is 7.9 acres in predominantly Black neighborhoods compared to 29.8 acres in predominantly white neighborhoods (Nesbitt et al, 2019)

Quality differs across communities

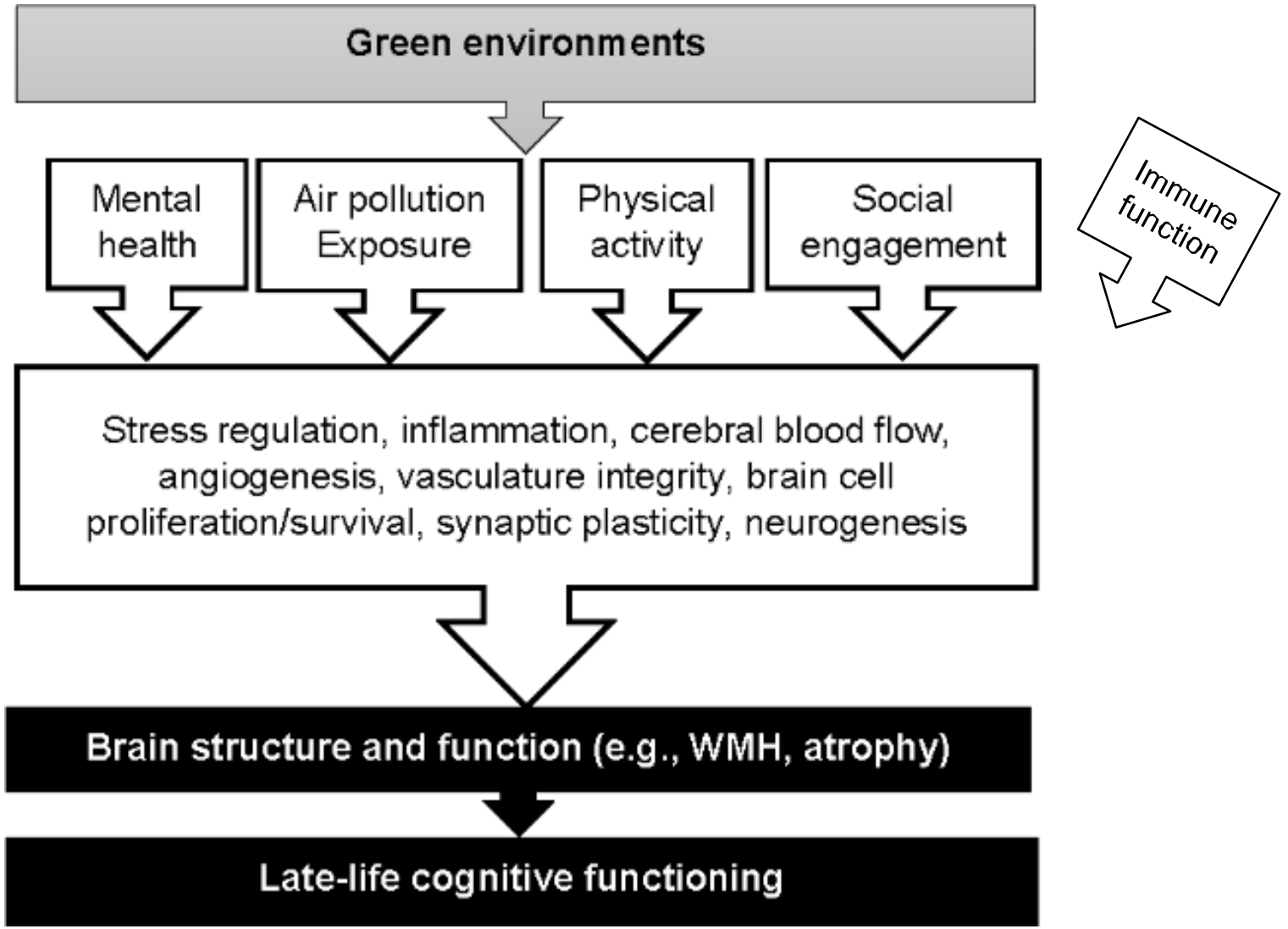
- Type of vegetation
- Amount of vegetation
- Amenities in those greenspaces/parks

Greenspace quality gaps between high and low SES neighborhoods, Victoria, BC (Ghanem 2022)



Ali Ghanem and Ruwini Edirisinghe 2022 IOP Conf. Ser.: Earth Environ. Sci. 1101 052032

Commonly suggested mechanisms

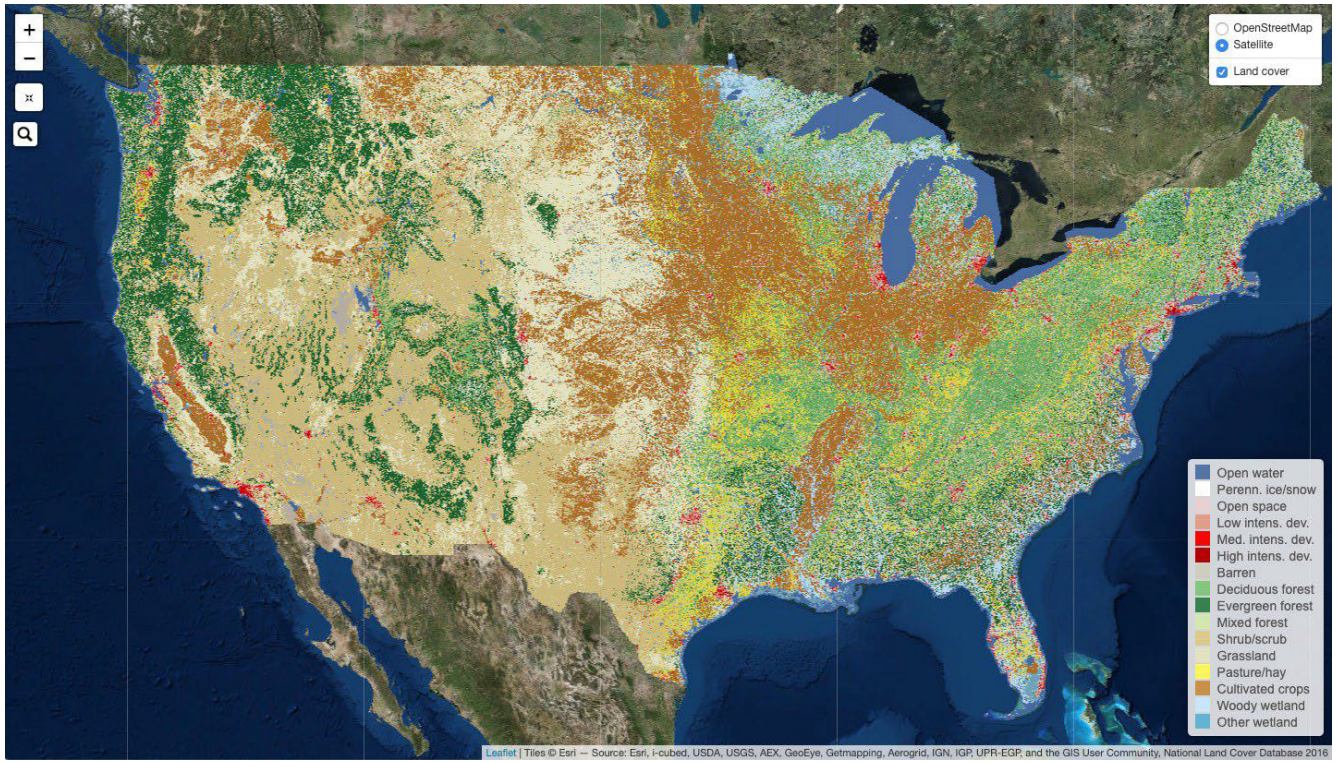


Neighborhood Green Land Cover and Neighborhood-Based Walking in U.S. Older Adults

Besser & Mitsova. Am J Prev Med. 2021 Jul;61(1):e13-e20. doi: 10.1016/j.amepre.2021.01.013. Epub 2021 Mar 27.

- 2017 National Household Travel Survey
- Cross-sectional study, n=72,753
- ≥65-year-olds with green land cover data
- Adjusted linear regression
- **Outcome:** Minutes of neighborhood walking/day

- **2011 National Land Cover Dataset:**
  - **Forest/tree canopy:** Deciduous, evergreen, or mixed forest >20% of vegetation cover
  - **Open/park space:** Parks, large housing lots, golf courses, recreational/ aesthetic plantings (<20% of land cover made of impervious surfaces)
  - Neighborhood measures derived for each US Census tract



Neighborhood Green Land Cover and Neighborhood-Based Walking in U.S. Older Adults

Besser & Mitsova. Am J Prev Med. 2021 Jul;61(1):e13-e20. doi: 10.1016/j.amepre.2021.01.013. Epub 2021 Mar 27.

- **Greater % open space** associated with more neighborhood walking in:
  - African American, Estimate: 0.069, 95% CI: 0.005, 0.133
- **Greater % tree canopy** associated with more neighborhood walking in:
  - Overall sample, Estimate: 0.028, 95% CI: 0.006, 0.050
  - Women, Estimate: 0.025, 95% CI: 0.005, 0.045
  - White, Estimate: 0.034, 95% CI: 0.004, 0.064

Neighborhood park access and longitudinal change in cognition in older adults: The Multi-Ethnic Study of Atherosclerosis

Besser et al. J Alzheimers Dis. 2021;82(1):221-233

- Multi-Ethnic Study of Atherosclerosis (MESA): Longitudinal study of subclinical cardiovascular disease from 6 US regions (Forsyth County, NC; New York, NY; Baltimore, MD; Saint Paul, MN; Chicago, IL; Los Angeles, CA)
- N=1,733; 11% Chinese, 29% African American, 17% Hispanic, 43% White
- Multivariable random intercept logistic regression

Exposure:

- % neighborhood park space at baseline cognitive testing (1/2-mile around residence)

Outcome - change in cognition over ~6 years:

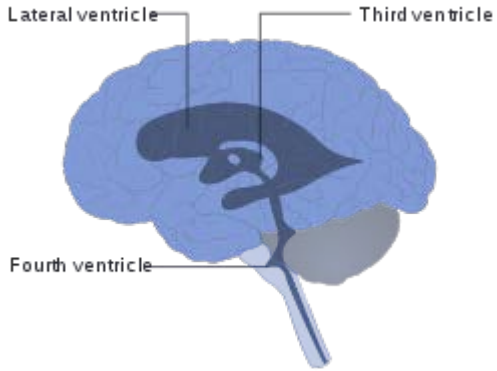
- CASI, global cognition
- Digit Symbol Coding, processing speed

Greater % park space associated with maintain/improved global cognition over time:

- aOR: 1.04; 95% CI: 1.00-1.08 (p=0.046)
- Association stronger among African American versus White participants

Associations between neighborhood greenspace and brain imaging measures in non-demented older adults: the Cardiovascular Health Study

Besser et al. Soc Psychiatry Psychiatr Epidemiol. 2021 Sep;56(9):1575-1585.



Methods:

- Cardiovascular Health Study: Longitudinal cohort study of ≥65 yr olds (1989-1999, 4 US regions)
- N=1,125, 89% White, 11% Black
- Adjusted multivariable linear regression
  - Covariates: age, sex, race, income, education, neighborhood median HH income, whole brain volume (mm3), site
- National Land Cover Dataset
  - Neighborhood % total green space (1 km around residence), average 5 years before MRI
- Magnetic resonance imaging (one time point):
  - Ventricle grade score (0-least to 9-most abnormal)
- Greater neighborhood % greenspace 5 years prior to MRI borderline associated with lower ventricle grade score
  - Estimate: -0.30, 95% CI: - 0.61, 0.00

NIH/NIA K01 grant (K01 AG063895): **Longitudinal associations between neighborhood greenspace and brain aging in cognitively normal older adults**

- Data on individuals followed annually at 3 Alzheimer's Disease Research Centers
- Multiple cognitive domains (e.g., memory, attention, language, exec. function)
- MRI measures (white matter hyperintensities and hippocampal volume)
- **Aims:**
  - Is early-, mid-, and late-life exposure to greenspace associated with brain health outcomes in late-life?
  - Are 5 and 10-year changes in greenspace associated with brain health outcomes in late life?
  - Do associations vary by sex, race/ethnicity, city/region?

NIH/NIA K01 grant: **Life Course Sociodemographics and Neighborhood Questionnaire** (LSNEQ). Besser et al. Health Place. 2023 Mar 30;81:103008.

Self-reported greenspace measures

- Park access and greenness at childhood, midlife, and later life

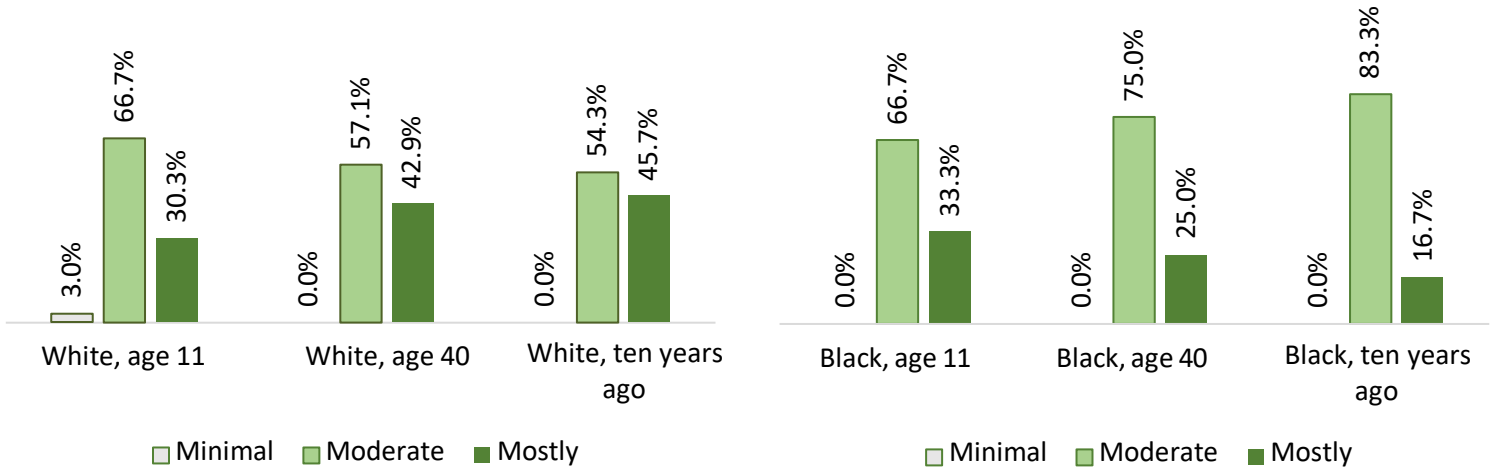
Life course neighborhood greenness index:

- Internal consistency (alpha=0.79)
- Test-retest reliability (ICC=0.71)

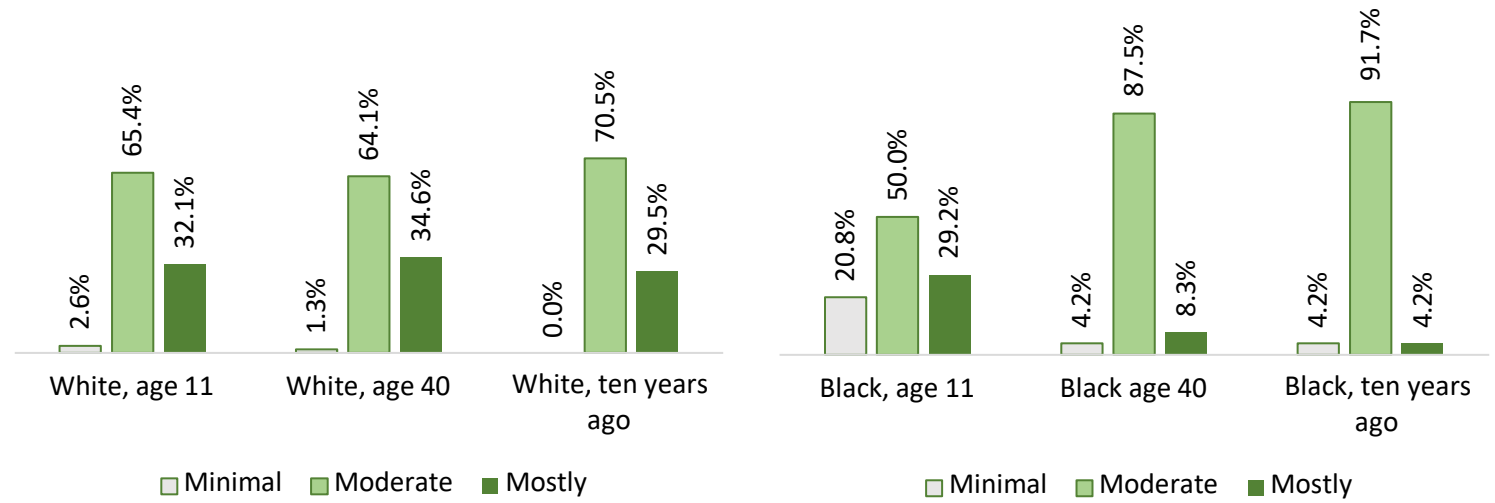
Higher lifecourse neighborhood greenness scores associated with **slower longitudinal decline in language scores** (n=322 from 3 Alzheimer's Disease Research Centers, unpublished)

Neighborhood Greenness for different ages and racial groups

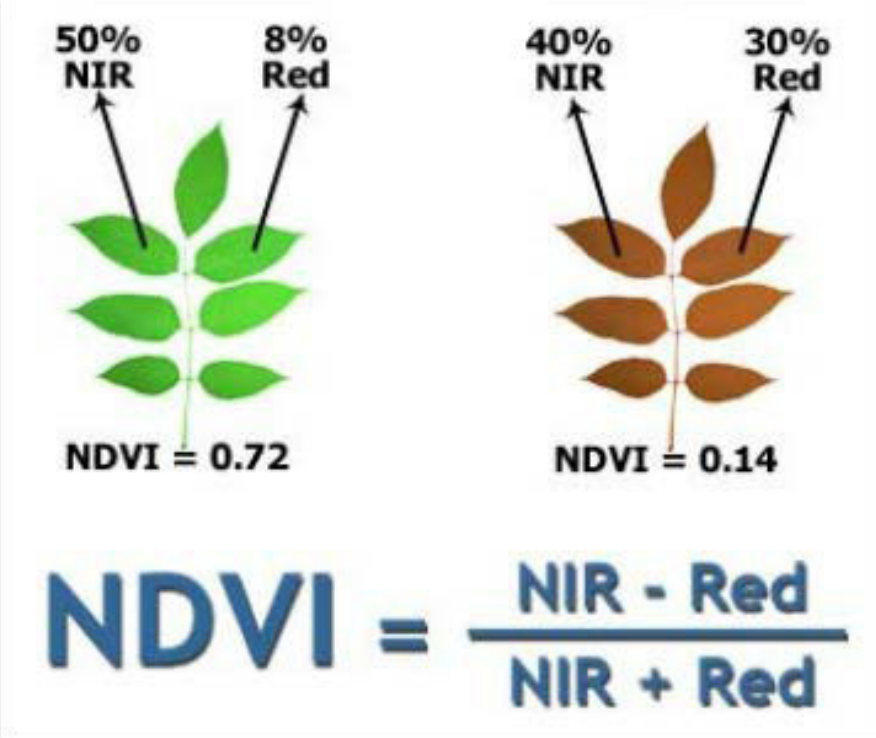
Sacramento, California, n=65



St. Louis, Missouri, n=104



Normalized Difference Vegetation Index



- Calculated from LANDSAT satellite imagery, US Geological Survey
- Range; -1 to +1 (positive measures=healthier vegetation)

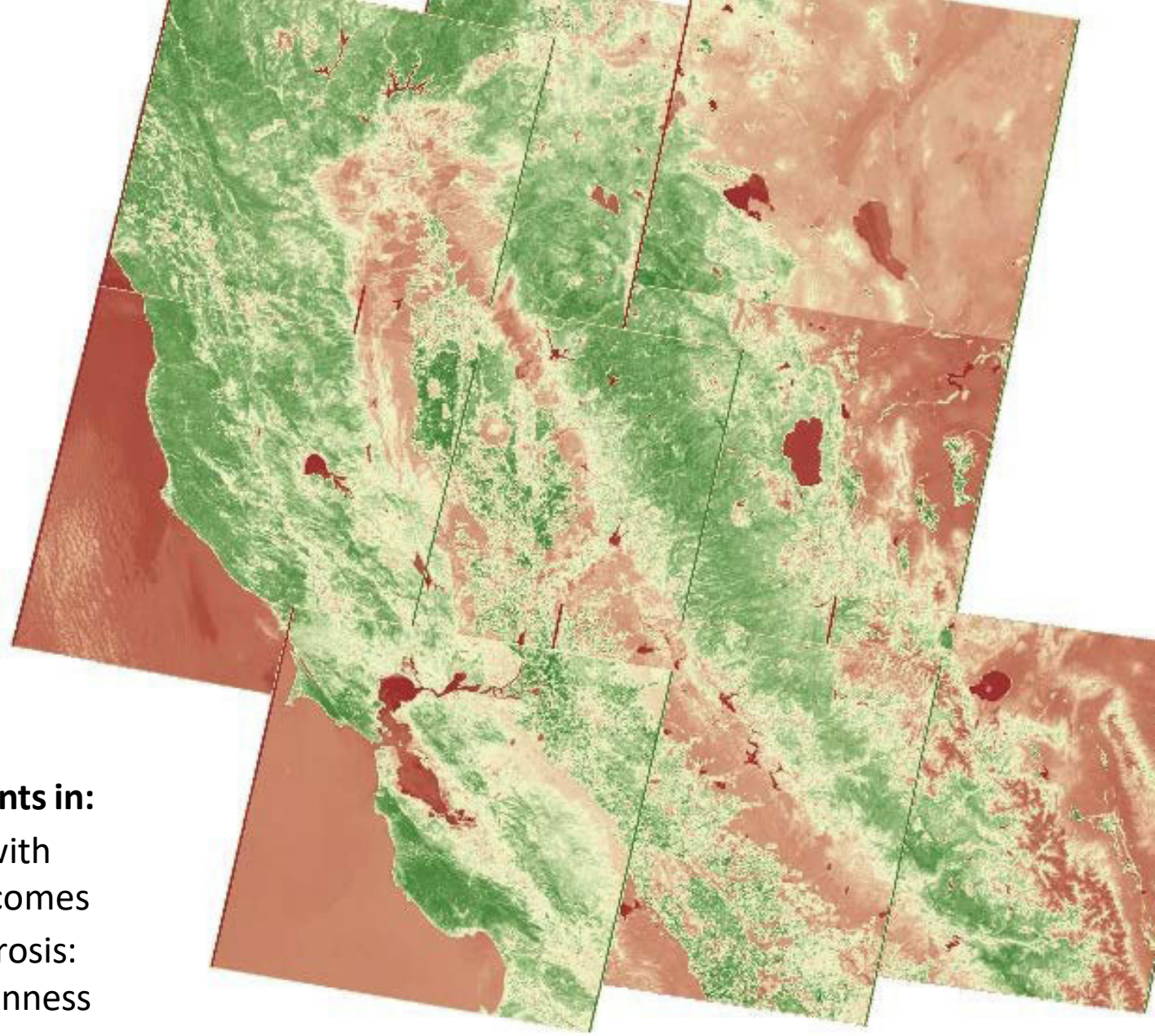
Features	**NDVI** (range)
Water (deep & shallow)	-0.41379 to -0.10401
Builtups / river sand	-0.10401 to 0.055727
Fallow / Wasteland	0.055727 to 0.20579
Crop, grass	0.20579 to 0.37035
Agroforestry	0.37036 to.0.51073
Forest	051074 to 0.82051

Example NDVI map

Sacramento region, California 1999

1984 → present

Satellite imagery available for past ~40 years

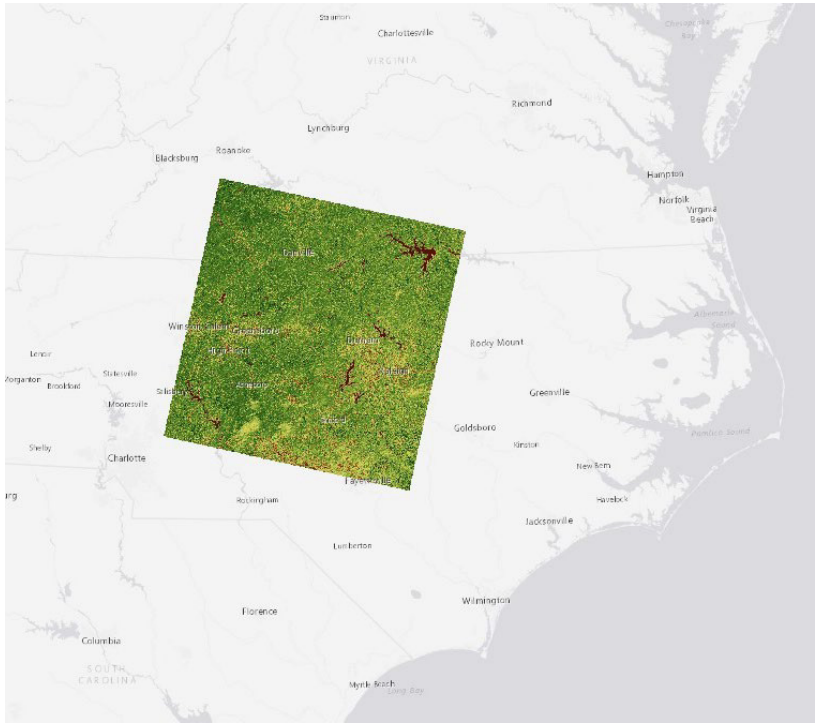


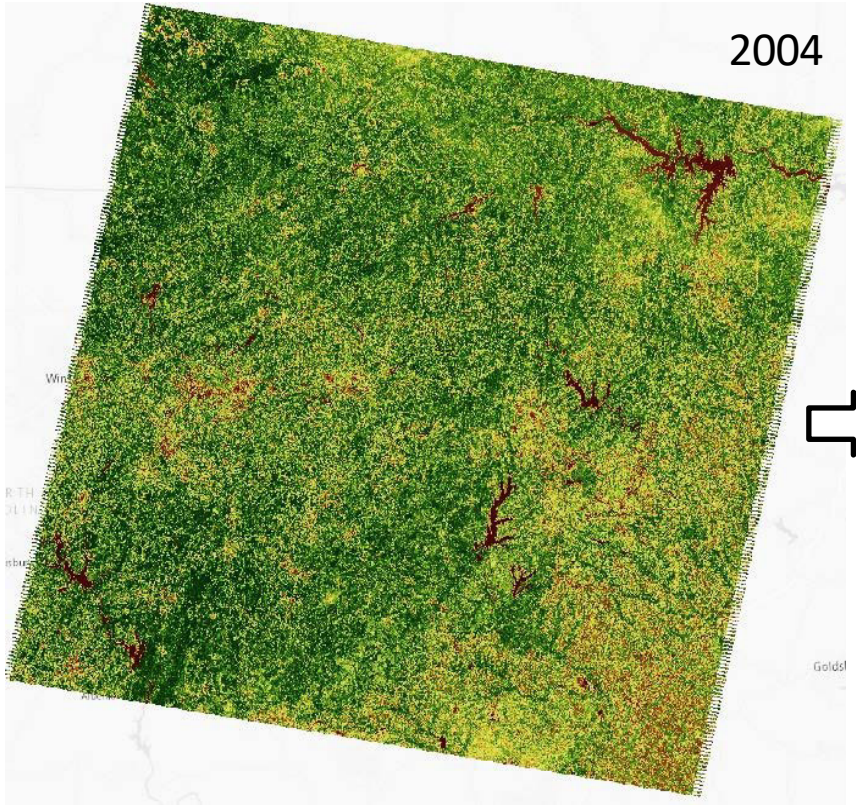
Green = healthier vegetation

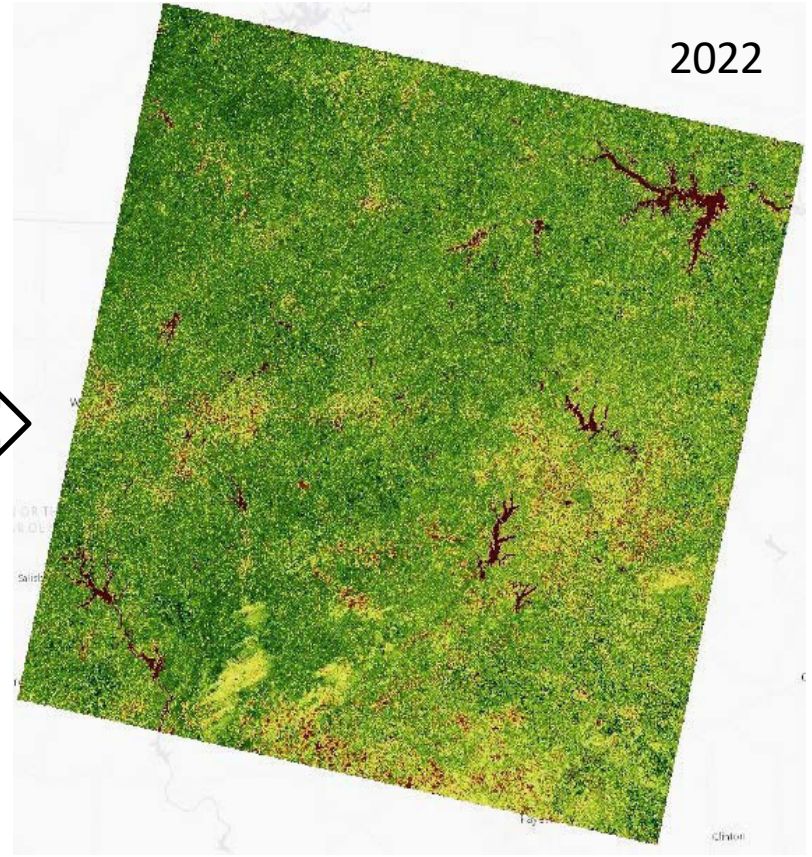
Developing NDVI measures back to 1984 for participants in:

- NIH/NIA K01 (3 ADRCs/regions): Associations with Alzheimer's and related dementia specific outcomes
- NIH/NIA R21, Multi-Ethnic Study of Atherosclerosis: Associations between midlife greenspace/greenness exposure and late-life cognitive/MRI outcomes

Change in NDVI values from 2004 to 2022, Winston-Salem, NC





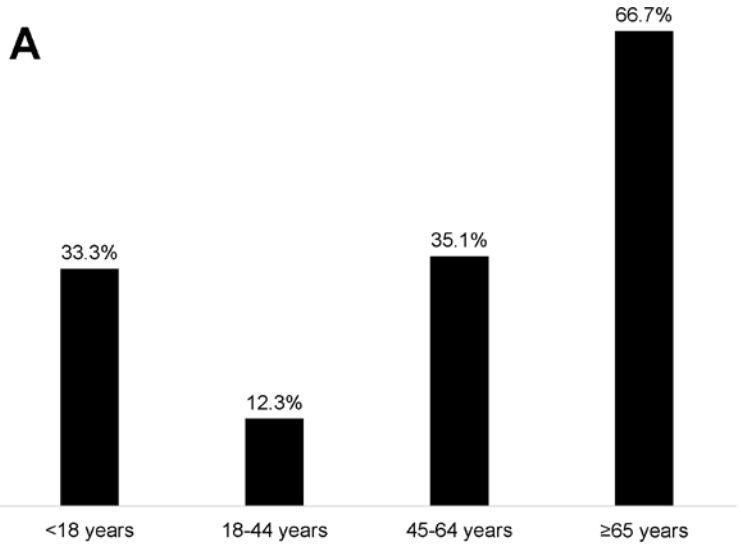


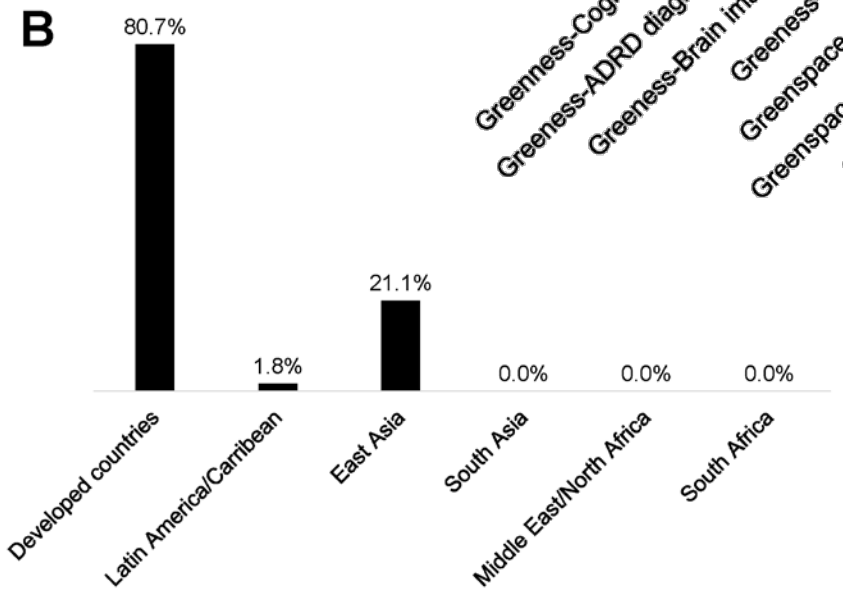
Darker the green = more healthy vegetation

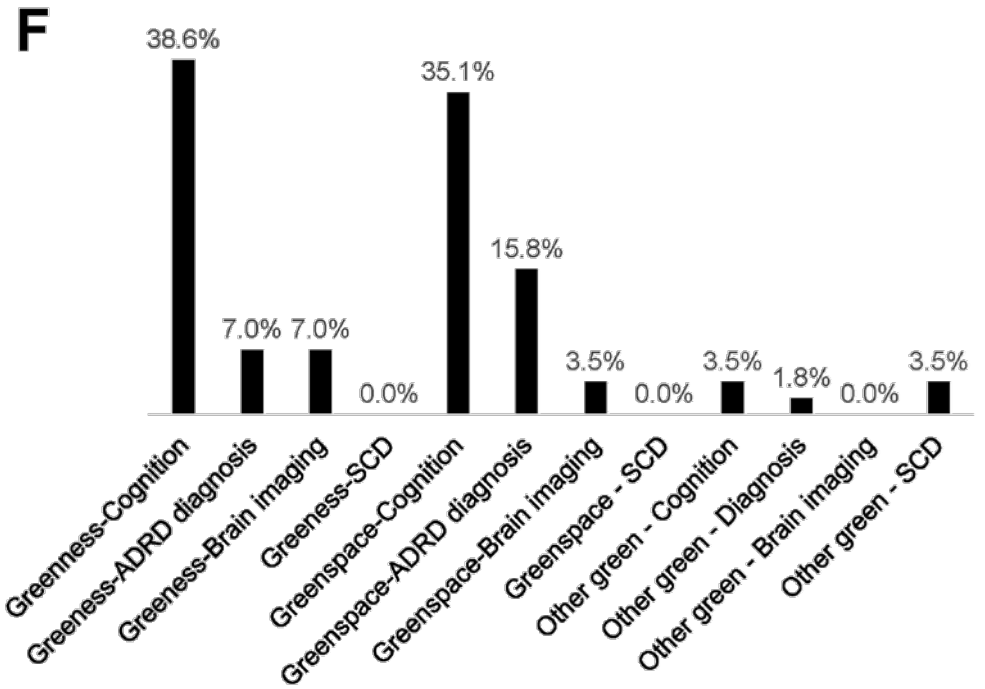
Loss of healthy vegetation over 18 years

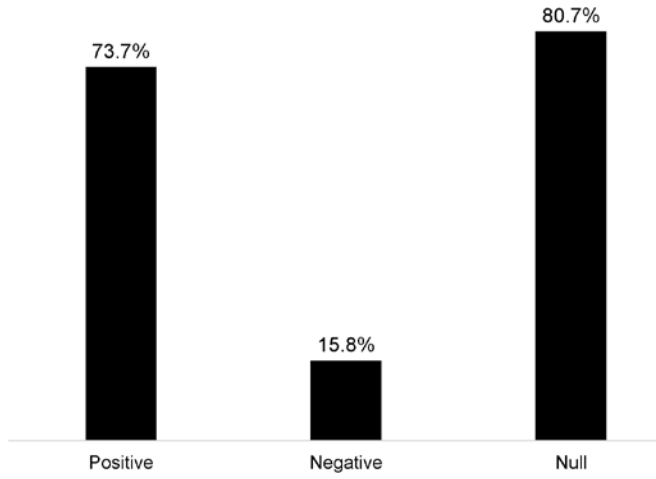
Extant evidence for greenspace-brain health associations

- As of March 2022: 57 papers published on topic*
- 4 studies examined differences in associations by racial/ethnic group







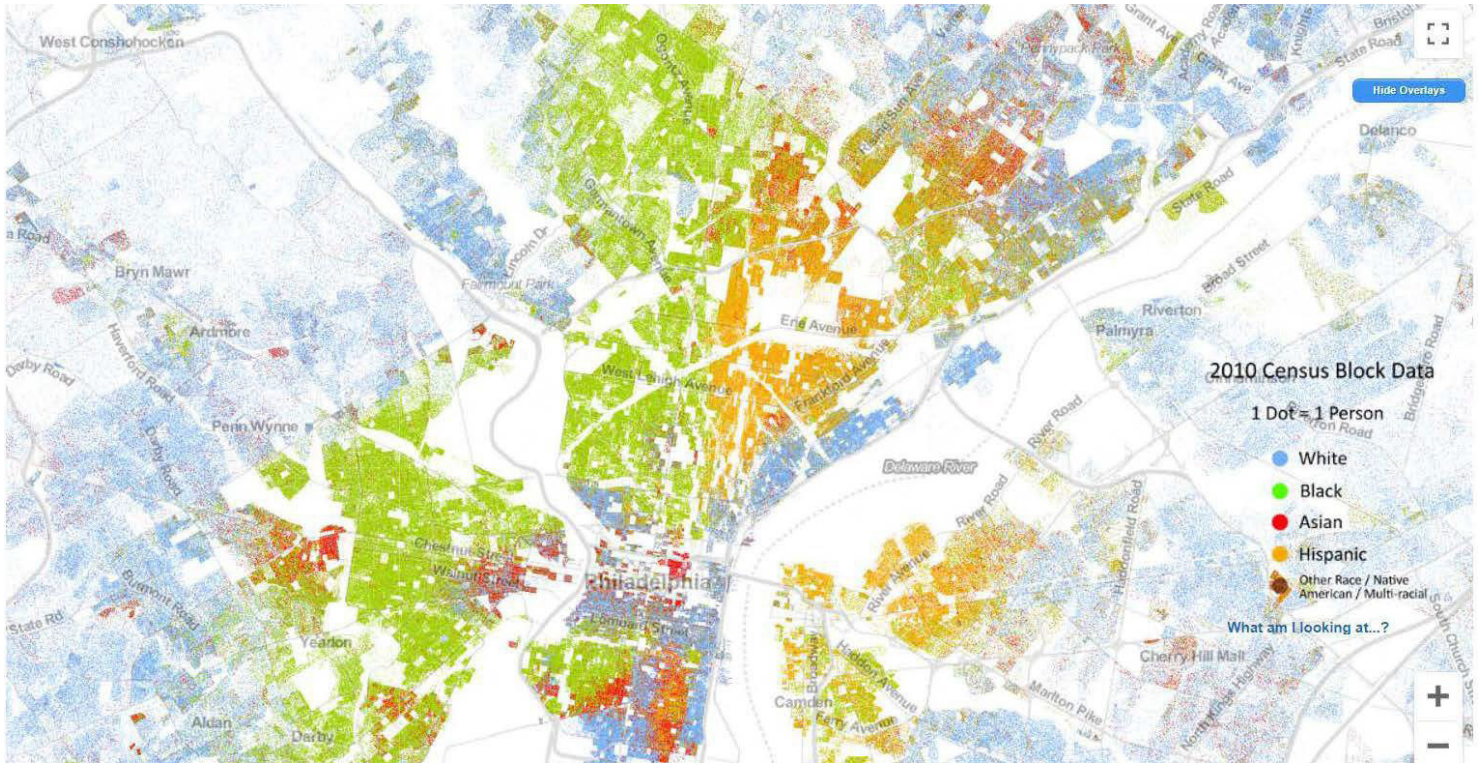


*Besser LM, Jimenez MP, et al. Diversity of Studies on Neighborhood Greenspace and Brain Health by Racialized/Ethnic Group and Geographic Region: A Rapid Review. *In press*.

Prior review: Besser L. Outdoor green space exposure and brain health measures related to Alzheimer's disease: a rapid review. BMJ Open. 2021 May 3;11(5):e043456. doi: 10.1136/bmjopen-2020-043456. PMID: 33941628; PMCID: PMC8098949.

Neighborhood racial/ethnic segregation

- Structures/policies in the US led to segregation of racial and ethnic groups into different residential neighborhoods
- Populations living in predominantly non-White segregated neighborhoods have worse health outcomes (e.g., life expectancy)
  - Reduced access to financial and community resources that promote health

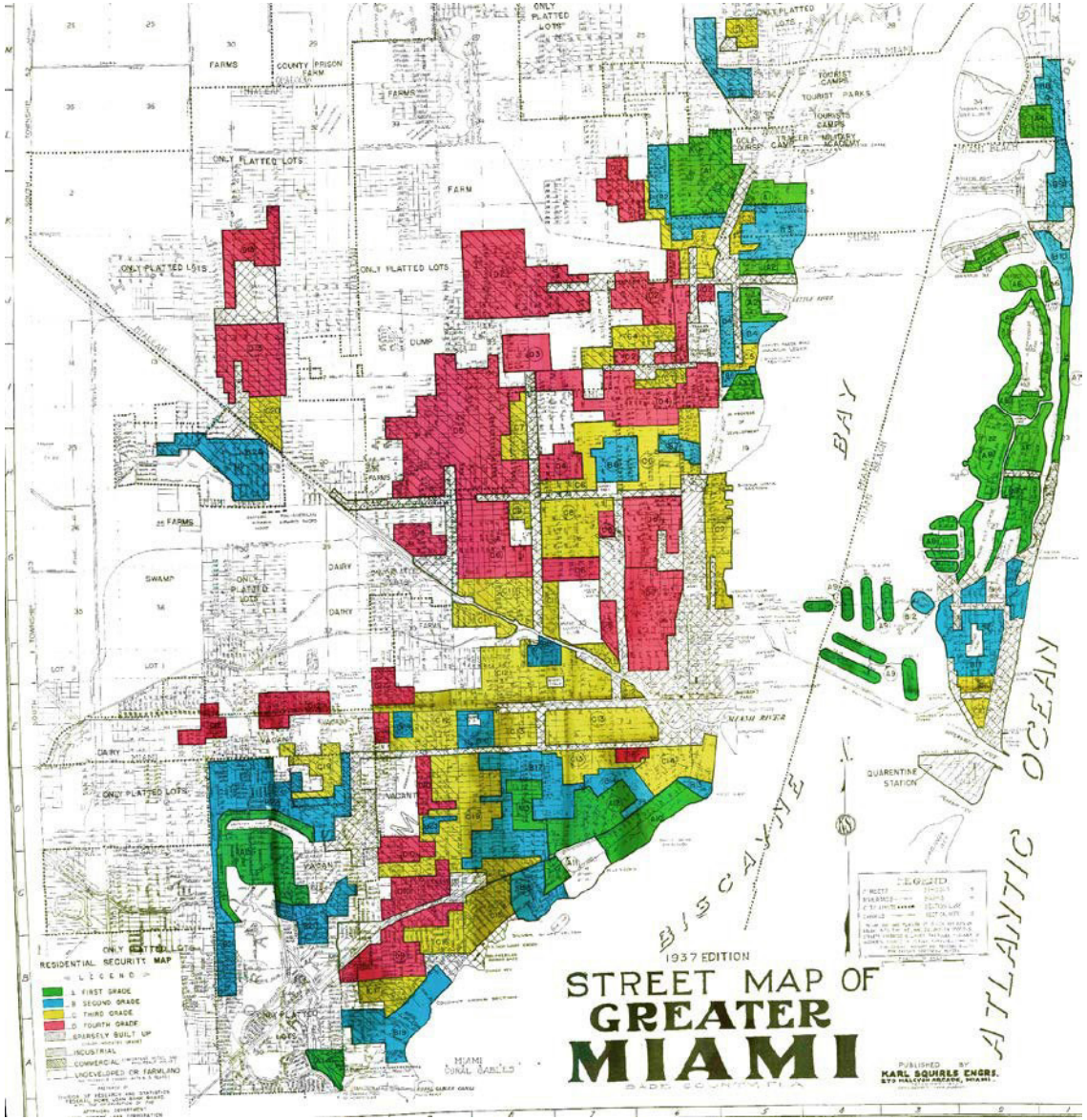


Philadelphia, Pennsylvania, US

Neighborhood walking among older adults living in historically redlined US neighborhoods: The 2017 National Household Travel Survey. Besser et al. Am J Prev Med. 2022 Dec;63(6):926-934.

Redlining: 1930s, US government policy (FHA) resulted in:

- Black, working class, and immigrant neighborhoods color-coded on maps
- Indicating investment risk
- Negatively impacted mortgage attainment/homeownership
- Led to long-standing segregation by race/ethnicity and socioeconomic status



Map source: Robert K. Nelson, LaDale Winling, Richard Marciano, Nathan Connolly, et al., "Mapping Inequality," *American Panorama*, ed. Robert K. Nelson and Edward L. Ayers, accessed April 29, 2022, https://dsl.richmond.edu/panorama/redlining.

“Hazardous” neighborhoods today, Miami

“Best” neighborhoods today, Miami

Neighborhood walking among older adults living in historically redlined US neighborhoods: The 2017 National Household Travel Survey

N=4,651 from 37 states	"Best" or "still desirable"	"Hazardous" or "definitely declining"	Unadjusted OR (95% CI)
	Mean (SD)		
Area deprivation index (Higher=greater deprivation)	33.8 (27.0)	50.8 (30.0)	1.65 (1.56-1.74)
% open/park space	21.9% (16.7)	12.2% (11.7)	0.62 (0.59, 0.65)
% low-income workers	23.4% (5.3)	26.8% (6.5)	1.10 (1.09-1.12)
Pedestrian oriented intersections/mi^2	63.4 (35.9)	60.7 (48.4)	0.87 (0.77-0.99)

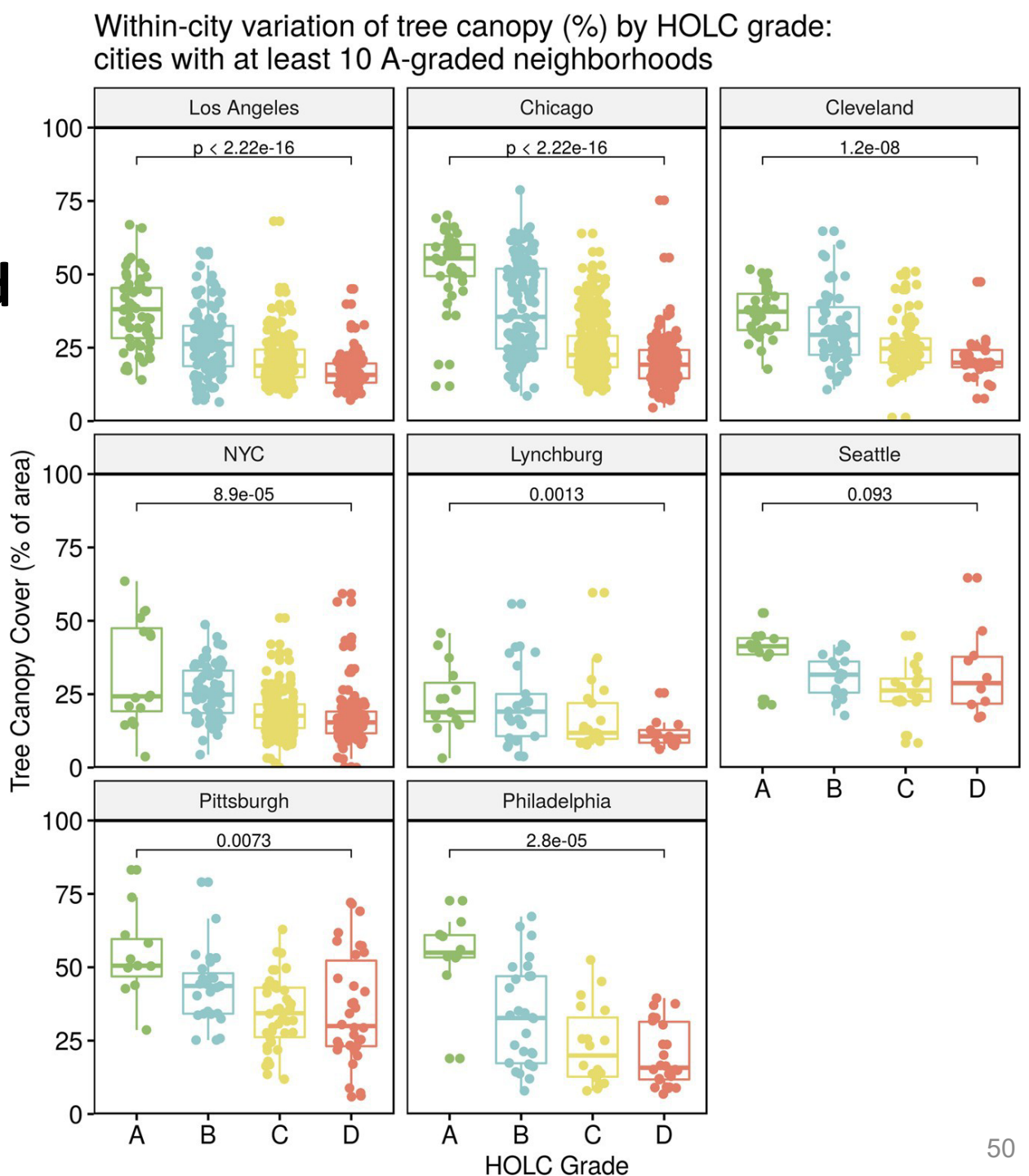
- Individuals in "hazardous" neighborhoods (versus those in "best" neighborhoods) reported less neighborhood walking (prevalence ratio=0.64; 95% CI=0.43, 0.97)

Locke et al (2021):

Residential housing segregation and urban tree canopy in 37 US cities

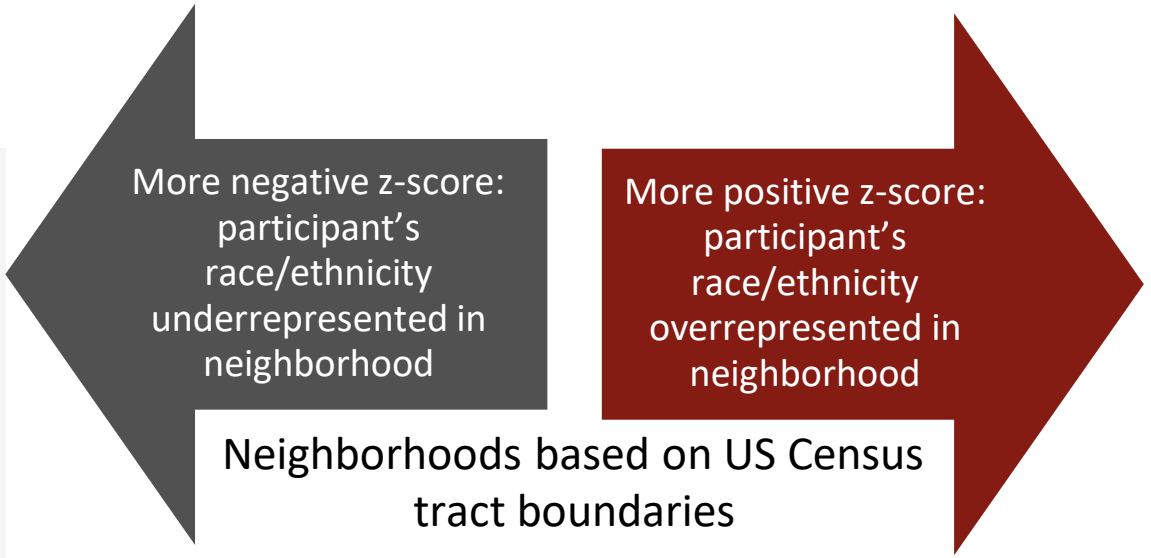
Analyzed 37 metro areas:

- Areas formerly **graded D** (mostly inhabited by racial and ethnic minorities) had average of **~23% tree canopy cover**
- Areas formerly **graded A** (US-born white residents in newer housing had average of **~43% tree canopy cover**



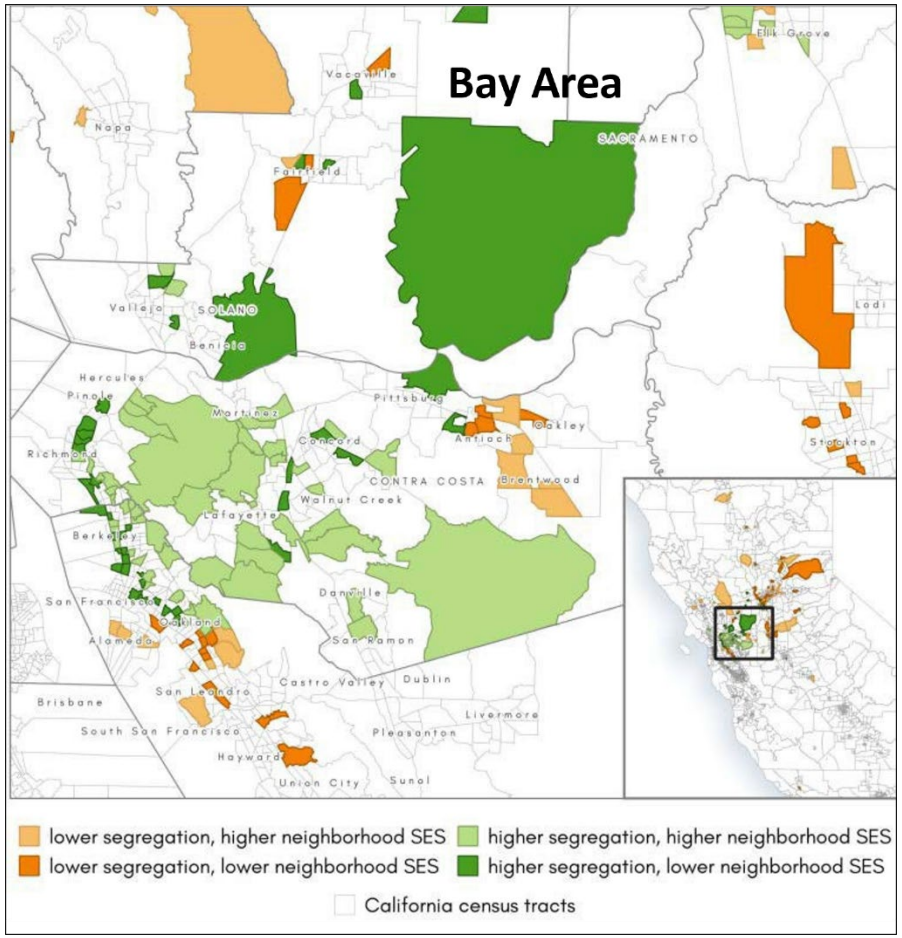
Neighborhood segregation and cognitive change: Multi-Ethnic Study of Atherosclerosis. Besser, Meyer, et al. Alzheimers Dement. 2023 Apr;19(4):1143-1151.

- 29% African American/Black, 17% Hispanic, 11% Chinese, 43% White
- n=1,712 with cognition measured at 2 time points
- Multivariable linear mixed effects regression with random intercepts and slopes
- **Black participants with greater neighborhood segregation had greater processing speed decline over ~6 years**
  - Estimate: -0.036 (95% CI: -0.067, -0.006)



Getis-Ord (Gi*) statistic:

- Compares racial/ethnic composition of US census tract to surrounding tracts and broader study region
- Positive/higher score: more individuals of participant's race/ethnicity in neighborhood
- Sample Gi* score range: -7.5 to +17.6



RESEARCH ARTICLE

Alzheimers Dement (Amst). 2023 Feb 8;15(1):e12401

Neighborhood socioeconomic status and segregation linked to cognitive decline

Oanh L. Meyer[1] | Lilah Besser[2] | Michele Tobias[3] | Kristen M. George[4] | Brandon Gavett[5] | Sarah Tomaszewski Farias[1] | Nishi Bhagat[3] | My Le Pham[3] | Stephanie Chrisphonte[2] | Rachel A. Whitmer[4]

- UC Davis Alzheimer's Disease Research Center, n=327
- **Neighborhood SES** (NSES) composite derived from six US Census tract variables (e.g., % with a high school diploma)
- **Neighborhood segregation:** Getis-Ord (Gi*)
- **Four-category combined segregation-NSES measure based on dichotomizing segregation and NSES measures**
  - Created this measure to help tease apart potential impact of racial segregation versus neighborhood SES

Among Black participants:

Slower episodic memory decline over time (vs high segregation-low NSES) among those in:

Lower segregation-lower NSES areas (estimate: 0.052, 95% CI: 0.018, 0.086)

Higher segregation-higher NSES areas (estimate: 0.059, 95% CI: 0.009, 0108)

Extant evidence for racial/ethnic segregation and brain health associations

Summary: Suggestive of detrimental association between neighborhood segregation and baseline cognition, and longitudinal change in cognition, and brain volumes measured via MRI among Black individuals, with more variable findings for Hispanic individuals.

Author (year)	Findings
Aneshensel (2011)	Living in highly segregated Black communities, worse baseline cognition if low education. Highest level of cognitive functioning among highly educated living in predominantly Black neighborhoods
Kovalchik (2015)	Greater composition and segregation of Hispanic residents assoc. with better baseline cognition but steeper decline over time
Caunca (2020)	Greater cumulative exposure to segregated neighborhoods associated with worse Digit symbol score (processing speed) among Black participants in middle age

Author (year)	Findings
Meyer, Besser, et al., (2021)	Black participants: lower baseline cognitive scores in highly clustered Latino neighborhoods; no association with cognitive change. Hispanic participants: highly clustered Latino neighborhoods associated with lower baseline cognitive score, slower cognitive decline over time.
Pohl et al., (2021)	"Non-Hispanic Black adults were most likely to experience negative effects of neighborhood segregation on cognition (language and memory) and dementia."
Hazzouri et al., (2022)	Cumulative exposure to a high level of racial segregation in young adulthood associated with smaller brain volumes among Black participants in midlife.

WIP: Alzheimer's Association Research Grant (Lilah Besser-PI, Oanh Meyer: co-PI)

Neighborhood segregation and longitudinal change in brain health measures

Aim 3: Conduct **neighborhood-based focus groups** with older adults and key stakeholders in the community to understand perceptions of neighborhood segregation and how segregation impacts behavior and opportunity, with the goal of elucidating possible mechanisms relating segregation to brain health.

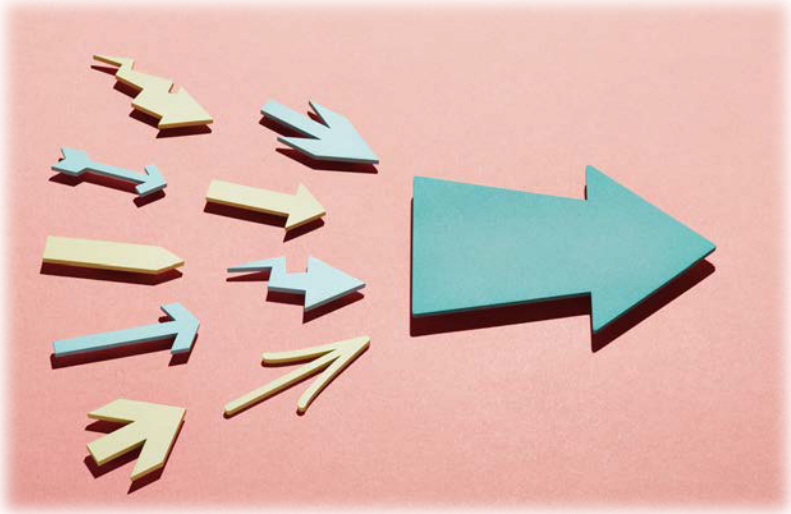
- **Highlights importance of lived experience and qualitative investigation**

Evidence to date: neighborhoods & brain health

Evidence is preliminary but suggestive for associations between racial/ethnic segregation and built environments (particularly for parks and greenspace) and brain health and related risk factors among older adults

Neighborhood racial/ethnic segregation

Neighborhood built environments
- Greenspaces



Risk factors for dementia

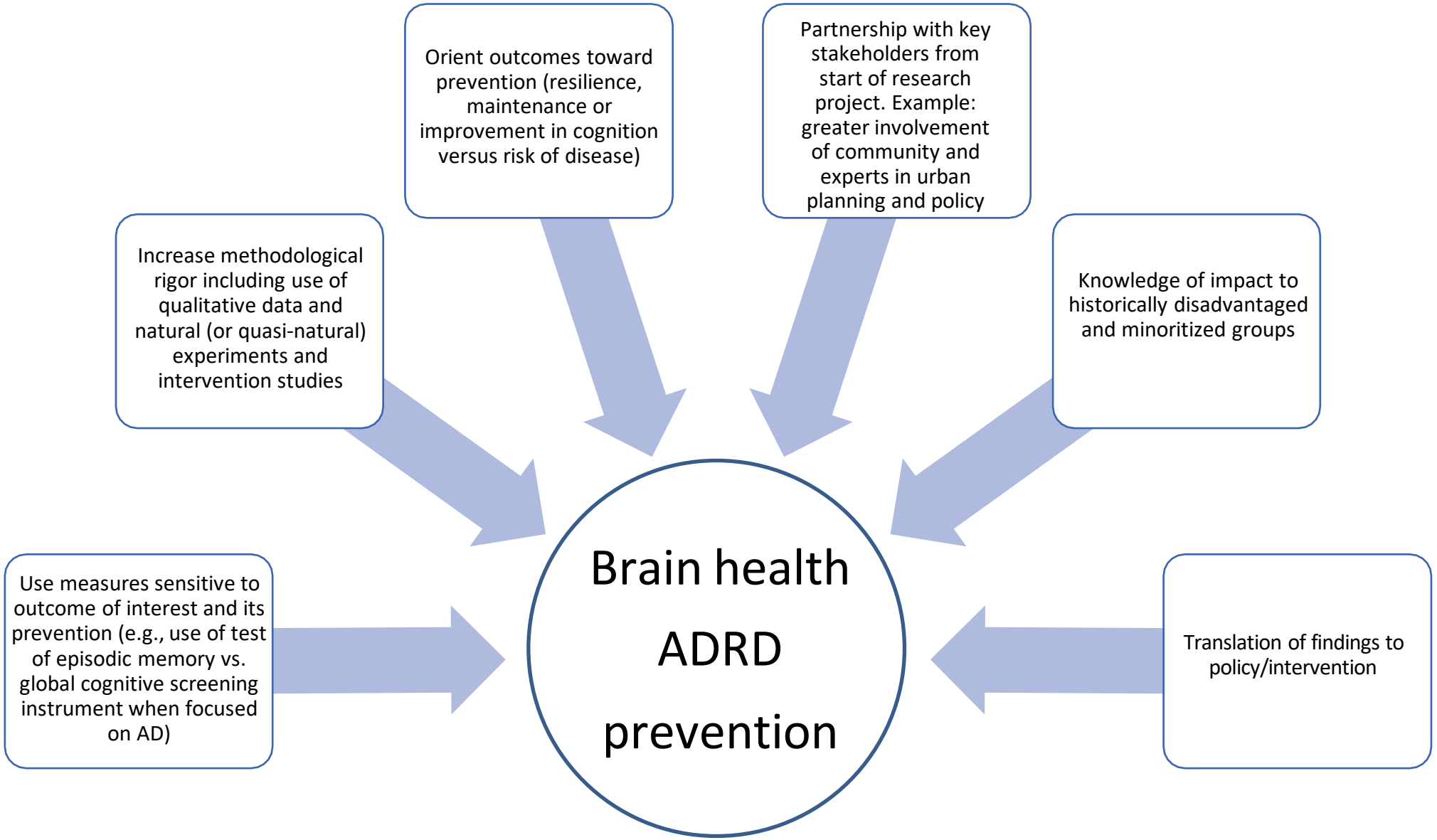
Brain health

Alzheimer's and related dementia outcomes

Future directions

Advancing the science linking neighborhood environments to brain health

Strategy	Details
More mixed methods research	Richness of and difference in information ascertained from interviews/focus groups
Refine capturing exposures (time period, place/boundaries, degree)	• Time period: childhood, midlife, late life • Place/boundaries: neighborhood vs broader • Degree of exposure: walking, living in environment
Improved data sources for lifecourse exposures	Archiving of objective data (satellite imagery and maps) Determining what self-reported measures are valid and reliable
Understudied populations	• Historically disadvantaged communities/groups (LatinX, Asian, AIAN,..) • Rural residents (could be tied to negative factors that counteract positive benefits to cognitive health (e.g., agricultural chemical exposures) • Immigrant populations • Lower- and middle-income countries
Brain biomarker outcomes for risk/disease	MRI and other biomarkers - precursors to cognitive change, not biased by culture, language, SDOH like education
Other methodological issues	Non-linear and inverse associations, self-selection and reverse causation


Orient outcomes toward prevention (resilience, maintenance or improvement in cognition versus risk of disease)
Partnership with key stakeholders from start of research project. Example: greater involvement of community and experts in urban planning and policy
Increase methodological rigor including use of qualitative data and natural (or quasi-natural) experiments and intervention studies
Knowledge of impact to historically disadvantaged and minoritized groups
Use measures sensitive to outcome of interest and its prevention (e.g., use of test of episodic memory vs. global cognitive screening instrument when focused on AD)
Translation of findings to policy/intervention
Brain health
ADRD
prevention
Increasing orientation toward prevention and equity

Review

Methods to Address Self-Selection and Reverse Causation in Studies of Neighborhood Environments and Brain Health

Lilah M. Besser [1,*], Willa D. Brenowitz [2], Oanh L. Meyer [3], Serena Hoermann [4] and John Renne [4]

Observed associations may be biased by:

- **Self-selection:** e.g., individuals with better cognition move to denser neighborhoods because they prefer many destinations within walking distance of home
- **Reverse causation:** e.g., individuals with deteriorating health choose residences offering health services in neighborhoods in rural/suburban areas (e.g., assisted living).

Methods to address self-selection and reverse causality in neighborhood environment and brain health studies

Method	Potential to address: Neighborhood self-selection	Reverse causality
Randomized control trial	++++	++++
Multivariable regression: covariate adjustment for self-selection	+	
Multivariable regression: propensity score matching, inverse probability weighting	++	
Longitudinal study design	++	++
Restriction/stratification of sample	+	+
Quasi-experiment: natural experiment, instrumental variable analysis	+++	+++

Abbreviations: Qualitative scoring: no + = no potential; + low potential; ++ moderate potential; +++ moderate to high potential; ++++ High potential

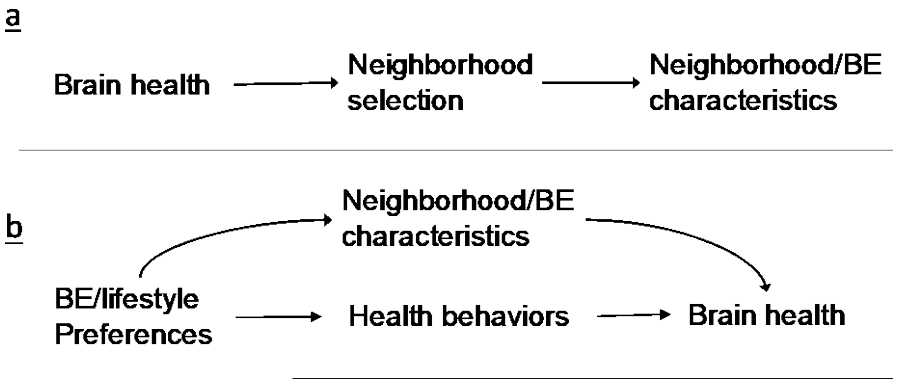


Illustration of relationship between neighborhood/built environment (BE) and brain health in the case of bias by (a) reverse causation; (b) self-selection by individual preferences.

Health Impact Assessments (HIAs):

- Used by government agencies, other organizations, and stakeholders
- Evaluate positive/negative health consequences of plans, policies, and projects from non-health sectors
- Equity and addressing health disparities: expressed goals of many HIAs and part of HIA practice standards
- Developed/used Tool for the Racial/Ethnic Equity Evaluation of Health Impact Assessments
  - Scored 50 U.S. HIA reports on planning-related projects/plans involving parks and greenspaces
  - More recent and more comprehensive HIA reports addressed racial/ethnic equity to a greater degree
  - Overall, HIA reports addressed racial/ethnic equity to lesser degree than expected given principal tenet of equity guiding HIAs and urban planning alike

Example of bridging the gap

- Increasing connection between public health practice/research and urban planning practice
- With an eye toward equity and reducing health disparities

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Evaluating Racial/Ethnic Equity in Planning-Related U.S. Health Impact Assessments Involving Parks and Greenspaces

A Review

Lilah M. Besser Cherilyn Bean Amanda Foor Serena Hoermann John Renne

Example items on Tool for the Racial/Ethnic Equity Evaluation of Health Impact Assessments

Community Engagement	Was the HIA instigated by or developed from the start in collaboration with racially/ethnically marginalized individuals from the community?
	Were racially/ethnically marginalized communities involved in each step of the HIA?
	Did the HIA include racially/ethnically marginalized communities or groups in the public participation process?
Scope/Context	Did the HIA specifically identify racially/ethnically marginalized groups and/or communities (e.g., Spanish speakers or African Americans) who may be affected?
	Did the HIA goals/research questions clearly address racism or racially/ethnically marginalized groups and communities?
	Did the HIA discuss any obstacles (e.g., political will, lack of funds) to implementing a racially/ethnically equitable plan, project, policy or program?
Analysis/evidence	Did the HIA evaluate existing or predicted racial/ethnic inequities with respect to quality of life, health, environmental exposures, or accessibility (e.g., housing, transportation, and access to parks)?
	Did the HIA utilize knowledge and experience from racially/ethnically marginalized communities/groups as evidence?
Recommendations	Did the HIA recommendations include a focus on racially/ethnically marginalized communities?
	Were any HIA recommendations made in response to concerns from racially/ ethnically marginalized communities?

Team, University of Miami's Comprehensive Center for Brain Health (PI: James E. Galvin)

Dr. Besser's funding & acknowledgements

NIH/NIA - **K01 AG063895**, "Longitudinal associations between neighborhood greenspace and brain aging in cognitively normal older adults"

NIH/NIA - **R21 AG075291**, "Objectively measured neighborhood greenness in midlife and late life cognitive and brain imaging outcomes for Alzheimer's disease: The Multi-Ethnic Study of Atherosclerosis"

Alzheimer's Association Research Grant - **AARG-21-850963**, "Neighborhood segregation and longitudinal change in brain health measures"

Thanks to my mentor: James E. Galvin

QUESTIONS? Lilah Besser: lmb9767@miami.edu @lilahbesser