Patterns of agricultural smoke exposure by sociodemographic characteristics in the Everglades Agricultural Area

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Roadmap

Prelude: Air pollution epidemiology: from traffic to landscape fires

Who gets exposed to $PM_{2.5}$?

Research Questions: Are there sociodemographic disparities in who is exposed to smoke from agricultural fires in Florida?

Exposure Assessment

Statistical Methods

Results: Who gets exposed?

Food for Thought:

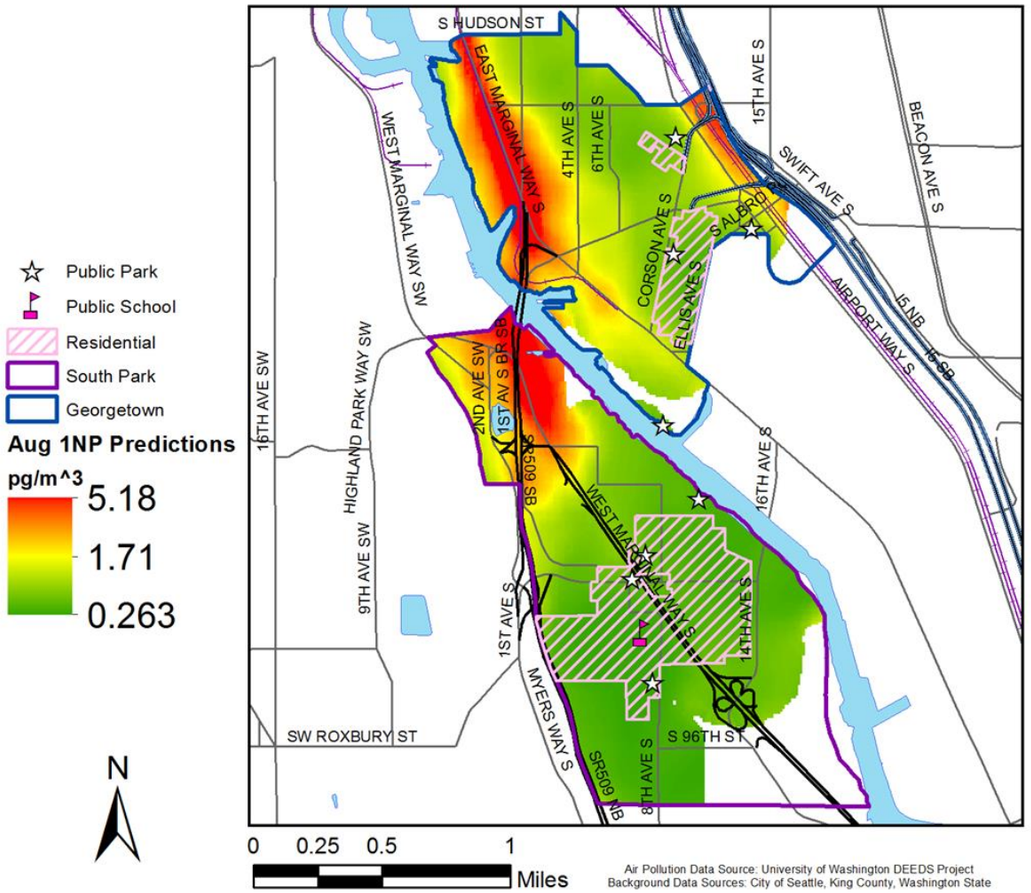
- Moving toward environmental justice
- Next steps: health outcomes

Prelude: Air pollution epidemiology

Traffic Related Air Pollution

- **Predictable** $PM_{2.5}$ patterns of exposure over space and time
- **Consistent** set of **exposure assessment** tools:
  - Community: GIS, fixed-site monitors, dispersion models, land use regression, satellite data
  - Personal: personal monitors -> what's in the PM?
- **Flexibility** in **epidemiological** study designs:
  - **Prospective studies** (i.e., cohort)
  - Time-series studies
  - Natural experiments (e.g., policy changes, disasters)

❖ Consistent, predictable exposure assessment leads to **etiologic** data



Neighborhood gradients for 1-nitropyrene (1-NP), a marker of diesel exposure exhaust, Seattle, WA (Source: Schulte et al. 2015)

doi.org/10.1021/acs.est.5b03639

Prelude: TRAP and WFS epidemiology

Wildfire Smoke

- **Unpredictable** $PM_{2.5}$ patterns of exposure over space and time
- **Variability** in **exposure assessment** tools:
  - Ambient levels: chemical transport models, fixed-site monitors, satellite data, aircraft campaigns
  - Personal: occupational studies
- **Challenges** in epidemiological study designs:
  - **Retrospective studies** (including time series studies, case-crossover studies)
  - **Prospective studies** (Orr *et al.* 2020; Landguth *et al.* 2020) require rapid response at (currently) limited spatial extent

❖ Variable, unpredictable nature of smoke requires creativity for health assessment

Cameron Peak Fire from Fort Collins, CO. Oct 2020
Photo Credit: Ali Akherati, CSU

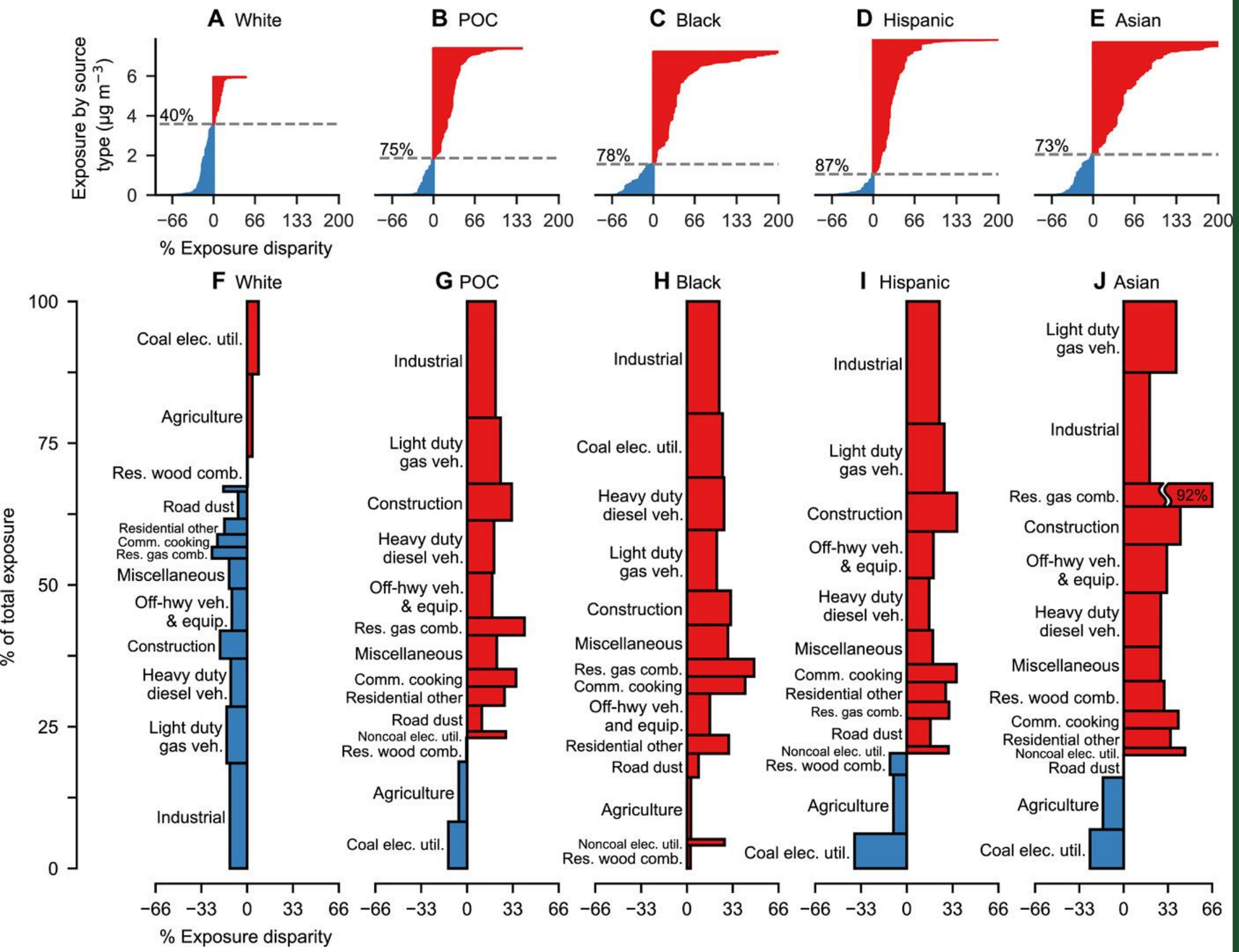
Prelude: Smoke from agricultural burns

Landscape Fire Smoke

- **Unpredictable** $PM_{2.5}$ patterns of exposure over space; **more predictable** patterns of exposure over time
- **Limitations** in **exposure assessment** tools:
  - Federal fixed-site monitors often located outside of burn areas and smoke impacted areas
  - Seasonality allows for planning
- **Considerations** in epidemiological study designs:
  - **Retrospective studies** (Pennington *et al.* 2023) found increases in asthma ED visits during burn days, though exposure assessment was non-traditional
  - **Prospective studies** possible given temporal structure of burns

❖ Spatial variation, but annual consistency

"Fire-Setting Ranchers Have Burning Desire To Save Tallgrass Prairie"
Photo Credit: NPR



Air Pollution + Race/Ethnicity

”PM2.5 polluters systematically and disproportionately affect people of color in the United States.”

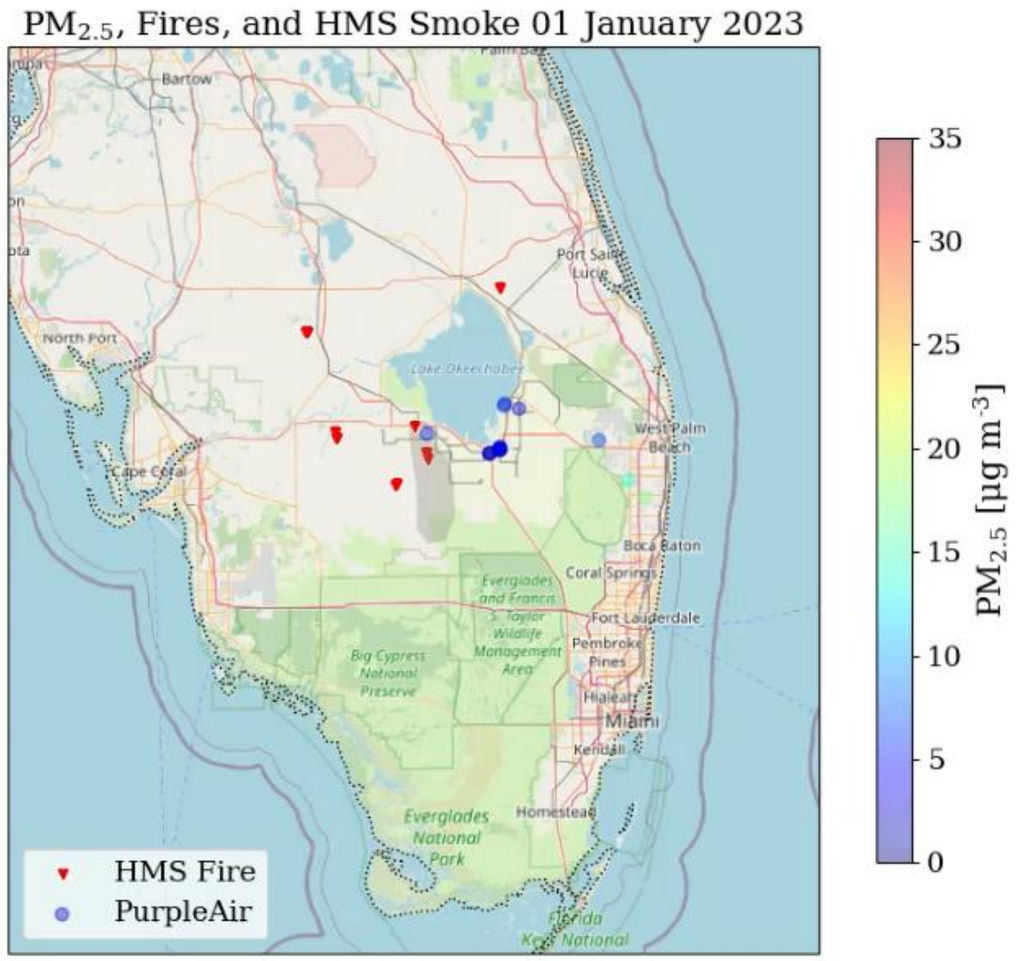
[Source: Tessum *et al.* 2021; DOI: 10.1126/sciadv.abf4491]

Research Question

Are there sociodemographic disparities in exposure to smoke from agricultural fires?

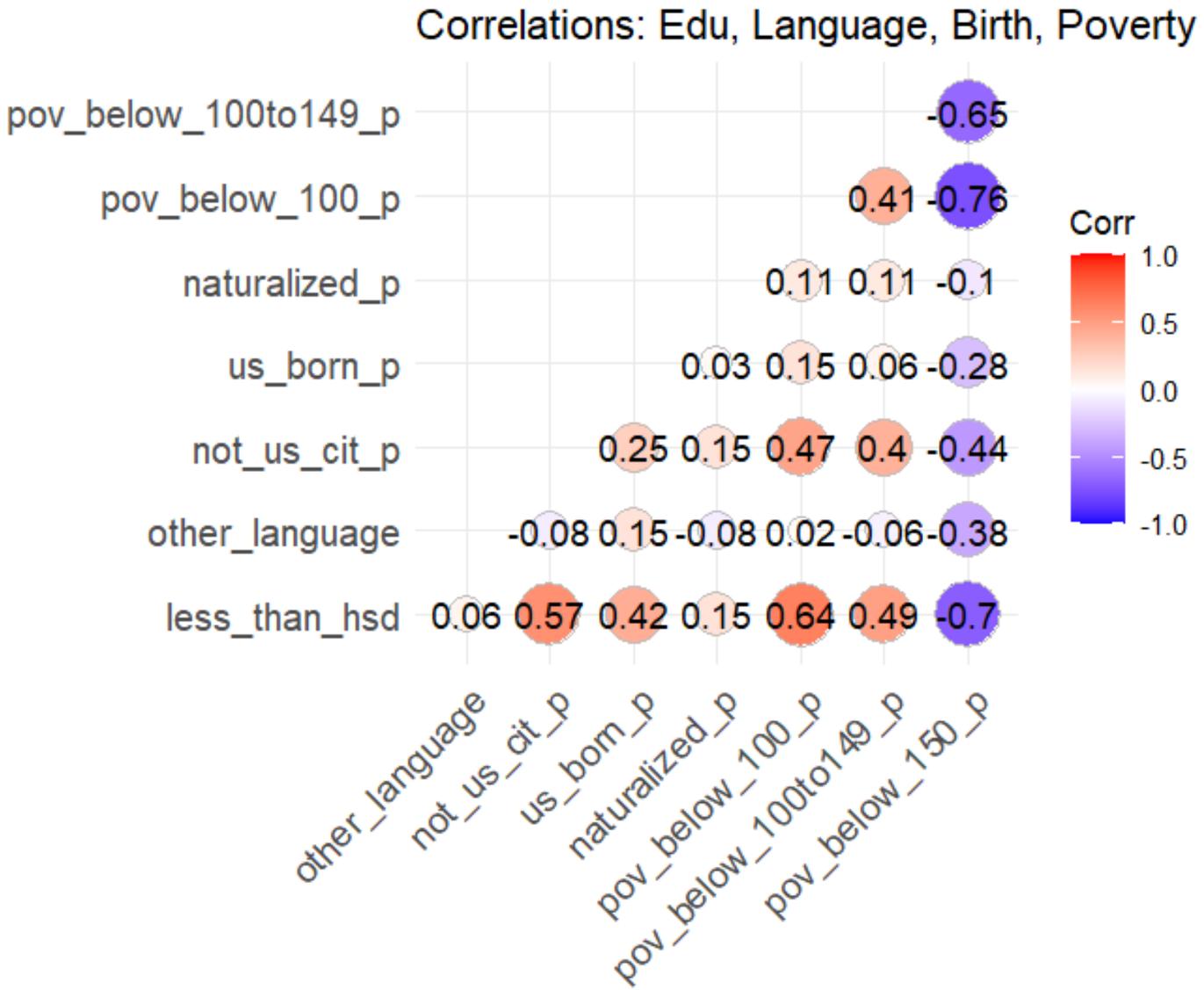
Case Study: Florida EAA 2016-2020

Exposure assessment methods



Demographic data + statistical methods

- **Sociodemographic data** at the census tract level for the four-county EAA were obtained from the American Community Survey (ACS), 2016-2020
- Major categories: race, ethnicity, markers of socioeconomic status (e.g., poverty, home ownership, car ownership), markers of acculturation (e.g., language spoken at home, US born).
- **Quasi-Poisson regression** to evaluate association of count of smoke plumes in census tract with ACS data
- **LASSO** was implemented for variable selection and model building



Results

Table 1. Outcomes: Smoke days and smoke intensity for the Florida Everglades Agricultural Area, 2016-2020 (n=418 census tracts). Includes counts of light, moderate, and heavy smoke days	
Smoke days	**Counts Median (Q1, Q3); Min-Max**
PRIMARY OUTCOME: Total smoke days without transport smoke[1]	36 (31, 45) 24-309
No Smoke days	1,192 (1183, 1196) 919-1204
Total smoke days with transport smoke[1]	58 (54, 67) 46-331
SECONDARY OUTCOME: Smoke intensity, 3-levels	**Counts Median (Q1, Q3); Min-Max**
Light smoke without transport smoke	35 (30, 44) 24-306
Moderate smoke without transport smoke	0 (0, 1) 0-6
Heavy smoke without transport smoke	0 (0, 0) 0-1

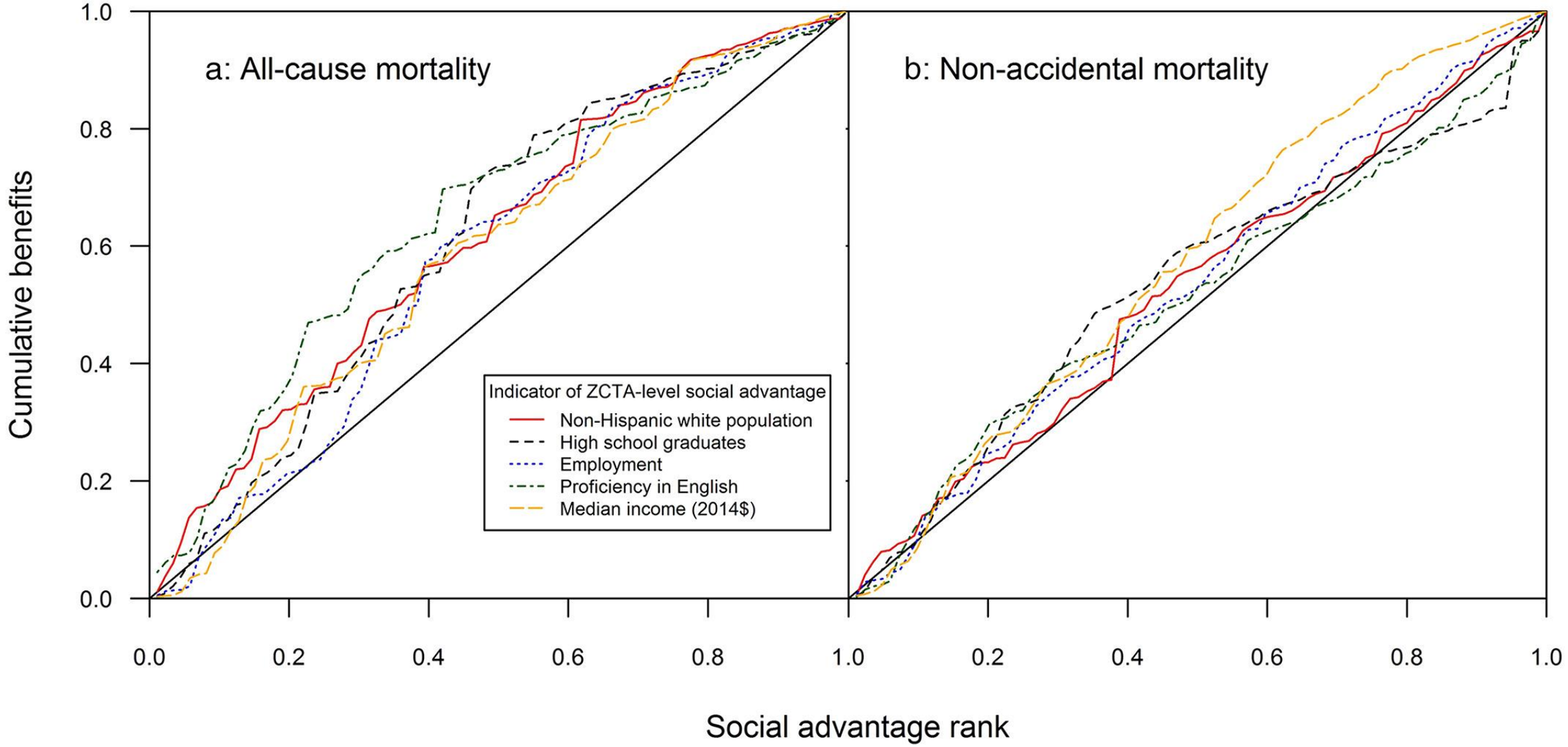
Results

- **Interpreting** Poisson (or quasi-Poisson) models is tricky (annoying) because it's a log-count model (outcome: IRR)
- Results of interest:
  - A 10% increase in population with **< HS education** is associated with an **increase of 24.6% increase** in census tract smoke days (95% CI: 18.5, 30.9)
  - A 10% increase in population who are **not US citizens** associated with a **76% decrease** in census tract smoke days (95% CI: 1.9, 3.5)
  - A 10% increase in **households with no vehicle** was associated with a **15% increase** in census tract smoke days (95% CI: 4.1, 27.1)
  - **Race/ethnicity** not selected by LASSO

Table 2. Results of quasi-Poisson regression model with variables selected by LASSO

term	estimate	95% CI low	95% CI high
(Intercept)	-65.498	-253.860	122.751
% Female	0.688	-1.194	2.572
% Age 0 - 19	0.006	-0.002	0.015
% < HS Education	**0.022**	**0.017**	**0.027**
% Racial group other	**-0.008**	**-0.017**	**0.000**
% US Born	0.694	-1.189	2.579
% Not US Citizens	**-0.027**	**-0.035**	**-0.019**
% HHDs no vehicle	**0.014**	**0.004**	**0.024**
% HHDs 1 vehicle	-0.004	-0.008	0.001
% < 100% poverty	0.003	-0.006	0.011

Food for Thought



Concentration curves for rates of avoided deaths (per 10,000 persons) resulting from reduced $PM_{2.5}$ (a) or O_3 (b) exposures under Health Benefits Scenario 1 when ranking ZCTAs by indicators of social advantage. ZCTAs = ZIP Code Tabulation Areas. [Source: Martenies *et al.* 2020. *GeoHealth* [doi.org/10.1029/2019GH000206]]

Food for thought

Palm Beach Post, October 10, 2023

Public health warnings for long-range transport smoke from Canadian fires

No warnings for local smoke from sugar cane burns

Full article can be read at: https://palmbeachpost-fl.newsmemory.com/?publink=01fd0fb95_134ad86

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Sugar cane fires pollution railed

Affected communities criticize lack of warning

Antigone Barton

Palm Beach Post USA TODAY NETWORK

When smoke from Canadian wildfires last week clouded the skies over South Florida, Palm Beach County health officials issued a warning, urging residents across the region who are most vulnerable to the effects of pollution to stay indoors.

The next day, as the state authorized the first fires of the sugar industry's preharvest cane-field burns in the Glades, residents of the largely Black communities there were alerted of the blazes only by the smoke that burned their throats and the ash they have come to to call "black snow" falling on their homes.

For those living with asthma or other breathing issues, children and elderly residents, that was a familiar warning to stay indoors. And in spite of mounting evidence that pollution from the fires puts all residents' health at risk, that is the only warning they get.

This year, as their four-month summer respite from sugar-cane fires wound to a close, members of the community- based Stop the Burn-Go Green Campaign released a statement asking for more and calling the health department's silence "deafening." The campaign has noted that following complaints on the effects of the fires from residents of more affluent communities to the east, the state has authorized fires only when prevailing winds will not carry smoke into those communities.

The group also cited findings released last year from a study using more than 10 years of data and led by Florida State University scientists that showed exposure to smoke from the annual eight-month cane burning season shortens the lives of South Florida residents, killing from one to six people prematurely each year.

Palm Beach County Health Director Dr. Jyothi Gunta could not be reached for comment.

The group also point to a $4.2 million federal grant recently awarded to Florida Atlantic University scientists to study potential links between Glades residents' exposure to pollution from sugar cane fires and Alzheimer's disease and other age-related dementias.

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Next steps

FAU LANDS $4.2 MILLION NIH GRANT FOR AIR QUALITY, ALZHEIMER'S STUDY

Worldwide, the practice of preparing agricultural fields by burning crop residue contributes large quantities of gaseous pollutants and aerosol particles into the atmosphere.

BY GISELE GALOUSTIAN | 8/23/2023

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Thank you

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