



Overall, this presentation will contextualize for members of the SACIM advisory committee how our *Public Health Exposome* framework is used to identify important associations between chemical and non-chemical stressor exposures and chronic disease outcomes in vulnerable populations using both data-driven and hypothesis driven methods.

The short talk will demonstrate, using *Public Health Exposome* datasets (1.0-4.0) how to *use data driven, computational and hypothesis driven* analytics to *discover* new scientific insights into associations between the built, natural, physical and social environments, adverse health outcomes and population-level outcomes. The *PHE* framework offers a new exposure science approach for conducting risk trajectory assessments that can be used to assess the effects of multiple, interactive, and cumulative chemical and non-chemical stressor exposures on negative health outcomes.

By curating large amounts of disparate, heterogeneous data, the *PHE* approach provides environmental public health, epidemiologists and chronic disease researchers with the tools to develop, target, and evaluate current and past public health programs and policies.



**Department of Health and Human Services  
Secretary's Advisory Committee on Infant Mortality (SACIM)**

**Session: Environmental Contributions to Infant and Maternal Health**

**Tuesday January 26, 2021  
12:30pm-1:30pm**

**Individual, Community and Population Level Environmental-Associated Attributes  
on Adverse Pregnancy Outcomes in High-Risk Census Tracts in Ohio**

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College of Public Health**

**Department of Neuroscience  
College of Medicine**



**Conflict of Interest Statement**

The author declares no conflict of interest



Life expectancy at birth, by metro area

100 - Longer life ↑

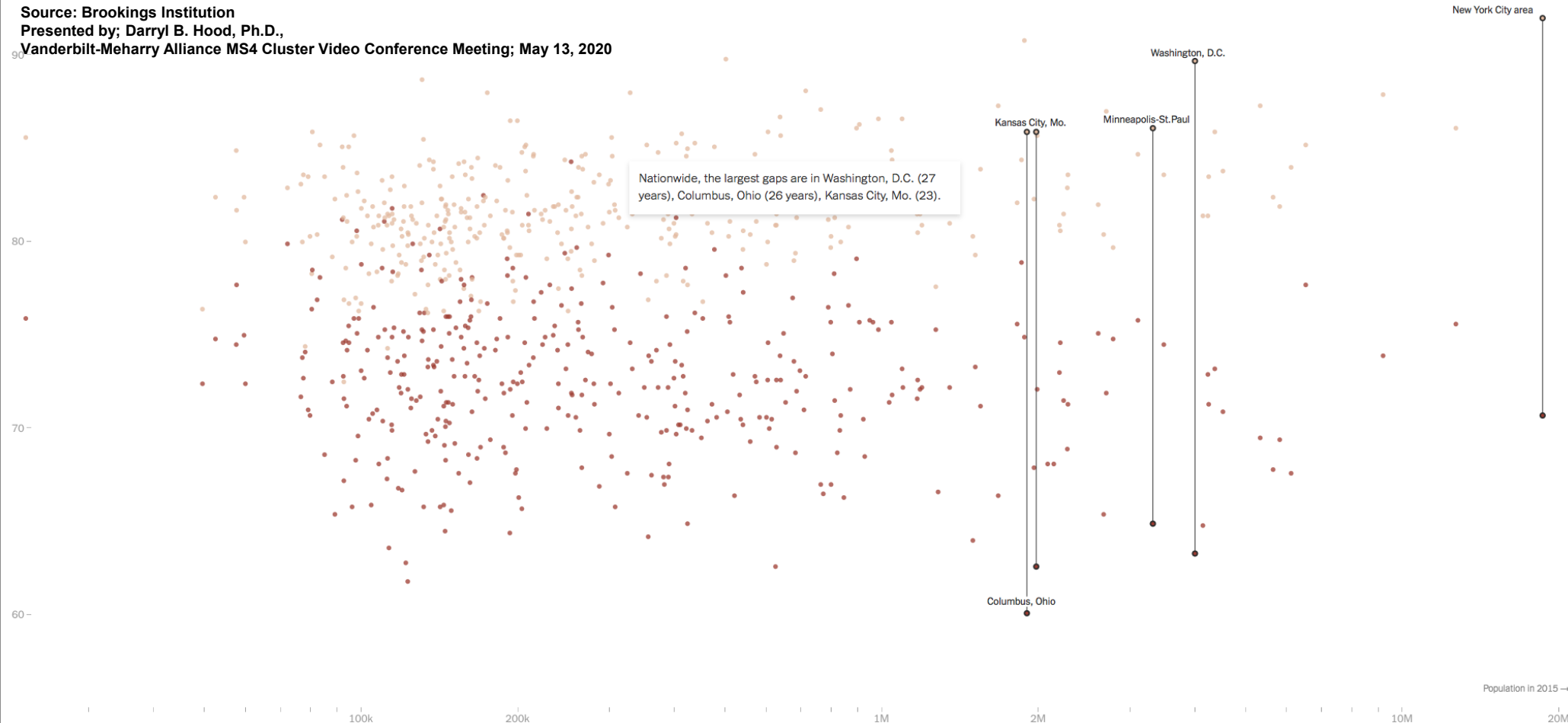
# Life expectancies at birth in the richest and poorest neighborhoods in metro areas in the USA

Source: Brookings Institution

Presented by; Darryl B. Hood, Ph.D.,

Vanderbilt-Meharry Alliance MS4 Cluster Video Conference Meeting; May 13, 2020

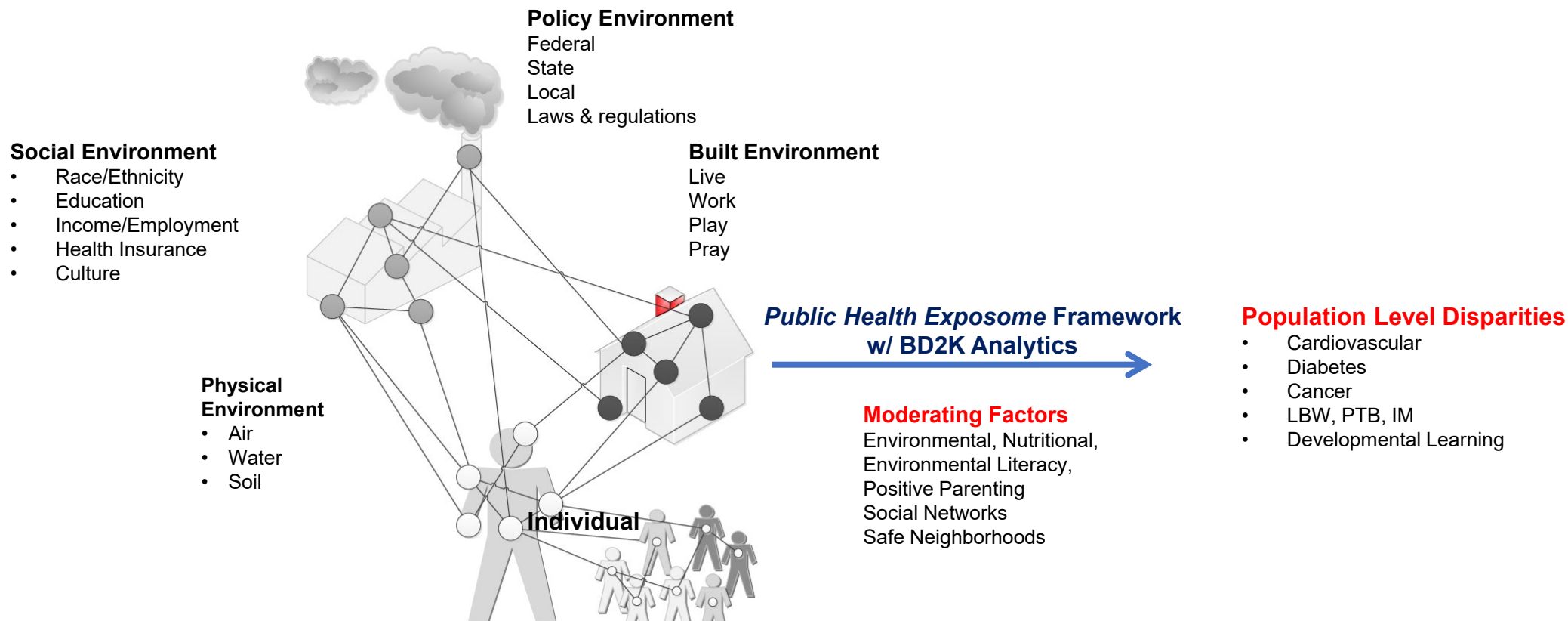
● Highest median income  
● Lowest median income



Columbus, OH has the second worst disparity in life expectancy at birth by census tract



# Place matters with regard to health care disparities and disparate health outcomes



## Exposure to Chemical & Non-Chemical Stressors

**Behaviors**

- Smoking
- Alcohol
- Drugs
- Diet/Nutrition
- Consumer Products

**Disparate Health Outcomes**

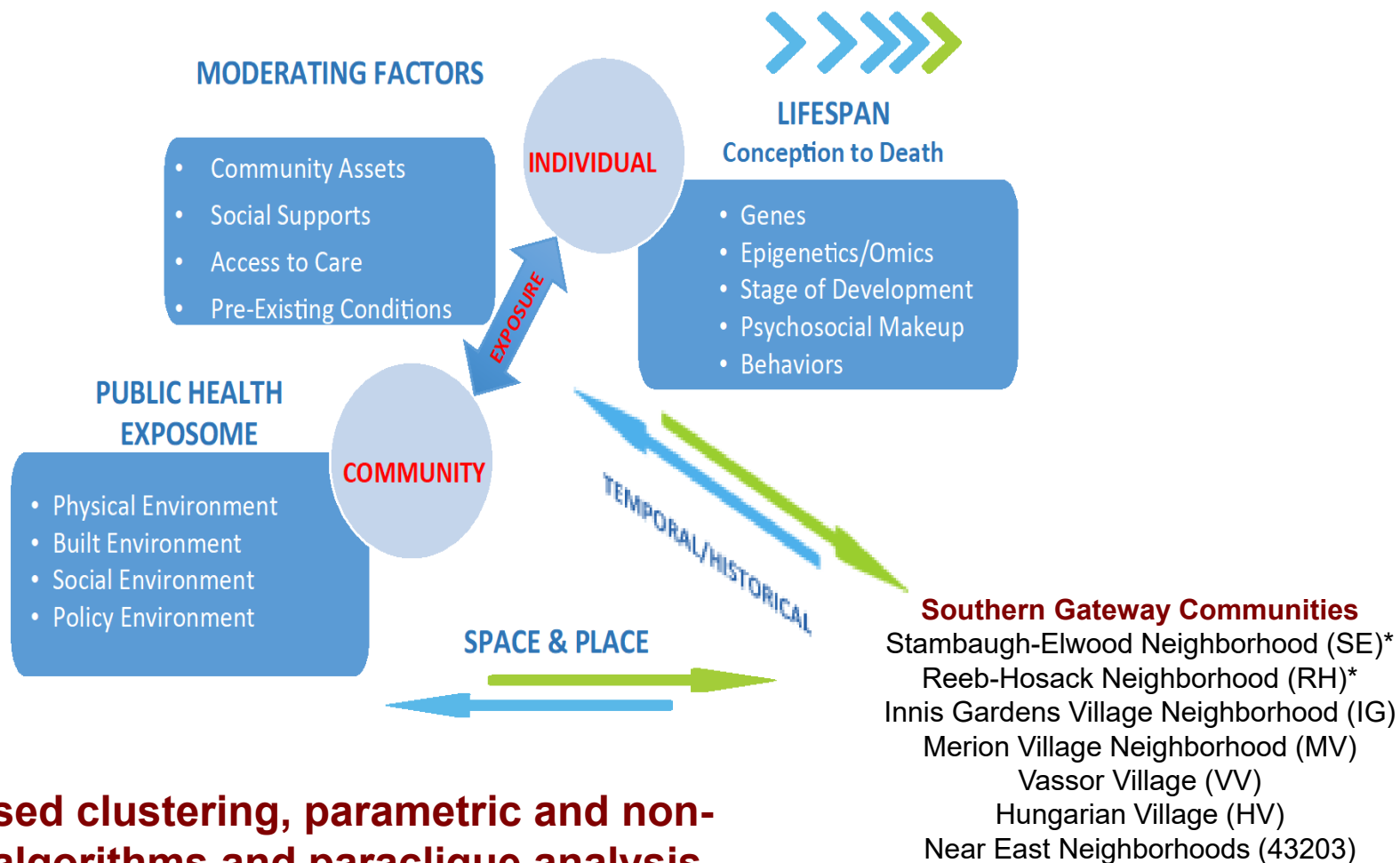
- Morbidity/Mortality
- Immune System/ **Immuno-suppression**
- Neuro-cognitive developmental delay
- Longevity and other Chronic Diseases

**Omics**

- Metabolomics
- Transcriptomics
- Microbiomics
- Epigenomics
- Genomics



# Public Health Exposome framework



**Supervised and unsupervised clustering, parametric and non-parametric, combinatorial algorithms and paraclique analysis**



# Spatial and Temporal Aligned Data

SOUTHERN COMMUNITY COHORT STUDY					PUBLIC HEALTH EXPOSOME			
<u>Timeline</u>	<u>Enrollment</u>	<u>Biological Samples</u>	<u>Medicare &amp; Medicaid Claims Data</u>	<u>State Cancer Registry</u>	<u>SS Death Index Files</u>	<u>Natural Environment</u>	<u>Built Environment</u>	<u>Social Environment</u>
2002	Demographics, smoking hx, medical hx, health insurance, Family medical Hx, Emotional/social support, environment, work history, usual eating habits	<b>Blood Urine Buccal Swabs</b>	2002	2002	2002	Daily gridded data PM2.5 (3km grid) Min Temp (1 km grid) Max Temp (1km grid) Heat Index (1km grid) PM10 (12 km) SO2 (12 km) NO2 (12km) Ozone (12km) Solar Radiation (12km) Formaldehyde (12km)	Road Networks Manufacturing, mining and construction, energy, transit service, broadband internet availability, home sales, housing prices, disaster declarations, Locations of hospitals and critical access hospitals; Medically Underserved Areas; Counts and rates of health resources, business and residential vacancy, households receiving housing subsidies, rental rates, housing affordability, museums and libraries, health care facilities, housing quality, home ownership, public transit, childcare access, supermarket access, food deserts, mental health treatment facilities, locations of drug and alcohol treatment facilities, locations of buprenorphine physicians, SNAP Retail Locations, farmers markets,	BLS/Unemployment home values, housing stock, rental units, vacancy, household turnover, school enrollment, educational attainment, per capita income, family incomes, household incomes, aggregate income by type, incomes by age for older households, income inequality, people in poverty, families in poverty, population by ethnicity, age, sex, people with disabilities, total population, foreign born population, predominant foreign born population, household characteristics, families, veterans, homeowner characteristics, renter characteristics, affordability and cost burdens, unemployment, employment, commute to work, vehicles per household, home heating fuel types, healthcare uninsurance and healthcare insurance, Manufacturing, mining and construction, Opportunity Insights, Residential segregation, health risk behavior, opioid prescriptions, life expectancy, social vulnerability index, Medicare/Medicaid, immigration FBI uniform crime reports, bank failures, food insecurity rates, child food insecurity, percent of insecure eligible for National Nutrition Assistance, and food-budget shortfall , loans, religion, migration, social needs index, school performance,, SSI, voter turnout, voter turnout, Occupations,
2003								
2004								
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013	<u>Survey Wave 2</u>							
2014								
2015								
2016	<u>Survey Wave 3</u>							
2017	<u>Survey Wave 4</u>							
2018								
2019								

**Table 1. Summary of socio-demographic and health indicators in Southern Gateway neighborhoods by zip-code vs Franklin County, Columbus City, and the State of Ohio.**

Source	43206	43207	43209	Franklin	Columbus	Ohio
<b>Population</b>	21,864 <sup>1c</sup> 22,162±979 <sup>d</sup>	45,144 <sup>1c</sup> 47,943±161 <sup>d</sup>	27,228 <sup>1c</sup> 27,934±782 <sup>d</sup>	1,163,414 <sup>1c</sup> 1,197,592±NA <sup>d</sup>	787,033 <sup>1c</sup> 811,943 ± 129 <sup>d</sup>	11,536,504 <sup>1c</sup> 11,560,380±NA <sup>d</sup>
<b>Race / ethnicity</b>						
Percent of African American population	43.9 <sup>1c</sup> 44.3±2.6 <sup>2</sup>	26.2 <sup>1c</sup> 25.9±2.1 <sup>2</sup>	25.8 <sup>1c</sup> 27±2 <sup>2</sup>	21.2 <sup>1c</sup> 21.30±0.2 <sup>2</sup>	28 <sup>1c</sup> 27.80±0.3 <sup>2</sup>	12.2 <sup>1c</sup> 12.20±0.1 <sup>2</sup>
Percent of Latino population	2.3 <sup>1c</sup> 2.4±1.4 <sup>2</sup>	3.4 <sup>1c</sup> 4.5±1.2 <sup>2</sup>	2.8 <sup>1c</sup> 2.9±1 <sup>2</sup>	4.8 <sup>1c</sup> 4.9±NA <sup>2</sup>	5.6 <sup>1c</sup> 5.70±0.2 <sup>2</sup>	3.1 <sup>1c</sup> 3.30±0.1 <sup>2</sup>
<b>Education</b>						
Education < 9 <sup>th</sup> grade	4.4 <sup>1</sup> 4.4±1.6 <sup>c</sup>	7.5 <sup>1</sup> 6.8±1.5 <sup>c</sup>	2.8 <sup>1</sup> 1.7±0.6 <sup>c</sup>	3.4 <sup>1</sup> 3.2 ±0.2 <sup>c</sup>	3.9 <sup>1</sup> 3.80±0.3 <sup>c</sup>	3.6 <sup>1</sup> 3.20±0.1 <sup>c</sup>
Education up to high school	30.6 <sup>1</sup> 27.9±2.6 <sup>2</sup>	39.6 <sup>1</sup> 42.3±2 <sup>2</sup>	18.5 <sup>1</sup> 17.9±2 <sup>2</sup>	27.1 <sup>1</sup> 25.5±0.4 <sup>2</sup>	27.3 <sup>1</sup> 26.10±0.5 <sup>2</sup>	36.1 <sup>1</sup> 34.50±0.1 <sup>2</sup>
Bachelor degree	15.8 <sup>1</sup> 21.2±2.2 <sup>2</sup>	4.1 <sup>1</sup> 6.2±0.9 <sup>2</sup>	27.1 <sup>1</sup> 28.4±1.8 <sup>2</sup>	21.2 <sup>1</sup> 23.40±0.3 <sup>2</sup>	19.9 <sup>1</sup> 21.80±0.5 <sup>2</sup>	13.7 <sup>1</sup> 16.10±0.1 <sup>2</sup>
Graduate education	9.2 <sup>1</sup> 12.3±1.9 <sup>2</sup>	1.4 <sup>1</sup> 2.3±0.5 <sup>2</sup>	21 <sup>1</sup> 23.6±1.8 <sup>2</sup>	10.7 <sup>1</sup> 13.40±0.2 <sup>2</sup>	9.2 <sup>1</sup> 11.50±0.3 <sup>2</sup>	7.5 <sup>1</sup> 9.50±0.1 <sup>2</sup>
<b>Employment and income</b>						
Unemployed individuals >16 years in civilian labor force	4.5 <sup>1</sup> 9.4±1.4 <sup>2</sup>	3.6 <sup>1</sup> 8.5±1.3 <sup>2</sup>	3.3 <sup>1</sup> 4.3±0.8 <sup>2</sup>	3 <sup>1</sup> 5.60±0.2 <sup>2</sup>	3.5 <sup>1</sup> 6.20±0.3 <sup>2</sup>	3.2 <sup>1</sup> 5.80±0.1 <sup>2</sup>
Median Household income (US dollars)	34,794 <sup>1</sup> 41,717±2,244 <sup>2a</sup>	34,287 <sup>1</sup> 39,634±2,455 <sup>2a</sup>	46,016 <sup>1</sup> 53,924±3,918 <sup>2a</sup>	42,734 <sup>1</sup> 51,890±447 <sup>2a</sup>	37,897 <sup>1</sup> 44,774±464 <sup>2a</sup>	40,956 <sup>1</sup> 48,849±162 <sup>2a</sup>
Percent of families below the poverty level	18.3 <sup>1</sup> 24.7±4.1 <sup>2b</sup>	12.7 <sup>1</sup> 19.7±2.8 <sup>2b</sup>	10.2 <sup>1</sup> 11.8±2.4 <sup>2b</sup>	8.2 <sup>1</sup> 13.20±0.5 <sup>2b</sup>	10.8 <sup>1</sup> 17.40±0.7 <sup>2b</sup>	7.8 <sup>1</sup> 11.70±0.1 <sup>2b</sup>
<b>Health Insurance</b>						
Insured to health care %	84.8±2.2 <sup>c</sup>	83.1±2.1 <sup>c</sup>	90.6±1.4 <sup>c</sup>	87.60±0.3 <sup>c</sup>	85.6±0.4 <sup>c</sup>	89.10±0.1 <sup>c</sup>
<b>Chronic Health Disease – Percentage (IC 95%)</b>						
Diabetes/told they have diabetes %	8.0 <sup>3</sup> (1.3, 14.7)	13.7 <sup>3</sup> (5.4, 22.0)	5.4 <sup>3</sup> (0.7, 10.1)	4.0 <sup>3</sup> & 10.1 <sup>3</sup> (8.8, 11.4)		6.0 <sup>3</sup>
Obesity /overweight or obese %	51.2 <sup>3</sup> (32.6, 69.8)	69.8 <sup>3</sup> (59.5, 80.2)	58.8 <sup>3</sup> (41.6, 76.0)	20.0 <sup>3</sup> & 64.1 <sup>3</sup> (61.9, 66.4)		22.0 <sup>3</sup>
Current Asthma %	5.9 <sup>3</sup> (0.0, 11.7)	16.6 <sup>3</sup> (9.0, 24.2)	7.4 <sup>3</sup> (0.0, 16.2)	9.6 <sup>3</sup> (8.3, 10.9)		
Tobacco use/currently smoke %	34.9 <sup>3</sup> (17.6, 52.2)	34.6 <sup>3</sup> (23.7, 45.4)	18.2 <sup>3</sup> (1.4, 35.0)	13.0 <sup>3</sup> & 22.1 <sup>3</sup> (20.1, 24.2)		29.0 <sup>3</sup>
Ever Told had Depressive Disorder %	16.2 <sup>3</sup> (4.4, 28.1)	28.6 <sup>3</sup> (18.3, 38.8)	18.9 <sup>3</sup> (6.2, 31.7)	20.8 <sup>3</sup> (18.9, 22.6)		
<b>Pregnancy and Birth Outcomes</b>						
Total Number of Births	779 <sup>3</sup>	1,274 <sup>3</sup>	734 <sup>3</sup>	38,053 <sup>3</sup>		
Low Birth Weight %	11.9 <sup>3</sup>	11.6 <sup>3</sup>	9.7 <sup>3</sup>	9.0 <sup>3</sup>		
Preterm Births %	13.1 <sup>3</sup>	12.6 <sup>3</sup>	10.6 <sup>3</sup>	10.5 <sup>3</sup>		
Teenage Mothers %	4.1 <sup>3</sup>	2.7 <sup>3</sup>	0.1 <sup>3</sup>	1.5 <sup>3</sup>		
Infant Mortality Rate (2010-4)	10.9 <sup>3</sup>	12.5 <sup>3</sup>	*	8.4 <sup>3</sup>		
<b>Health promotion and disease prevention</b>						
Walk Score <sup>a</sup>	70 <sup>3</sup>	n/a	26 <sup>3</sup>		40 <sup>3</sup>	
Food Imbalance %	14.8 <sup>3</sup>	36.7 <sup>3</sup>	61.2 <sup>3</sup>	23.9 <sup>3</sup>		
<b>Sexually transmitted infections (cases per 100,000)</b>						
Chlamydia	386 (1,741.7) <sup>3</sup>	502 (1,047.1) <sup>3</sup>	205 (733.9) <sup>3</sup>	9,441 (788.3) <sup>3</sup>		
Gonorrhea	174 (785.1) <sup>3</sup>	178 (371.3) <sup>3</sup>	76 (272.1) <sup>3</sup>	3,265 (272.6) <sup>3</sup>		
<b>Leading causes of death (cases; ADR (95% CI)</b>						
Heart Disease	94; 169.6 (137.1, 207.6) <sup>3</sup>	341; 232.5 (207.6, 257.4) <sup>3</sup>	143; 125.1 (103.9, 146.3) <sup>3</sup>	5,623; 173.5 (168.9, 178.1) <sup>3</sup>		
Cancer	101; 169.9 (135.3, 204.5) <sup>3</sup>	317; 209.9 (186.6, 233.2) <sup>3</sup>	135; 130.7 (108.0, 153.4) <sup>3</sup>	5,729; 172.3 (167.7, 176.8) <sup>3</sup>		
Stroke	27; 54.5 (35.9, 79.3) <sup>3</sup>	83; 58.4 (46.5, 72.4) <sup>3</sup>	49; 44.1 (32.6, 58.3) <sup>3</sup>	1,361; 43.3 (41.0, 45.6) <sup>3</sup>		
Chronic Lower Respiratory Disease	42; 74.4 (53.6, 100.6) <sup>3</sup>	130; 89.5 (74.0, 105) <sup>3</sup>	26; 23.5 (15.4, 34.5) <sup>3</sup>	1,539; 48.3 (45.8, 50.8) <sup>3</sup>		
Diabetes	19; 32.6 <sup>3</sup> (19.6, 50.8) <sup>3</sup>	60; 41.1 <sup>3</sup> (31.4, 53) <sup>3</sup>	11; 11.0 <sup>3</sup> (5.5, 19.7) <sup>3</sup>	868; 26.1 <sup>3</sup> (24.3, 27.9) <sup>3</sup>		
Accident/Unintentional Injury	37; 56.4 (39.7, 77.7) <sup>3</sup>	108; 75.4 (61.0, 89.7) <sup>3</sup>	27; 29.2 (19.3, 42.5) <sup>3</sup>	1,485; 41.6 (39.5, 43.8) <sup>3</sup>		
Homicide	17; 24 <sup>3</sup> (14.0, 38.5) <sup>3</sup>	33; 24.5 (16.8, 34.3) <sup>3</sup>	8; 10.2 <sup>3</sup> (4.4, 20.2) <sup>3</sup>	305; 8.1 (7.2, 9.0) <sup>3</sup>		
Suicide	12; 18.2 <sup>3</sup> (9.4, 31.9) <sup>3</sup>	26; 18.4 (12.0, 27.0) <sup>3</sup>	11; 12.3 <sup>3</sup> (6.1, 22.0) <sup>3</sup>	427; 11.7 (10.6, 12.8) <sup>3</sup>		

1 2000 Census <sup>1c</sup> 2010 Census,  
2 2014 American Community Survey. Sampling estimations have (±95%MOE)  
{<sup>a</sup> Inflation adjusted 2014 dollars,  
<sup>b</sup> According to income in the last 12 months},  
<sup>3</sup> Franklin County HealthMap 2016,  
<sup>4</sup> Columbus Public Health – CPH Epi Program  
- \* values must be interpreted carefully.

(Cifuentes et al., 2019)





## Sociodemographic Variables

#	Variable Name	Units	Color
1	"population"	Total count	Yellow
2	"minority population"	Total count	Tan
3	"low-income population"	Total count	YellowGreen
4	"less than high school population (>25y) population"	Total count	Red
5	"households in linguistic isolation"	Total count	Brown
6	"under5 population"	Total count	LightYellow
7	"over64 population"	Total count	Dandelion

## Environmental Variables

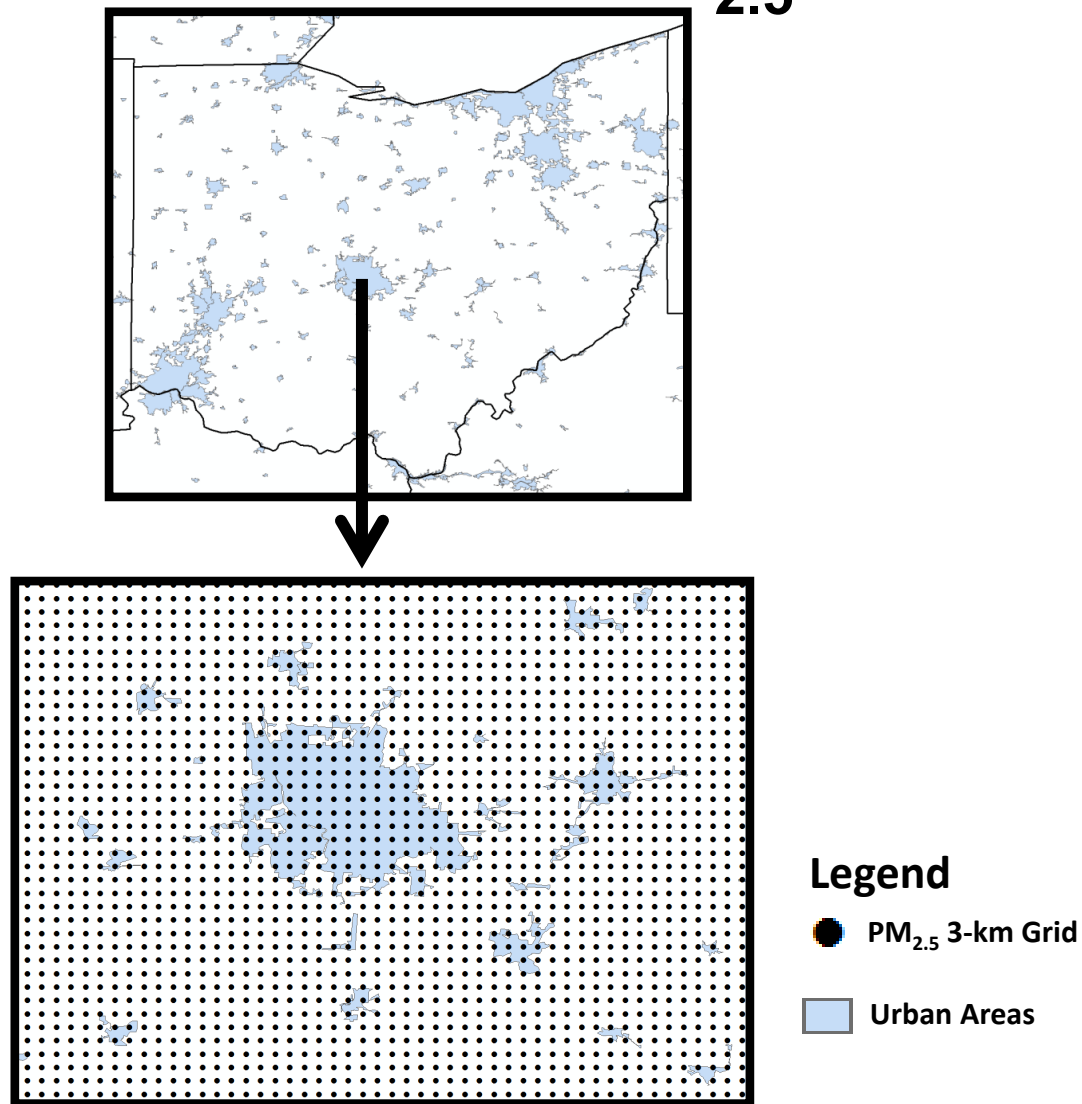
#	Variable Name	Units	Color
8	"pre-1960 housing (lead indicator)"	Total count	Fuchsia
9	"traffic proximity and volume"	Count of vehicles (average annual daily traffic) at major roads within 500 meters, divided by distance in kilometers (km)	MidnightBlue
10	"Proximity to major direct dischargers to water"	Count of NPDES major facilities within 5 km, divided by distance	Cyan
11	"Proximity to National Priorities List (NPL) sites"	Count of proposed and listed NPL sites within 5 km, divided by distance	Blue
12	"Proximity to Risk Management Plan (RMP) facilities"	Count of facilities within 5 km, divided by distance	Gray65
13	"Proximity to Treatment Storage and Disposal (TSDF) facilities"	Count of major TSDFs within 5 km, divided by distance	PineGreen
14	"Ozone level in air"	Summer seasonal average of daily maximum 8-hour concentration in air (ppb)	White
15	"PM2.5 level in air"	Annual average ( $\mu\text{g}/\text{m}^3$ )	Gray30

**Innovation in methodology:** Machine learning for the network used the 'Hill Climbing' with BIC criterion of the 'bnlearn' package in R software. Links were 69-accounting for 32.85% density and an average degree of 9.2. Post-hoc values of arrows (links) are p values based on linear conditional correlation, and line widths are highest for the lowest p values. Automatic visualization accounted for the relative value of the links (obtained by transforming p values by log-transformation and normalization/truncation from 5 to 1) by the VOS mapping algorithm followed by an energy-based algorithm, that located more connected nodes in the center of the graph. (Cifuentes et al., 2019)





# Satellite-derived PM<sub>2.5</sub> Data

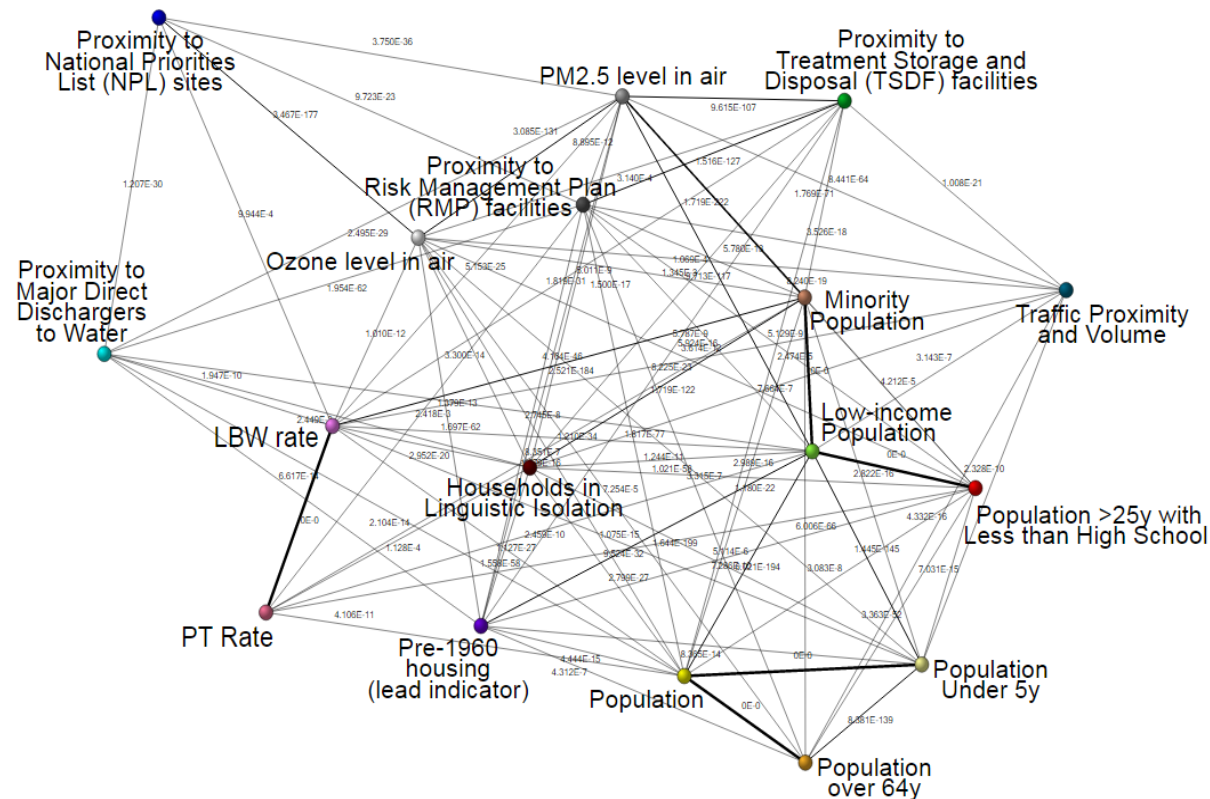


**Columbus, OH**

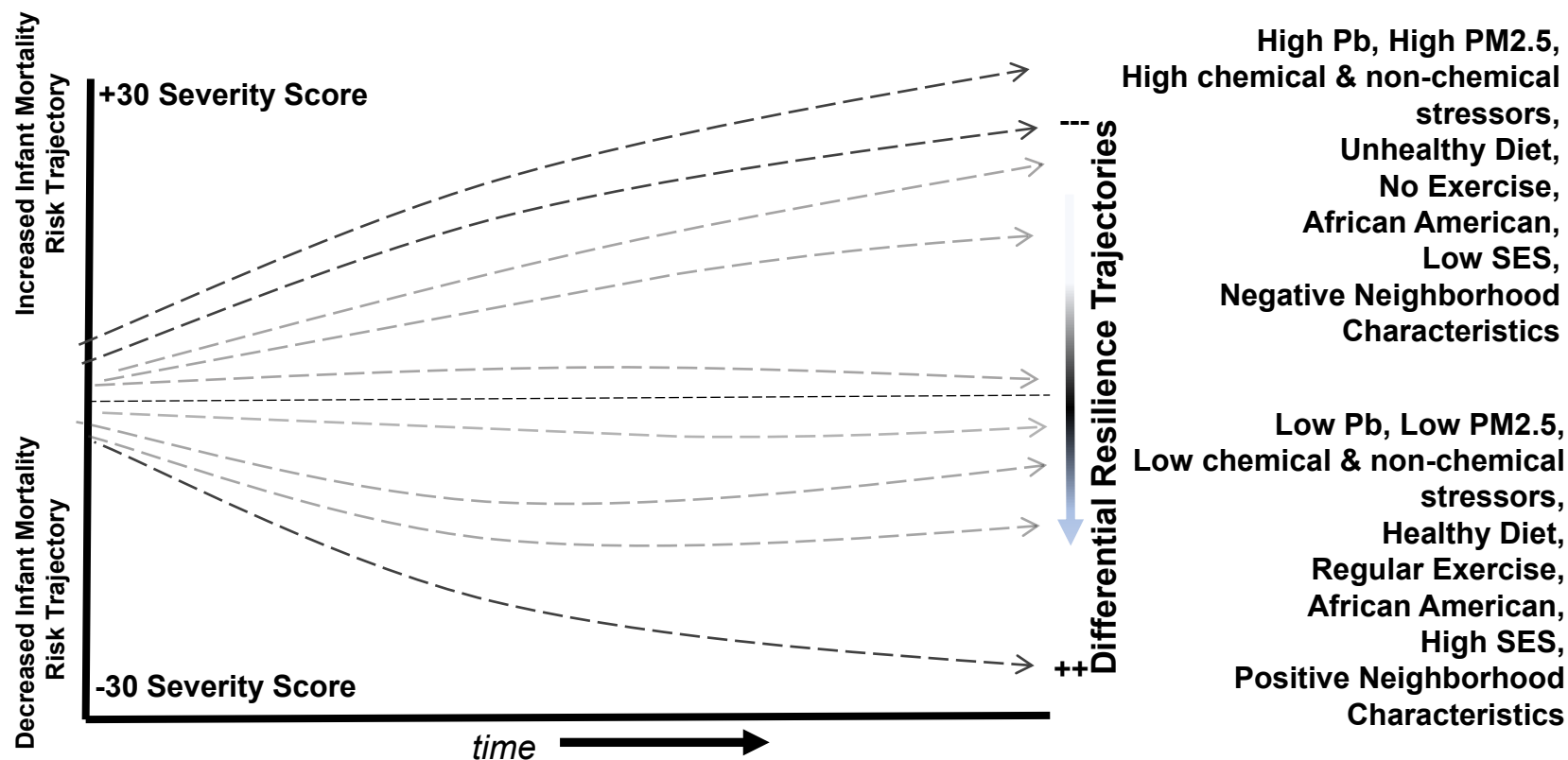
GLOBAL SIGNIFICANCE, LOCAL IMPACT



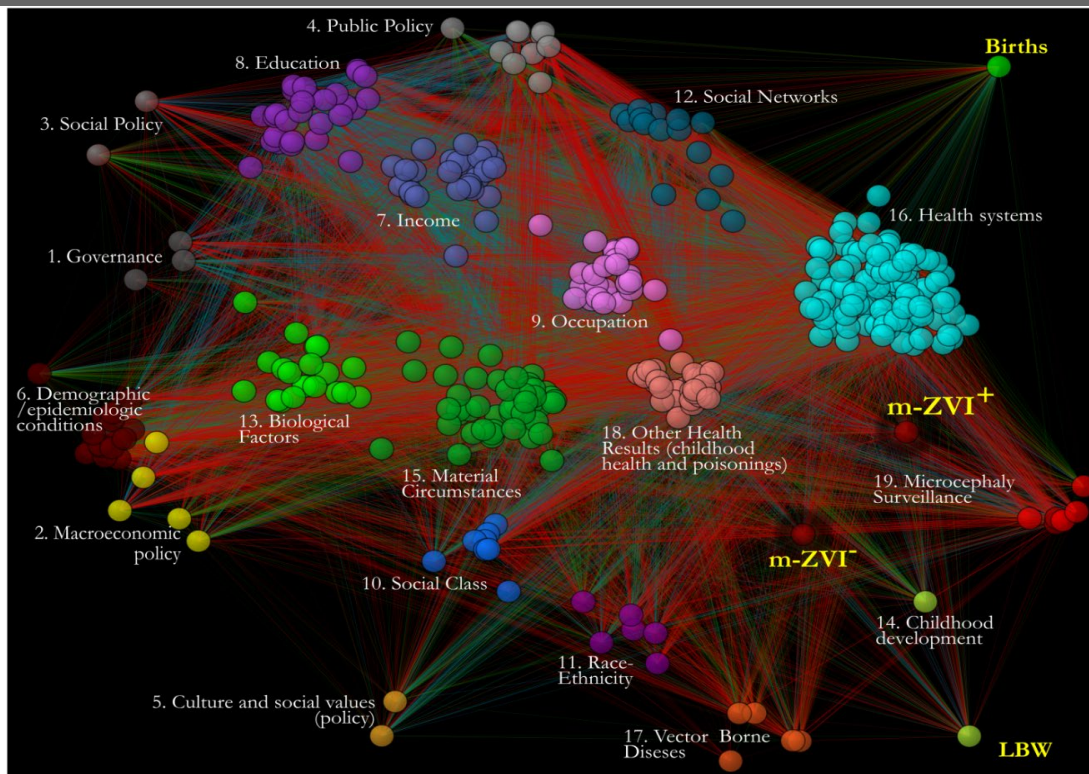
# Bayesian network inferred from USEPA EJSCREEN database and ODH data to demonstrate latent associations between environmental and socio-demographic variables with PTB and LBW within 88-counties in Ohio



**Modeling the complexity of relationships among social determinants of health and environmental variables/factors.** In this model, we included 7-socioeconomic variables and 8-environmental variables that were reported for 9,232 census blocks in Ohio. All variables were continuous. The model predicts that the socioeconomic variables low income (green), minority (tan), and under age 5 (light yellow) together with environmental variables PM 2.5 level in air (gray), proximity to facilities with a risk management plan (Gray65), and proximity to direct discharges in water (cyan) are associated with LBW and PTB . (Cifuentes et al., 2019)



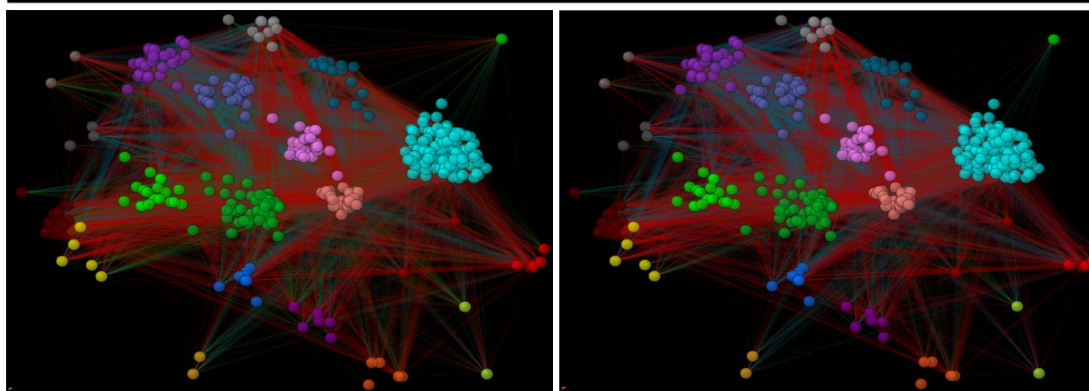
**Graphical representation of a Population-level model that estimates the cumulative risk trajectories for adverse Maternal and Child Health outcomes resulting from exposures to chemical and non-chemical stressors.** The model depicts how baseline incidence of Maternal and Child Health indicators (PTB, LBW and IM) in vulnerable census tracts interacts with chemical and non-chemical stressor exposures. This example anticipates that negative Maternal and Child Health (PTB, LBW, IM) trajectory tracks with high  $PM_{2.5}$  exposures, high exposures to environmental toxicants, poor diet, lack of exercise, low socioeconomic status and negative neighborhood characteristics. The model also depicts resilience trajectories as compensatory mechanisms (positive or negative) toward mitigating adverse Maternal and Child Health outcomes. (Cifuentes et al., 2019)



## ExWAS-based determination of ZVD context networks

Context networks derived from PHE framework and BD2K analytics demonstrate associations of multiple determinant factors with Zika Virus Disease incidence in Brazil's municipalities during the 2016 first semester outbreak. Groups of variables within each determinant factor have different colors according to Table S1 in supplementary data.

Four colors show positive strongest (dark blue) and strong (green) and negative strongest (dark red) and strong (light red) partial correlations among variables/nodes. A, shows the full network, including labels. B, corresponds to the threshold network by graphlet optimally far from random network. C, corresponds to threshold network clustering coefficient-based optimally far from random network.



(Cifuentes et al., 2020)



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**EPA-STAR**

**S11ES014156-05**

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**R56ES17448-01A1**

**U54NS041071-10**

**NCRR-RRO3032-35**

**T32MH065782**

**Vanderbilt**

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**USC**

**Pat Levitt**

**Dan Campbell**

**Auburn**

**M Chris Newland**

**TAMU**

**Steve Safe**

**Nancy Lurie Marks Foundation**

**&**

**Simons Foundation Autism**

**Research Initiative**



**Social Environment**

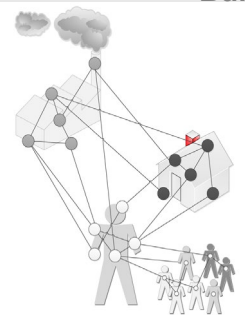
Race/Ethnicity  
Education  
Income/Employment  
Health Insurance Culture

**Physical Environment**

Air  
Water  
Soil

**Built Environment**

Live  
Work  
Play  
Pray



**Community Level**

Link Geocoded consortium participants survey data to PHE 4.0 w/PM2.5 grid to identify environmental and sociodemographic Paracliques

OBJECTIVE 1

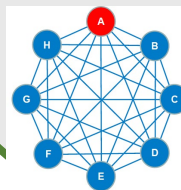
**Curation of Health Data from Interdisciplinary Stakeholder Consortium**

Utilization, FQHC, Home Health, Hospice, Hospital Outpatient, Imaging, Outpatient dialysis, Part B drug, Stroke, Respiratory Disease, Race, Ethnicity, Quality of Life, Mental Health and Substance Abuse, Provider Utilization, Cancer, Preventive Services, Osteoporosis, Beneficiaries, Nursing home care, Medicaid, Long term Care, Kidney Disease, Inpatient Care, High Cholesterol, Heart Disease, Gender, Expenditures, Emergence Care, Diabetes, Chronic disease and conditions



**Individual-Level**

Integrate consortium medical record health care data with *Public Health Exposome* database to inform the identification of Paracliques that are linked to an increased incidence PTB, LBW & IM



A = Infant Mortality  
B = black race  
C = MD re-imbursements  
D = Medicare costs  
E = air quality index days  
F = heart disease  
G = hospitalization  
H = chronic kidney disease

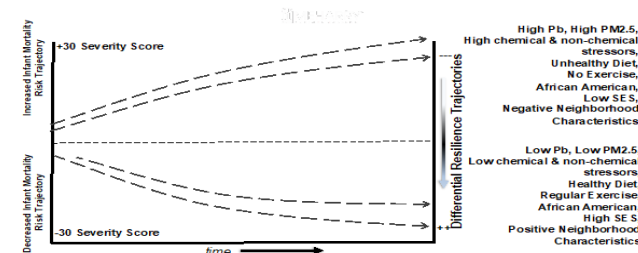
OBJECTIVE 3

**Population-Level**

Estimate the extent to which consortium participants exhibit differential cumulative risk trajectories for adverse maternal and child health outcomes (severity scores) in response to exposures from the built, natural, physical, and social environment to chemical and non-chemical stressors

Extract, normalize, synchronize consortium data with *Public Health Exposome* Paracliques

**Population-Level Risk Trajectory Model for Infant Mortality**



Graphical representation of a Population-level model that estimates the cumulative risk trajectories for adverse Maternal and Child Health outcomes resulting from exposures to chemical and non-chemical stressors. The model depicts how baseline incidence of Maternal and Child Health indicators (PTB, LBW and IM) in vulnerable census tracts interacts with chemical and non-chemical stressor exposures. This example anticipates that negative Maternal and Child Health (PTB, LBW, IM) trajectory tracks with high PM<sub>2.5</sub> exposures, high exposures to environmental toxicants, poor diet, lack of exercise, low socioeconomic status and negative neighborhood characteristics. The model also depicts resilience trajectories as compensatory mechanisms (positive or negative) toward mitigating adverse Maternal and Child Health outcomes. (Cifuentes et al., 2019)

**Curation of Survey Data from Interdisciplinary Stakeholder Consortium**

Sociodemographic questionnaire; Alcohol/Tobacco use; Religious/Spiritual Coping; Dietary Health Questionnaire; Environmental Exposure Questionnaire; Stress & Adversity Inventory; Everyday Discrimination Scale; Perceived Stress Scale; Generalized Anxiety Disorder; Patient Health Questionnaire 9; Medical Outcomes Study Social Support Survey; John Henryism Active Coping Scale; Connor-Davison Resilience Scale; National Asset Scorecard for Communities of Color



# ExWAS Approach to Understanding Environmental Input to Chronic Disease: A Conceptual Model

