

# Tools for assessing cumulative health risk in low-income communities and communities of color

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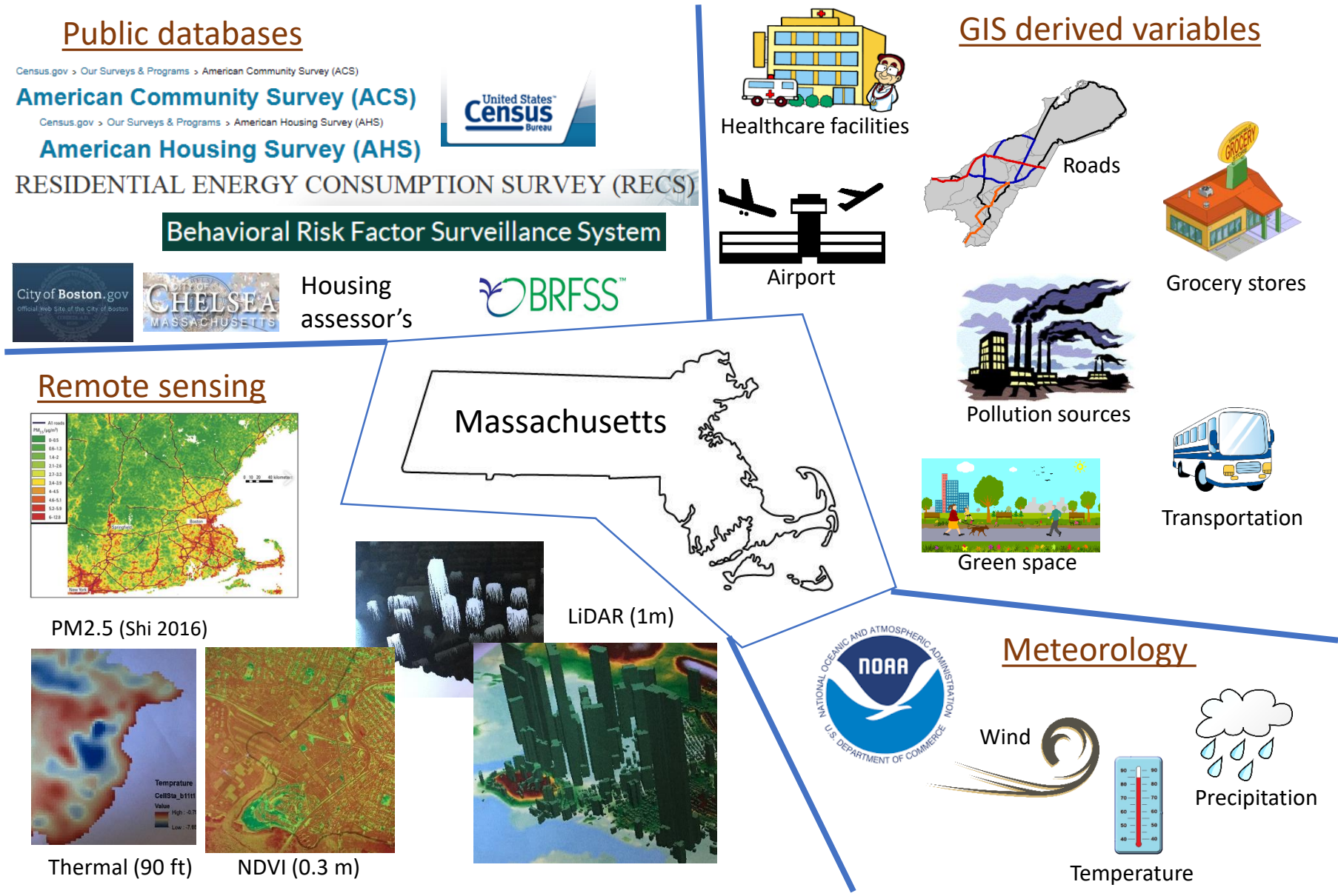
NASEM – Anticipatory Research for EPA's Research and Development Enterprise to  
Inform Future Environmental Protection: The Road Ahead

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# Building blocks

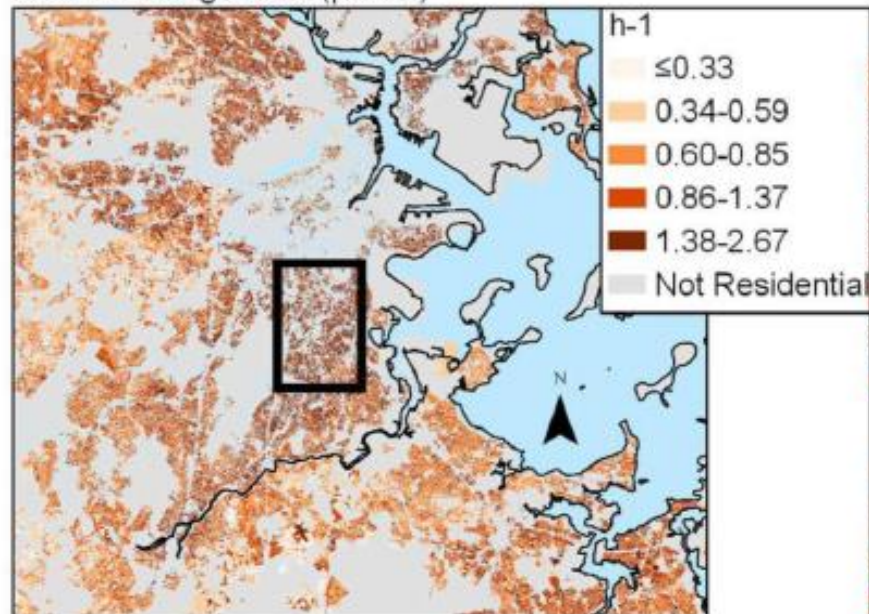
- Cumulative exposures
  - Geospatial data resources
  - Regression modeling approaches from representative measurements
- Sociodemographic distributions of exposure
  - Microsimulation/synthetic populations
- Epidemiologic methods for complex mixtures of chemical and non-chemical stressors

# Geospatial data example (<http://cressh.org>)

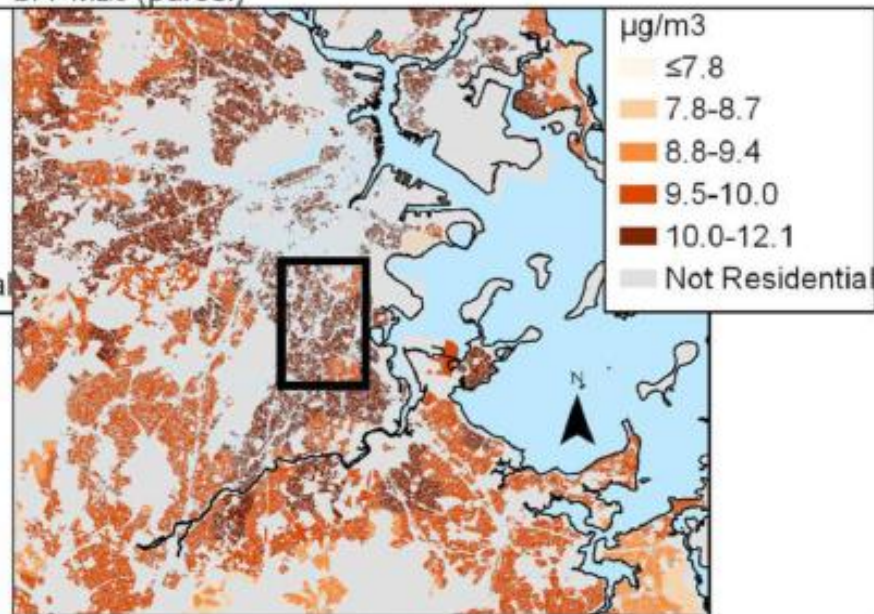




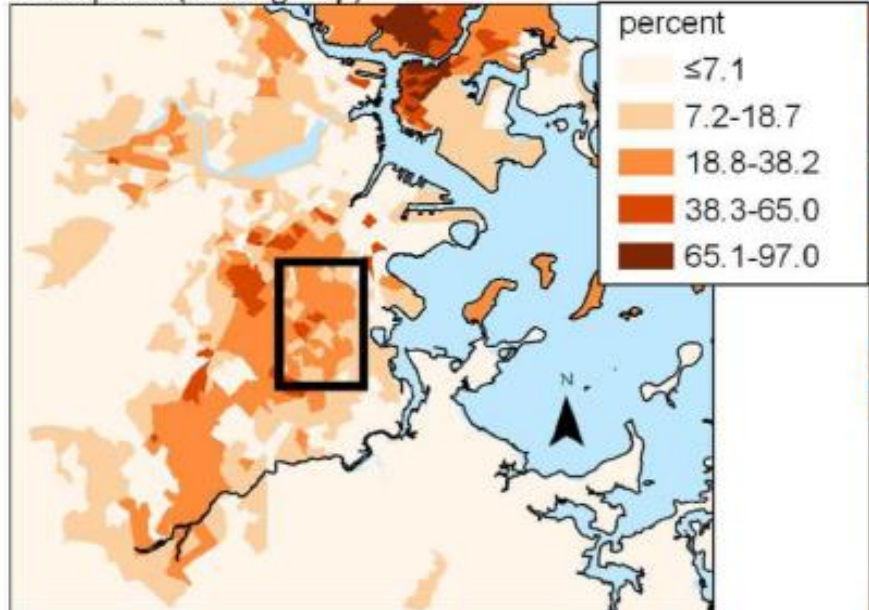
a. Air Exchange Rate (parcel)



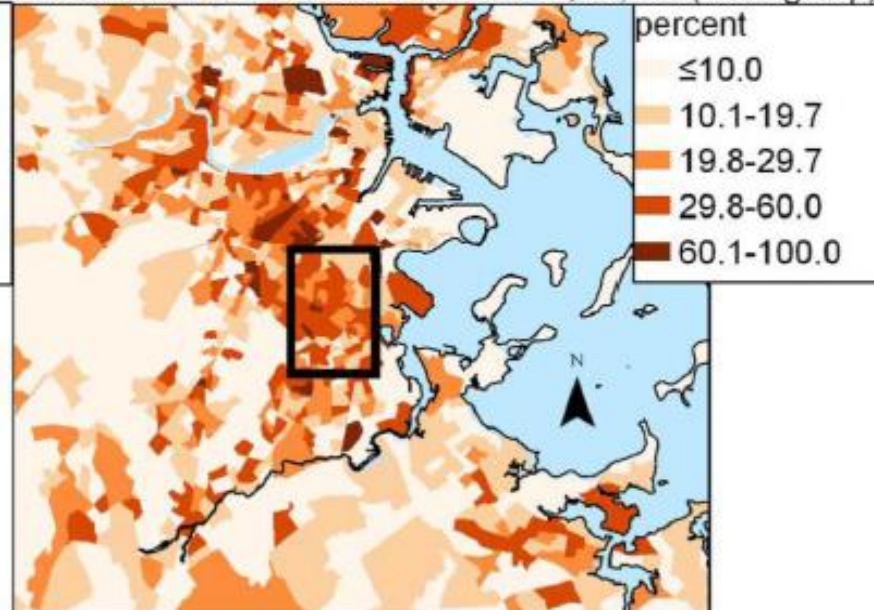
b.  $\text{PM}_{2.5}$  (parcel)



c. Hispanic (block group)



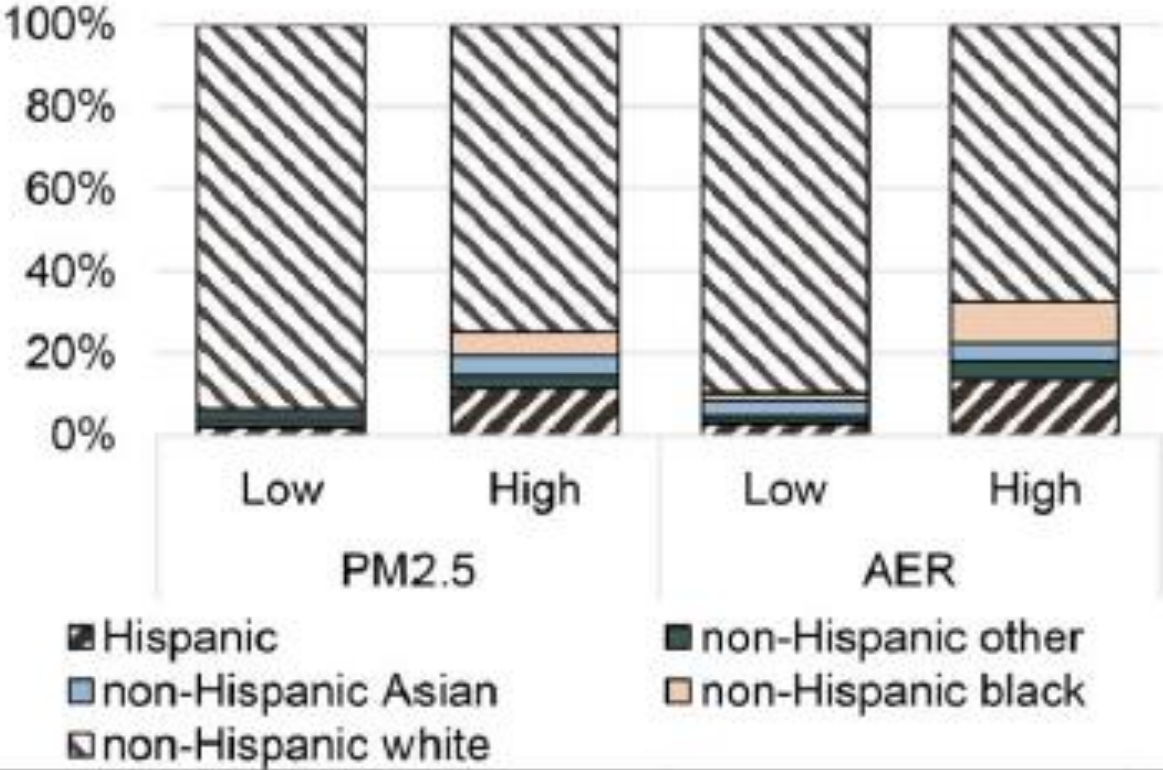
d. Median Annual Household Income  $< \$20,000$  (block group)



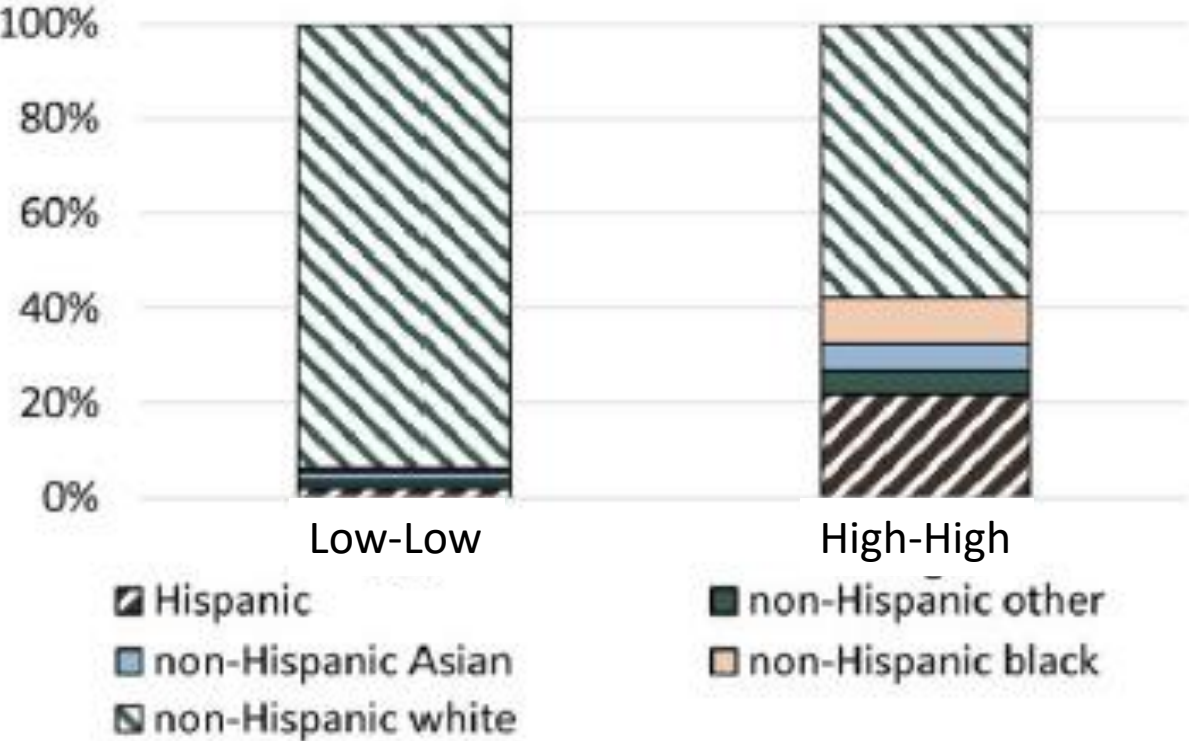
0 1.75 3.5 7 10.5 14 Kilometers

(Rosofsky et al. 2019)

Race/Ethnicity



Race/Ethnicity



(Rosofsky et al. 2019)

# Cumulative exposure: Regression modeling

- Collect measurements or model multiple exposures for a subpopulation (including chemical and non-chemical stressors)
- Build regression models to explain variability as a function of exposure pathways/sociodemographics broadly available
  - Often land use regression, but not exclusively
- Example: Biomarker measurements collected from participants in New Bedford Cohort study (PCB, Pb, Hg, etc.)



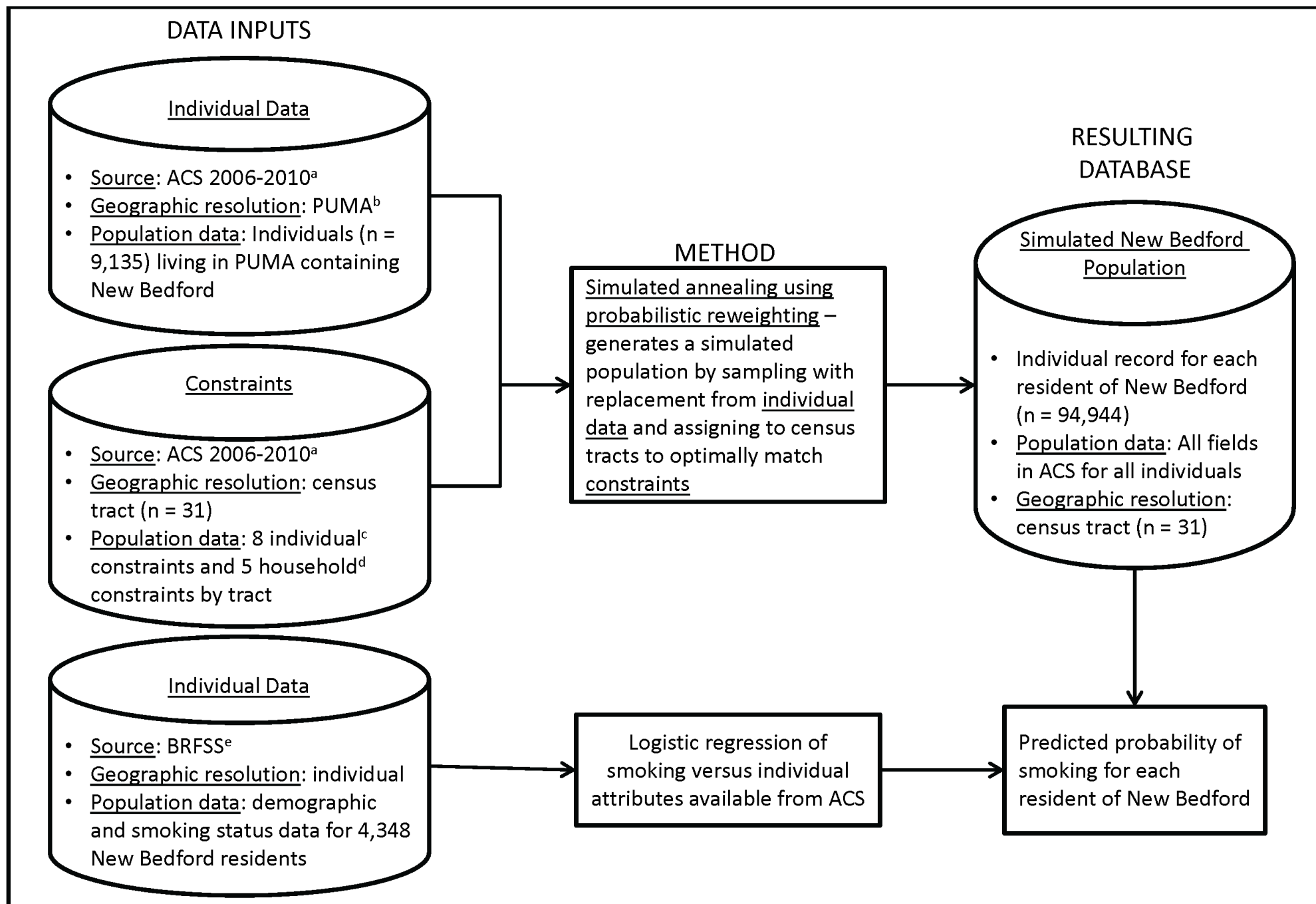
Characteristics	$\Sigma\text{PCB}_4$ ( $n = 659$ ) CV $R^2 = 0.54$	
	Est. <sup>a</sup>	95% CI
Maternal race/ethnicity		
Non-Hispanic African American	−19.3	−43.4, 14.9
Hispanic/Latino	17.9	−2.5, 42.6
Non-Hispanic, other race	13.1	−19.0, 58.4
Maternal ancestry		
Azores/Portugal	36.0	20.6, 53.4
Cape Verde	19.8	−13.1, 65.2
Maternal smoking during pregnancy	NS	NS
Maternal alcohol use in pregnancy	−1.7	−32.7, 43.5
Previous lactation	−4.7	−16.6, 8.9
Block group household income at birth <\$20,000/y	NS	NS
Married at birth	NS	NS
Maternal education (<high school at birth)	11.4	−2.7, 27.5
Parity		
1	−4.9	−16.6, 8.4
2	−18.4	−31.7, −2.5
≥3	−16.8	−35.2, 6.7
Adequate prenatal care	NS	NS
Paternal education <high school at birth	14.2	2.0, 27.9

(Khalili et al., 2019)

# Sociodemographic distributions of exposure

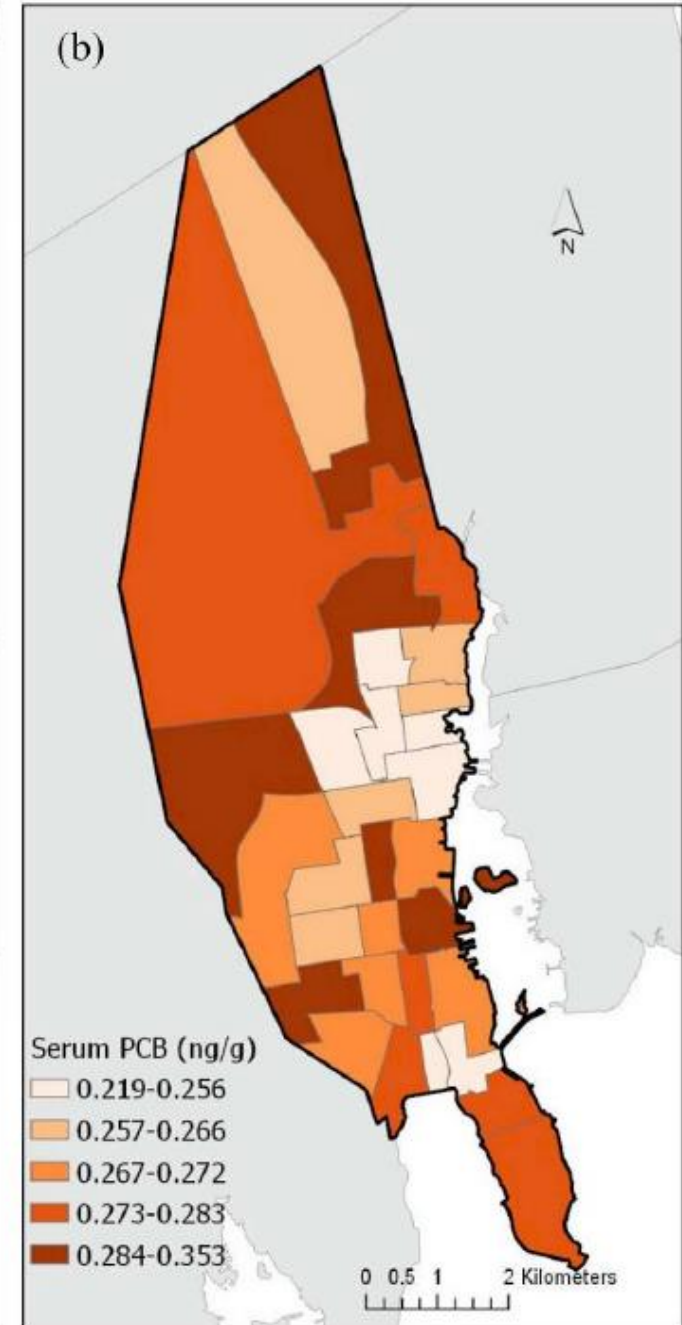
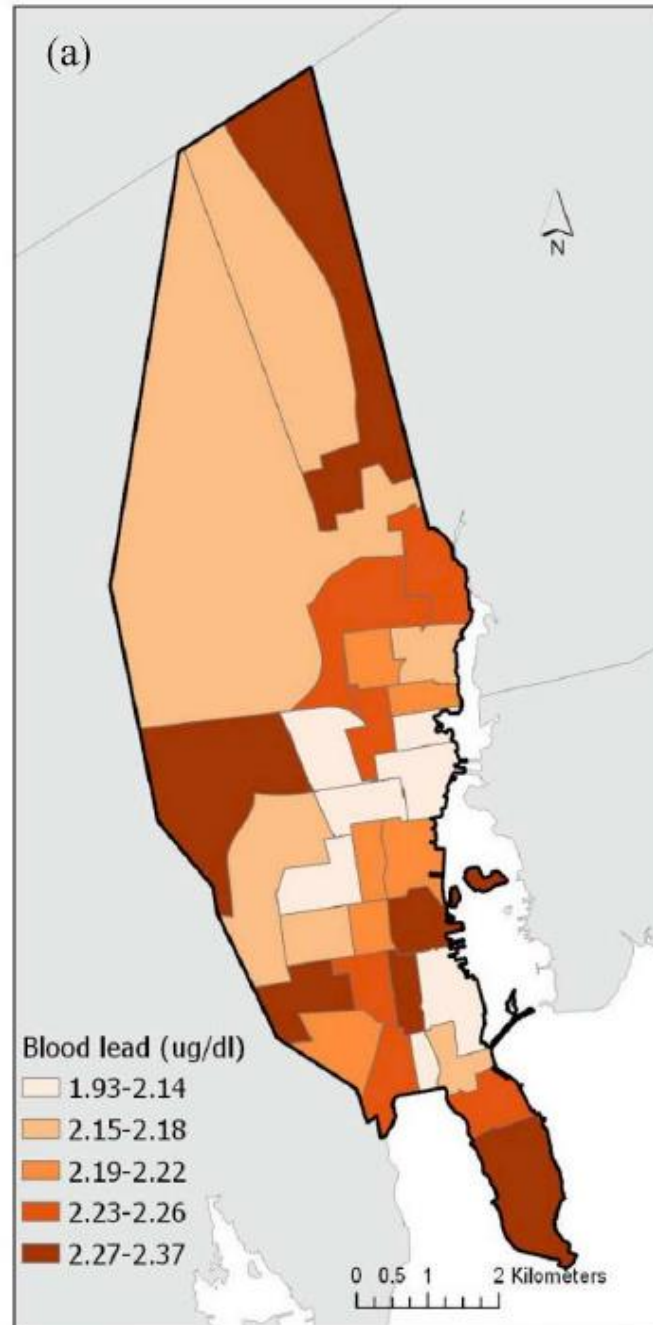
- Connecting exposure regression models with general population requires (public) multivariable data including all regression model predictors, with sufficient spatial resolution





(Levy et al. 2014)

# Modeled exposures

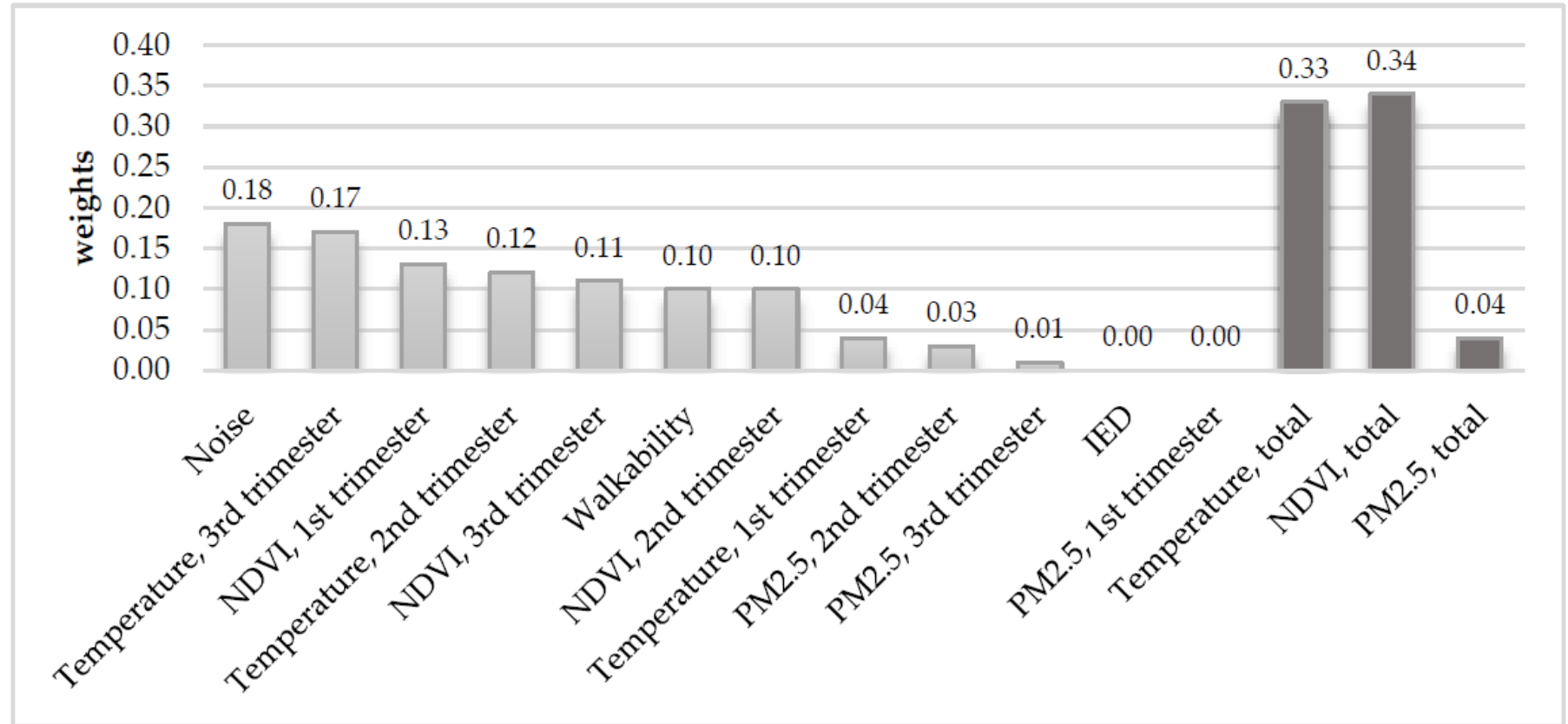


# Epidemiologic methods for complex mixtures

- Numerous advancements in the field in recent years
  - Workshops testing numerous analytical techniques -  
<https://www.niehs.nih.gov/news/events/pastmtg/2015/statistical/index.cfm>
  - NIEHS PRIME program -  
[https://www.niehs.nih.gov/news/events/pastmtg/2020/prime\\_2020/index.cfm](https://www.niehs.nih.gov/news/events/pastmtg/2020/prime_2020/index.cfm)
- Methods have pros and cons, but provide a strong foundation for cumulative risk modeling
  - Example: Multi-stressor epi connected with microsimulation platform

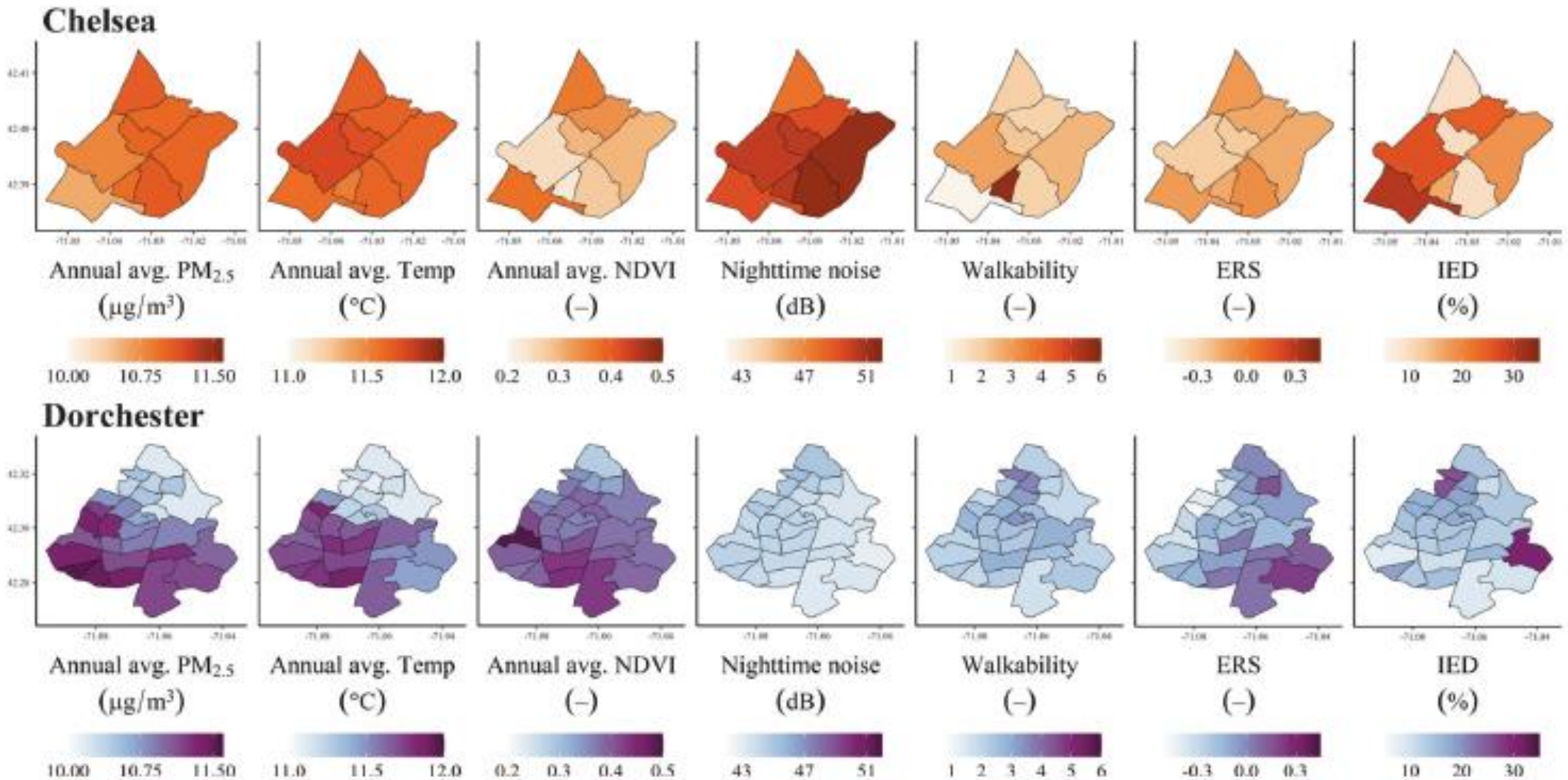
# Multi-stressor epi (Yitshak-Sade et al. 2020)

- Numerous stressors modeled for all births in MA
  - PM<sub>2.5</sub>, temperature, greenness, walkability, noise, SES
- Elastic net + weighted quantile sum regression



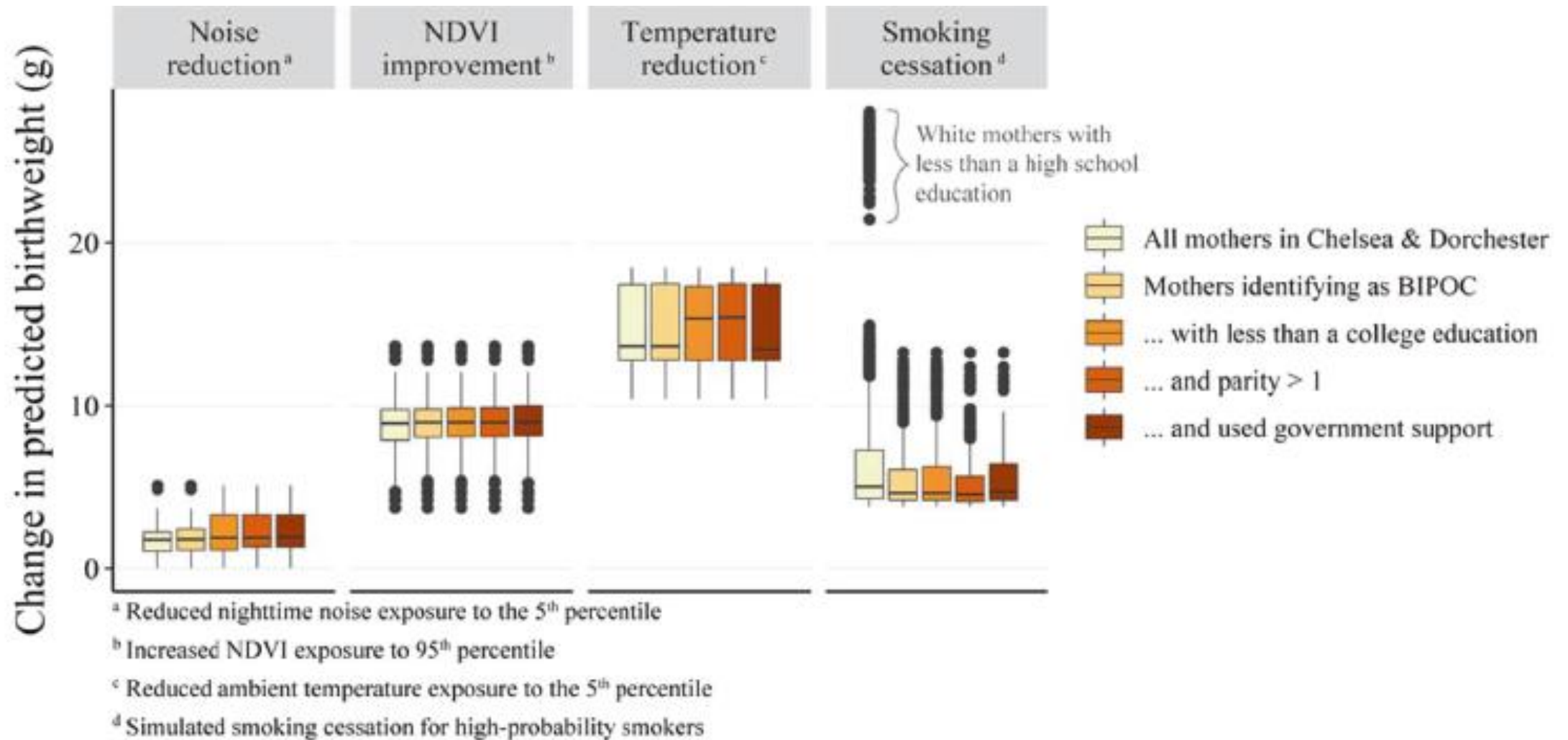
**Figure 2.** The weighted contribution of each of the selected exposures to a negative difference in birthweight: results of a Weighted Quantile Sum (WQS) regression.

# Microsimulation + cumulative risk modeling (Milando et al. 2021)





# Microsimulation + cumulative risk modeling (Milando et al. 2021)



# Conclusions

- Growth of geospatial data and other key datasets provides strong foundation for cumulative exposure modeling
- Microsimulation and other analytic techniques can characterize spatial + sociodemographic exposure patterns
- Analytic techniques are readily available to model combined effects of chemical and non-chemical stressors

# References

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- Milando CW, Yitshak-Sade M, Zanobetti A, Levy JI, Laden F, Fabian MP. Modeling the impact of exposure reductions using multi-stressor epidemiology, exposure models, and synthetic microdata: a case study of birthweight in two environmental justice communities. *J Exp Sci Environ Epidemiol* 31: 442-453 (2021).