


Assessing the Environmental Justice Implications of Decarbonizing the US Electric Grid: Estimating Changes in Asthma Exacerbation by Race and Income

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Literature on the Burden of Asthma

- Fine PM2.5, is an important risk factor for asthma exacerbation (Glad et al., 2012; Mar and Koenig, 2009; Rosenquist et al., 2020) and has been shown to be associated with cough, shortness of breath, and wheezing (Ostro et a. 2001; Mar et al. 2004).

- Prevalence of asthma is higher for people experiencing poverty and people of color (PoC) than for the rest of the population (Barnthouse and Bridgette 2019; CDC 2022; Grant et al. 2022; Pate 2021; Stern et al. 2020).
  - Asthma is the most common chronic lung disease of childhood (Zahran 2018). Among children (persons aged <18 years), asthma is more prevalent among those in families with low incomes and among non-Hispanic children compared with non-Hispanic White children (Zahran 2018; Pate et al. 2021)

- Poverty increases exposure to viral infections, allergens, and pollution, which can increase the risk of asthma exacerbation (Forno and Celedón 2012; Weinberg 2000), as do environmental conditions associated with poverty such as smoking and poor housing conditions (Rona 2000).

- The power sector is a major source of primary and secondary PM2.5 emissions.

Research Question and Methods

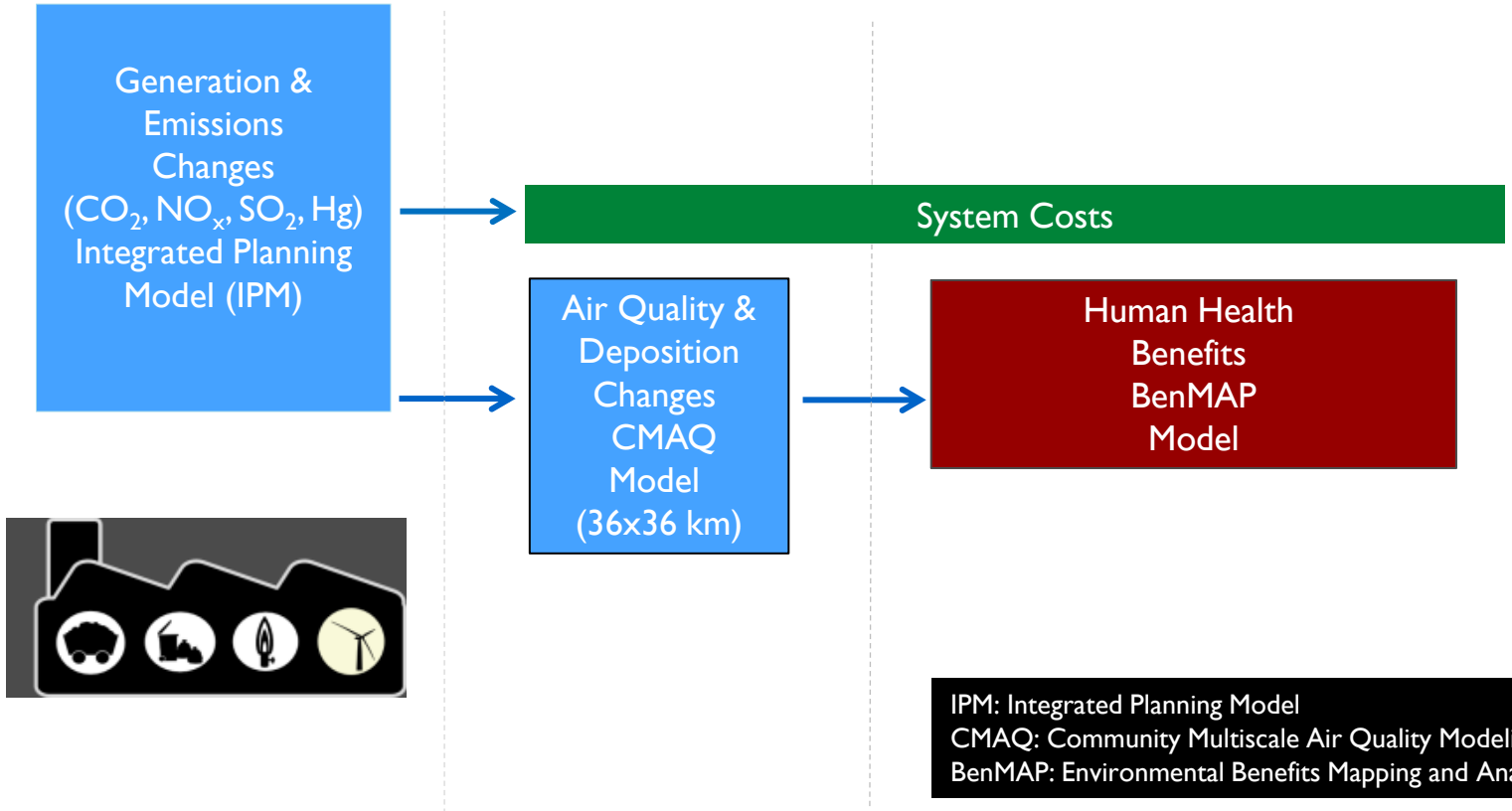
- Research Questions
  - Who benefits (reductions in asthma exacerbation) from decarbonization of the power section and how much do they benefit
    - Race
    - Income

- Method
  - Model EJ improvements in asthma exacerbation by carrying out a race-income-state decomposition analysis for a policy scenario with net-zero carbon emission in 2040
    - Use three regulatory grade models
    - Builds unique race and income-based asthma prevalence rates using the Behavioral Risk Factor Surveillance System (BRFSS) and Census's poverty thresholds (2008-2021)
      - ~ .5 million observations

Models and Methods

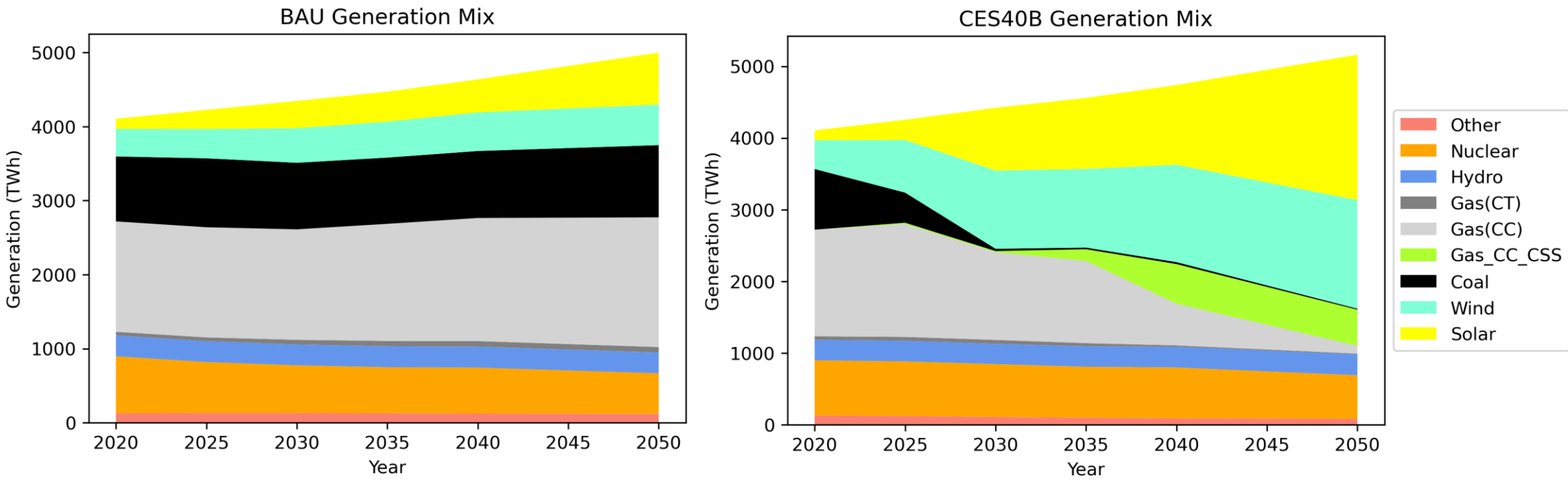
IPM: Integrated Planning Model
CMAQ: Community Multiscale Air Quality Modeling System
BenMAP: Environmental Benefits Mapping and Analysis Program

Models and Methods

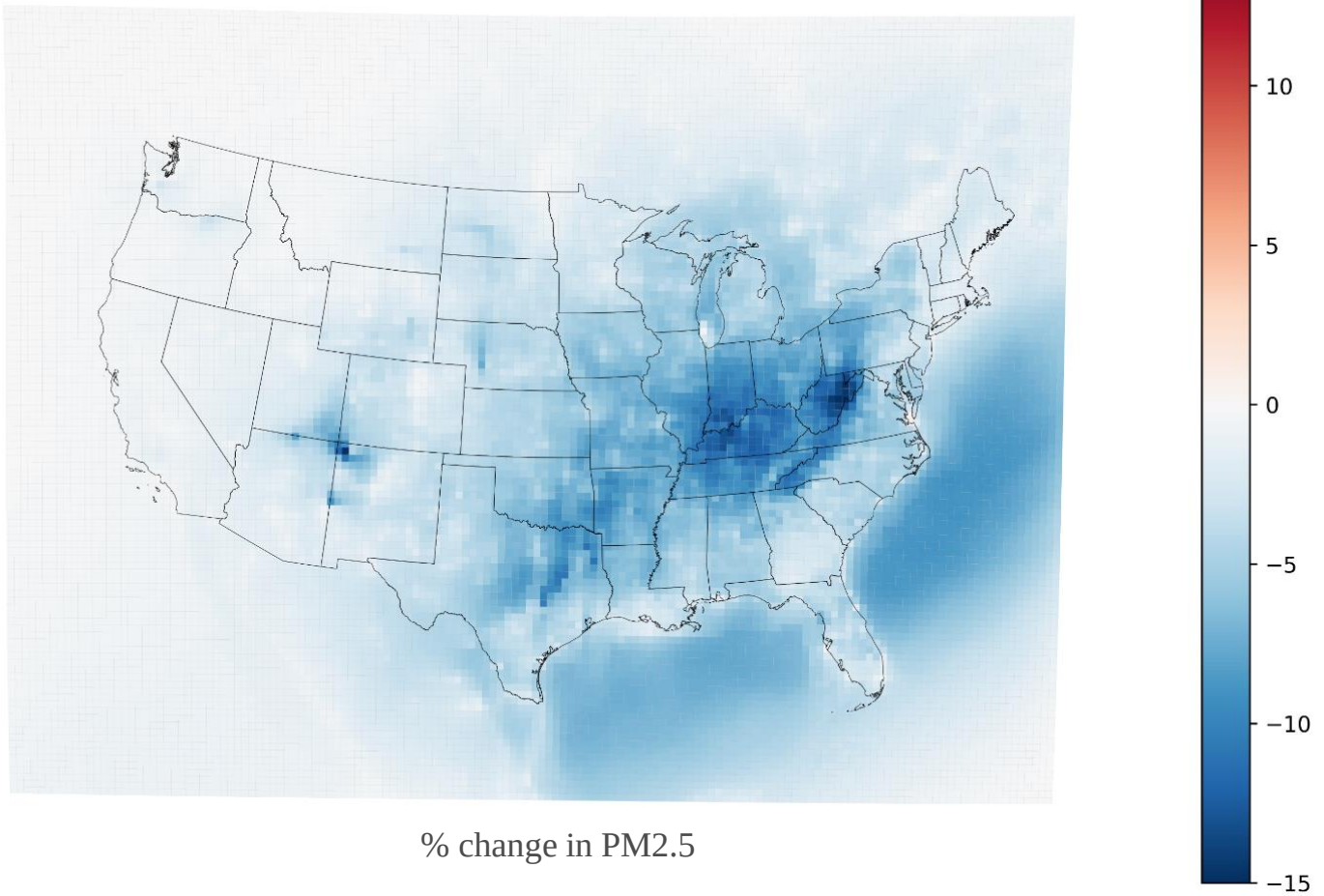


Driscoll et al. 2022; Vasilakos et al. 2022

IPM: Generation Mix



CMAQ: Changes in Ambient Air Quality



% change in PM2.5

BenMAP: Health Outcome

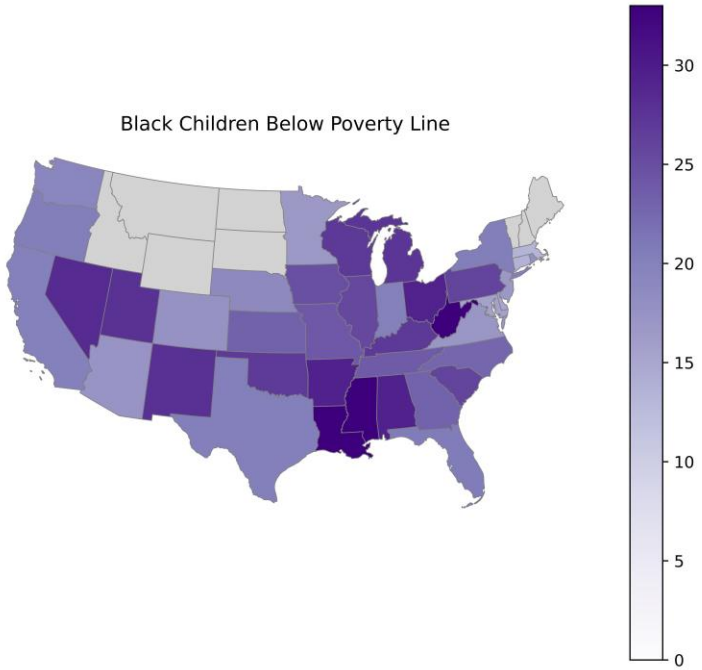
- CRF: Ostro et al. 2001
  - End points: Wheezing, Shortness of Breath, and Cough

- HIF:

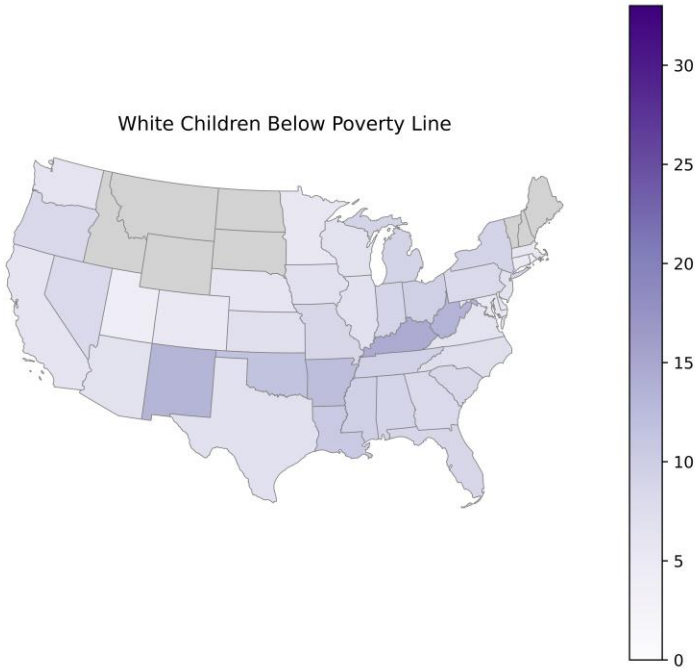
$$Asthma\ Exacerbation\ Averted_{i,r,s} = \left(1 - \left(\frac{1}{(1-A).\exp(\beta * \delta Q_c) + A}\right)\right) . A . \mu_{i,r,s} . \rho_{i,r,c}$$

  - β & A: epidemiological constant (Ostro et al.)
  - δQ_i: difference in air quality (CMAQ)
  - μ_{irs}: asthma prevalence (BRFSS & US Census 2008-2021)
  - ρ_{irc}: population (Population projections from BenMap)
  - $_i$: income (ACS5 2022)
  - $_r$: race
  - $_s$: state
  - $_c$: county

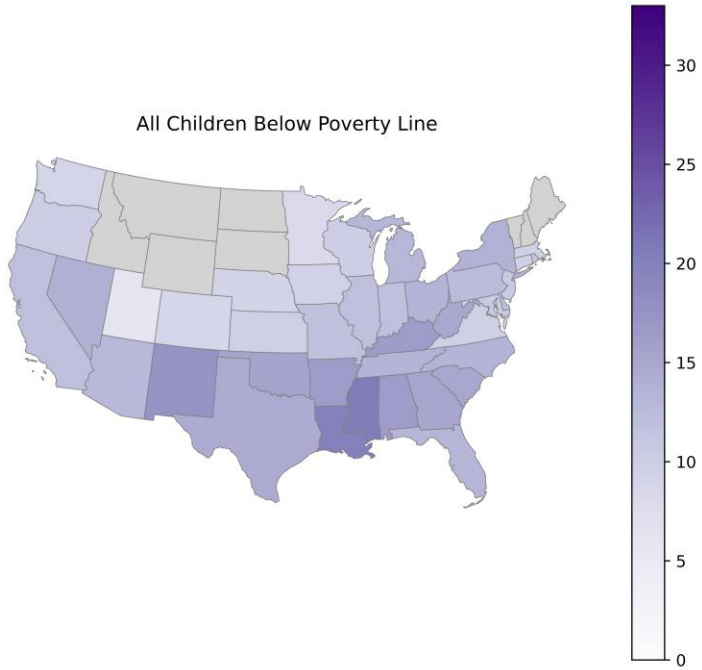
Child Poverty by Race



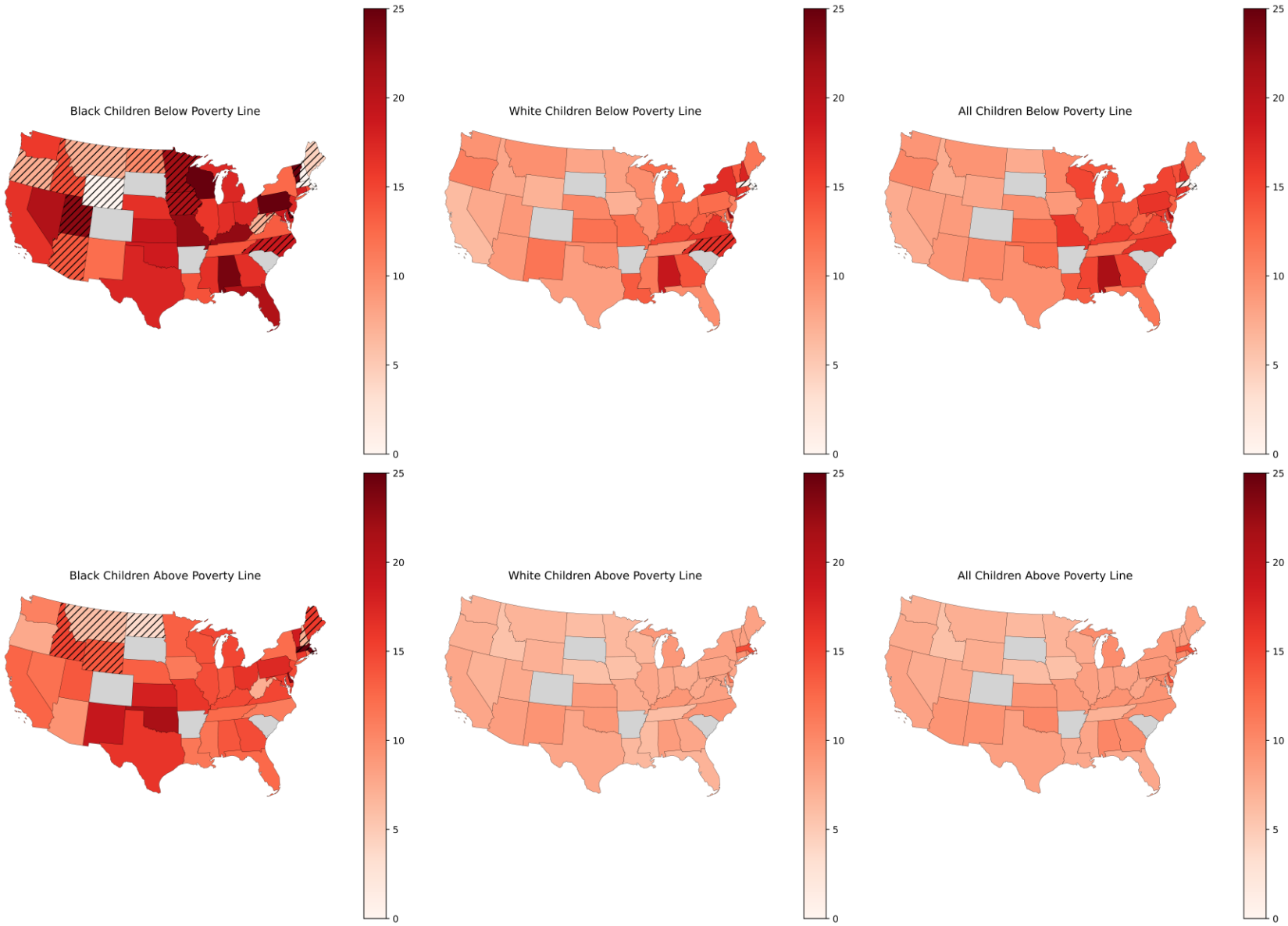
14-33%



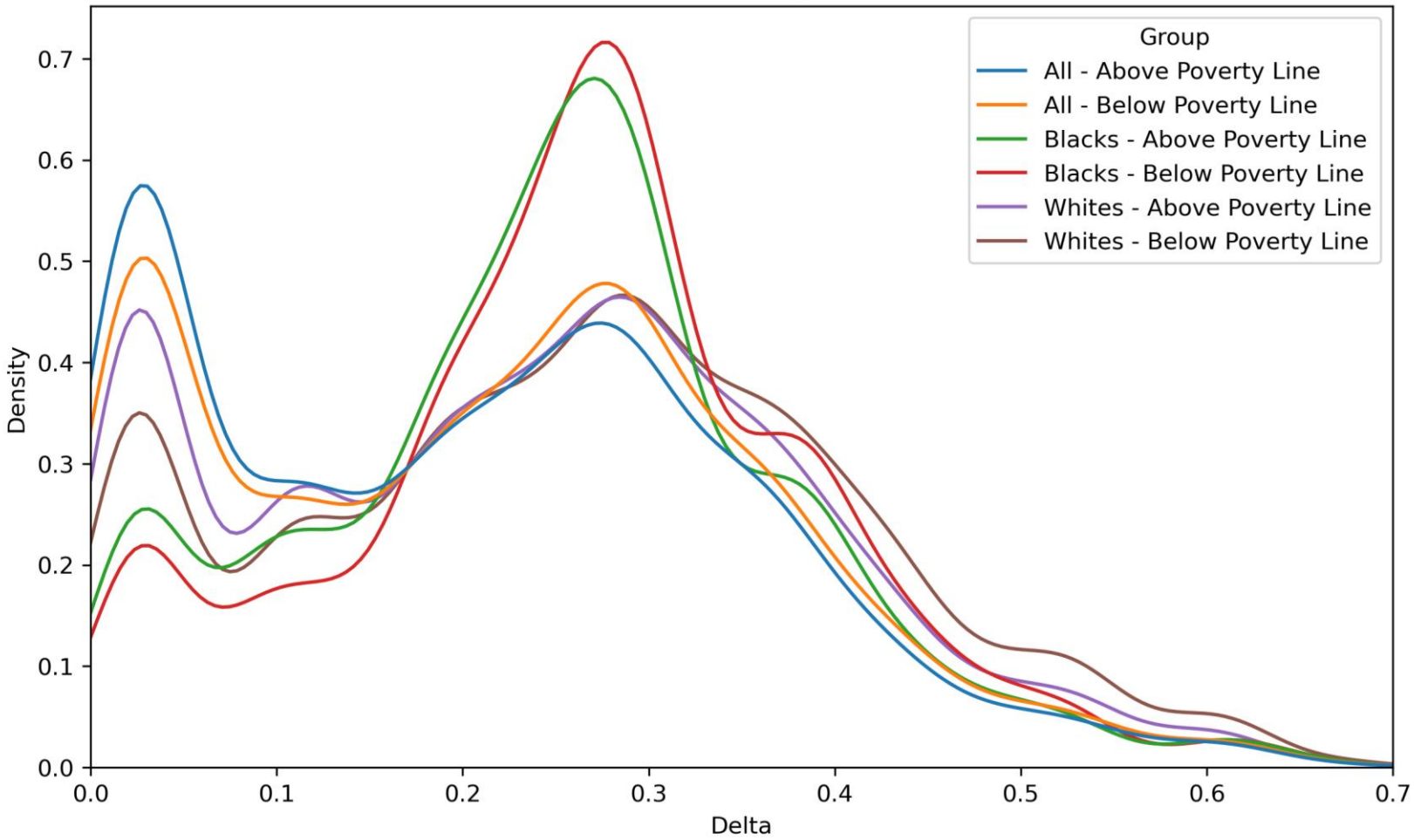
4-15%



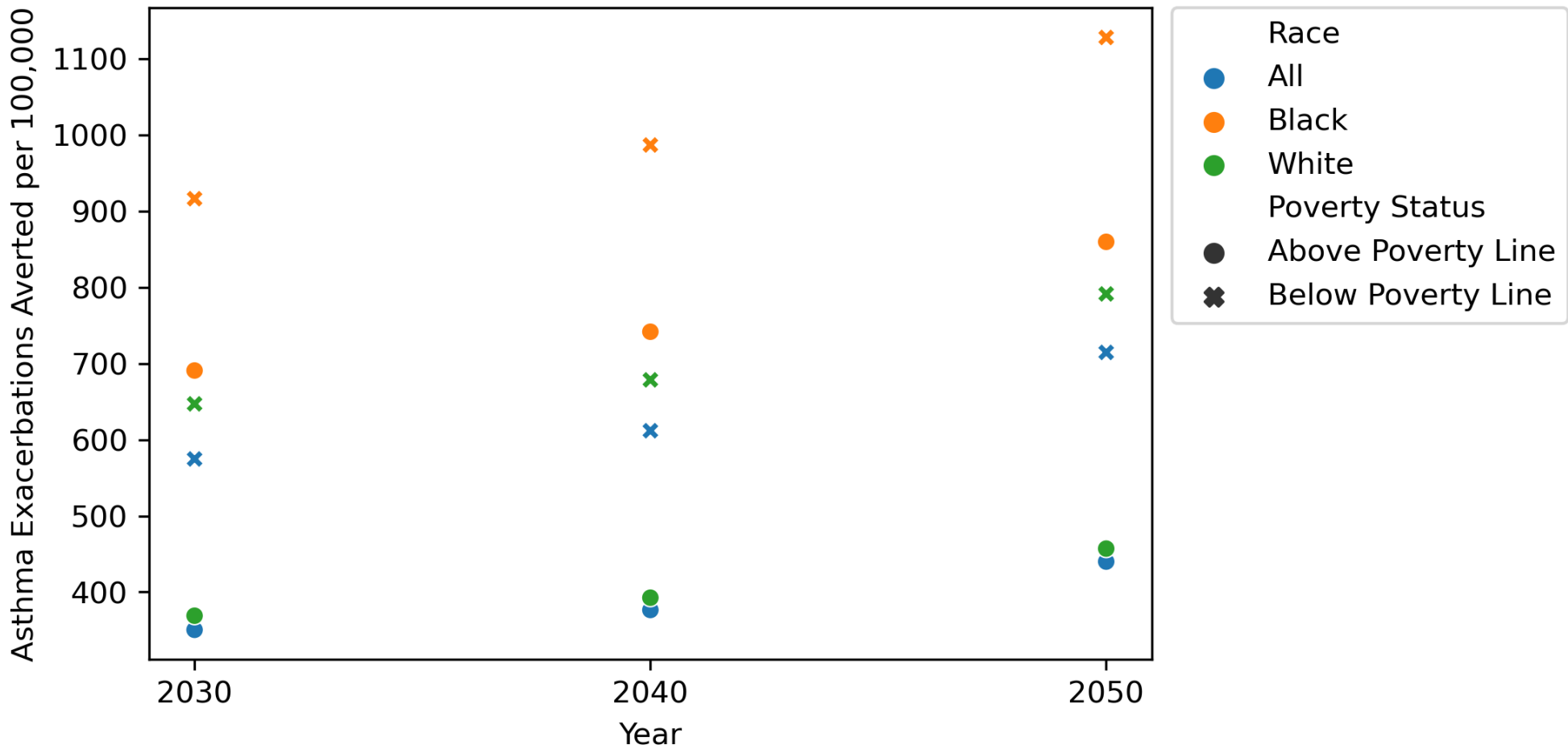
Asthma Prevalence in Children by Race and Income



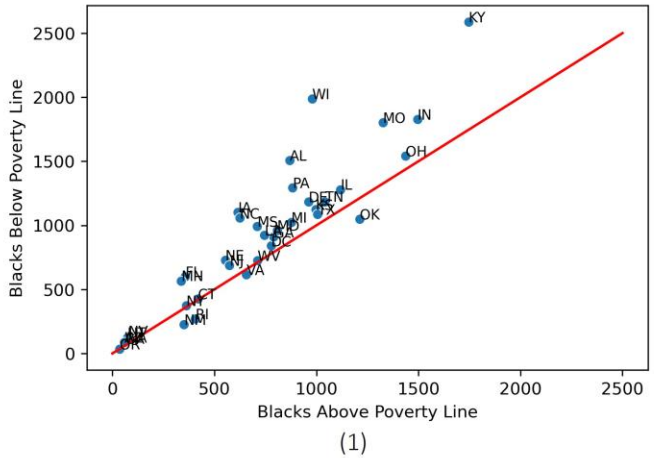
Reduction in Pollution Exposure by Race and Income



Reduction in Asthma Exacerbation by Race and Income



Comparing Asthma Exacerbation by Race and Income



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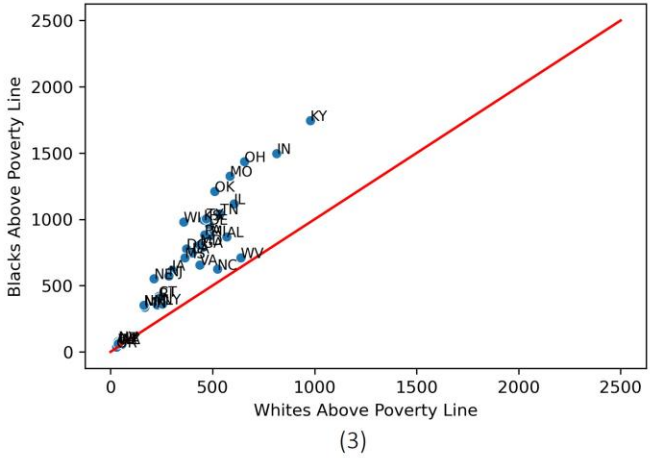

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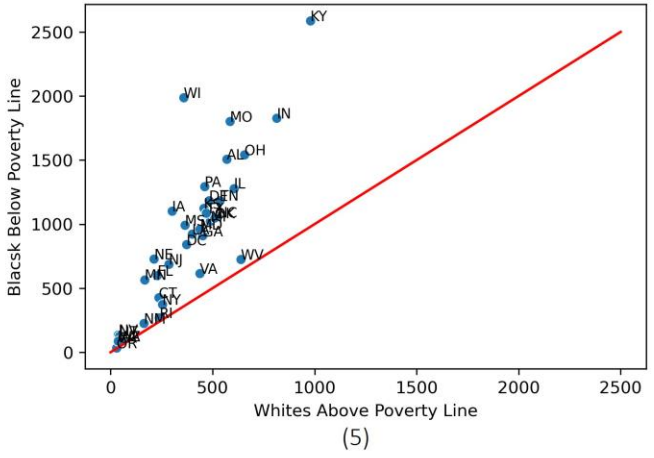

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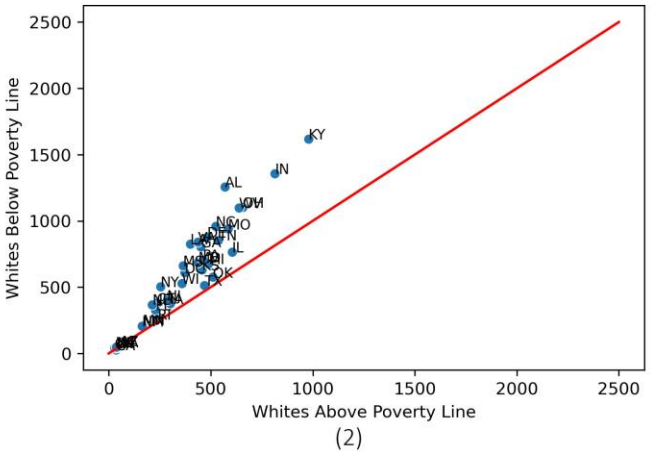

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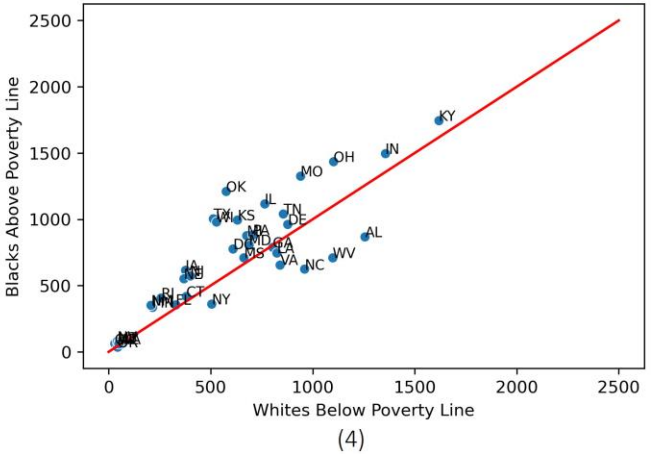

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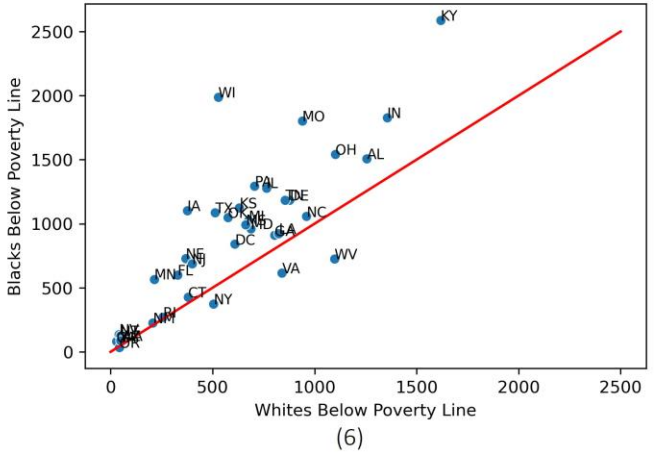

(6)

Conclusion and Implications

- Conclusion
  - Poverty and race-specific disaggregation of asthma prevalence suggests significant health gain for EJ-affected communities
  - Poor children have more significant health gains within each race group
  - Black have more significant health gains compared to Whites
  - Regional differences

- Implications
  - Use high-resolution geospatial environmental, health, and demographic datasets
  - Other health outcome
  - Decomposing results to subgroups can highlight significant EJ-health-related differences