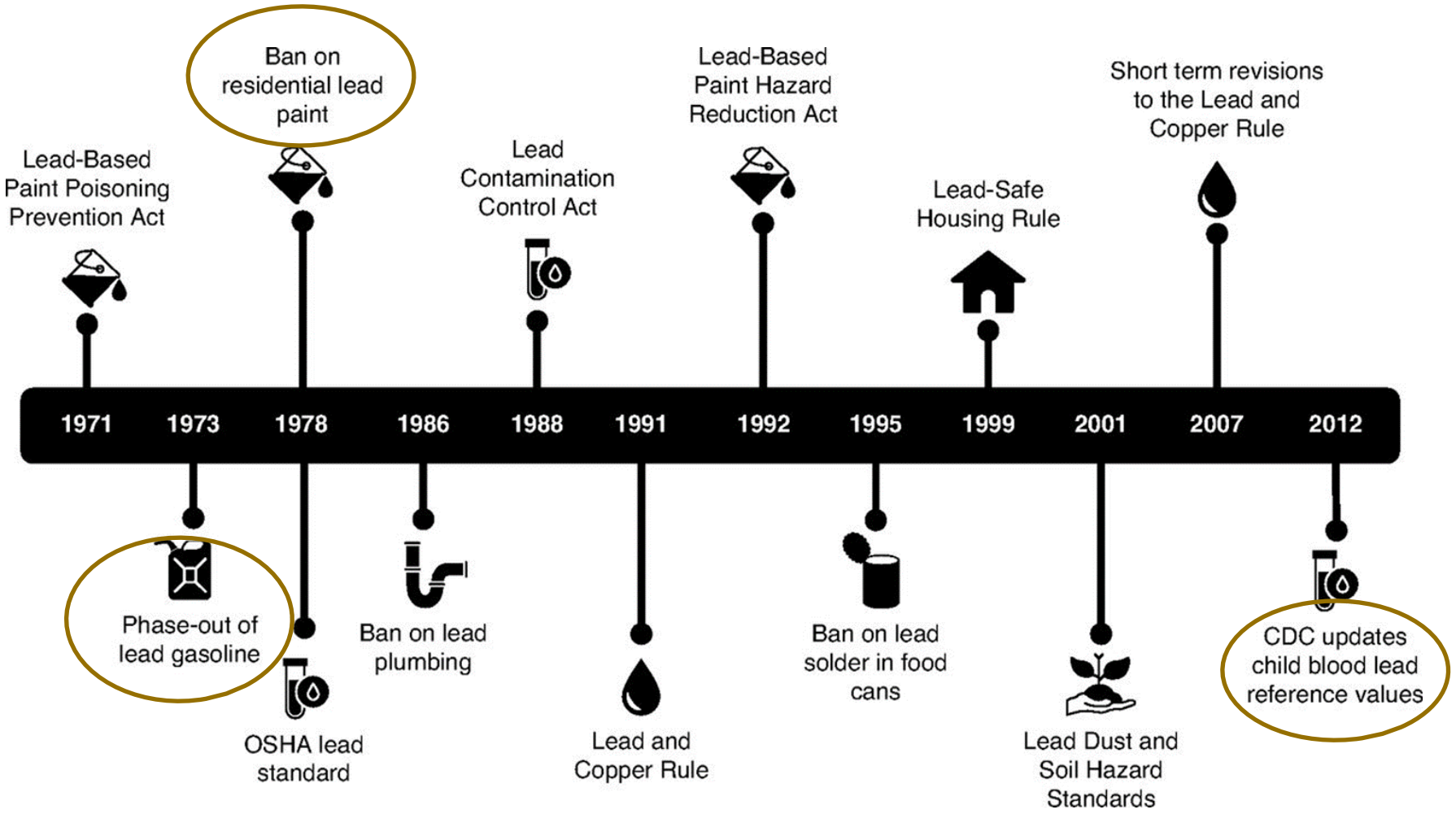
2023 TRI National Conference, US EPA

Exploring Environmental Injustice in Exposure to Airborne Lead from Industrial Facilities in Kentucky

Charlie Zhang,
University of Louisville
Kristina Zierold,
University of Alabama at Birmingham

Timeline of Lead Laws and Regulations



Racial Inequalities in Drinking Water Lead Exposure: A Wake-Up Call to Protect Patients with End Stage Kidney Disease
Anne E. Nigra, Ana Navas-Acien. JASN Oct 2021, 32 (10) 2419-2421; **DOI:** 10.1681/ASN.2021060793

CDC's Blood Lead Reference Value (BLRV)

- Children with blood lead levels at or above the BLRV represent those at the top 2.5% with the highest blood lead levels.

TABLE 1. Definitions for interpreting children's blood lead levels — United States, 1960–2021

Year	Blood lead level (μg/dL)	Interpretation*
1960	60	NA
1970	40	Undue or increased lead absorption
1975	30	Undue or increased lead absorption
1978	30	Elevated blood lead level
1985	25	Elevated blood lead level
1991	10	Level of concern
2012	5	Reference value
2021	3.5	Reference value

Abbreviation: NA = not available.
* https://stacks.cdc.gov/view/cdc/61820

Ruckart PZ, Jones RL, Courtney JG, LeBlanc TT, Jackson W, Karwowski MP, Cheng PY, Allwood P, Svendsen ER, Breysse PN. Update of the Blood Lead Reference Value - United States, 2021. MMWR Morb Mortal Wkly Rep. 2021 Oct 29;70(43):1509-1512. doi: 10.15585/mmwr.mm7043a4. PMID: 34710078; PMCID: PMC8553025.

Nature of the Problem

- Exposure to lead is attributable to a variety of sources including lead in paint for old homes, drinking water, soils, traffic dust, industrial pollution, etc.
- Policy solutions in the past several decades such as banning the use of lead-based paint and removal of lead from gasoline and drinking water pipelines have significantly decreased the risks of environmental lead exposure.
- Exposure to harmful lead remains a critical public health concern due to its toxic nature and omnipresent distribution in the environment.

Environmental Injustice in Lead Exposure

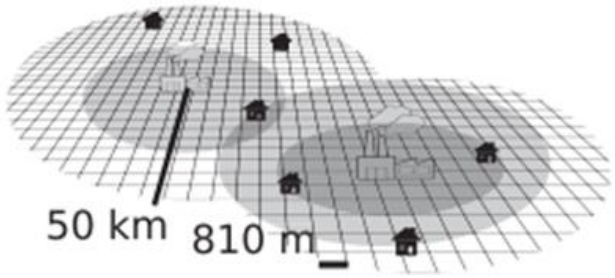
- While the magnitude of lead exposure for the general population in the U.S. has decreased over decades, environmental injustice between different sociodemographic groups persisted.
- Low-income and communities of color are more likely to be exposed to elevated levels of toxic pollutants including lead from industrial facilities
- Less research has investigated racial/ethnic disparities in lead exposure from toxic release inventory (TRI) facilities

Research Objective

- The aim of this study was to examine racial and economic disparities in proximity to lead-releasing industrial facilities and the concomitant lead exposure in Kentucky.
- **Hypothesis #1:** Census tracts with higher proportions of blacks and poverty rates were more likely to be found in the vicinity of TRI facilities than their white counterparts.
- **Hypothesis #2:** Blacks and the poor had higher levels of average lead exposure per person than whites.

Data and Methods

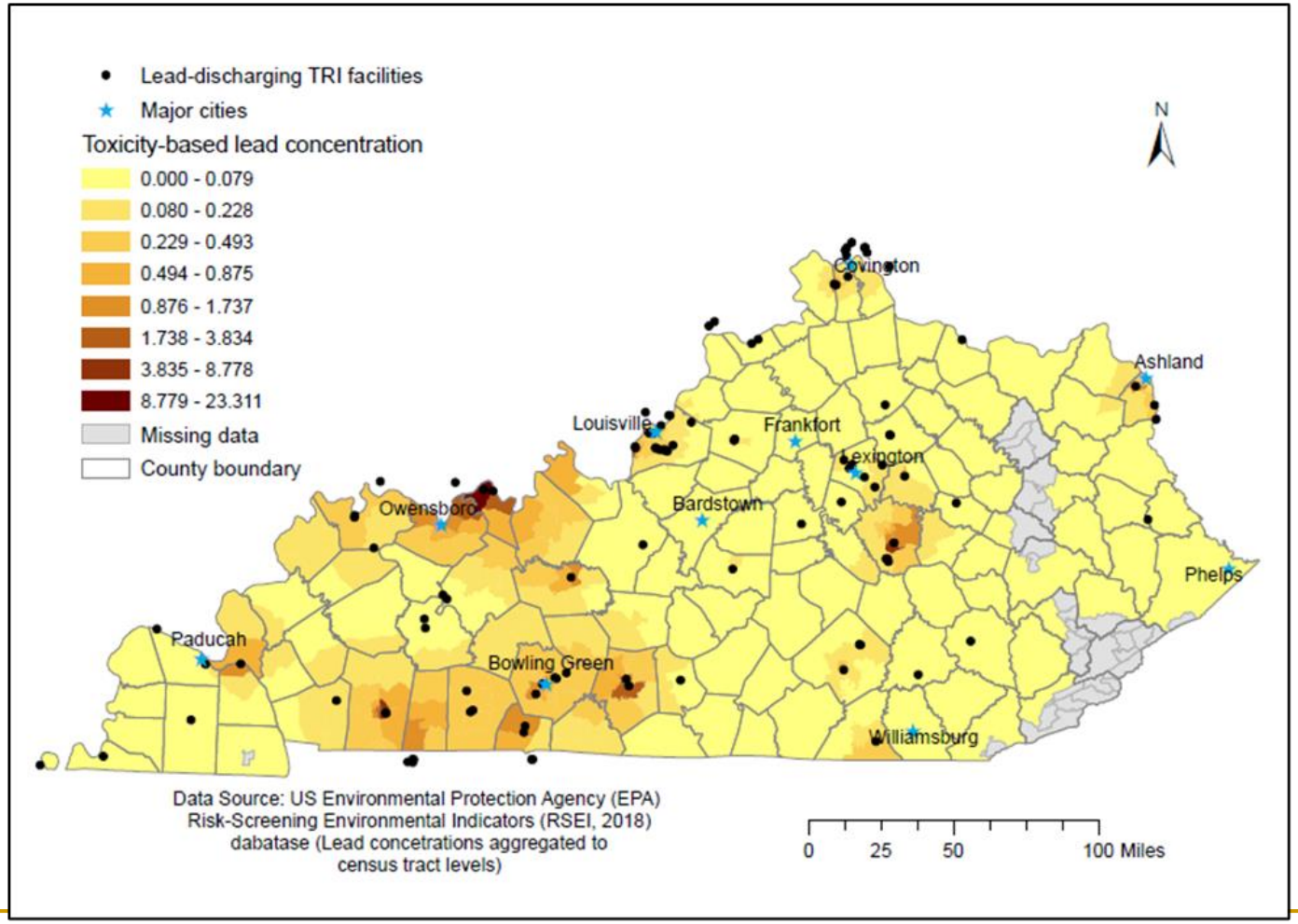
- Data for proximity/exposure to lead
  - Locations of lead-emitting facilities in Kentucky and nearby states from EPA's TRI Explorer
  - EPA Risk-Screening Environmental Indicator (RSEI) geographic microdata disaggregated by chemical type
- Demographic data:
  - 2010 Decennial Census
  - 2018 ACS five-year estimates



RSEI data model
(Ash & Boyce, 2018)

Ash M, Boyce JK. Racial disparities in pollution exposure and employment at US industrial facilities. *Proceedings of the National Academy of Sciences of the United States of America.* 2018;115(42):10636-10641.

Exposure to Airborne Lead from TRI Facilities in Kentucky



Data and Methods (Cont.)

- Measured straight-line distances from centroids of census tracts to TRI facilities
- Location quotients for blacks in each census tract compared with percent of blacks across the state
- Calculated population-weighted exposure to airborne lead to compare the differences between blacks and whites
- National Center for Health Statistics (NCHS)'s urban-rural locale codes were used to examine spatial variations in lead exposure.

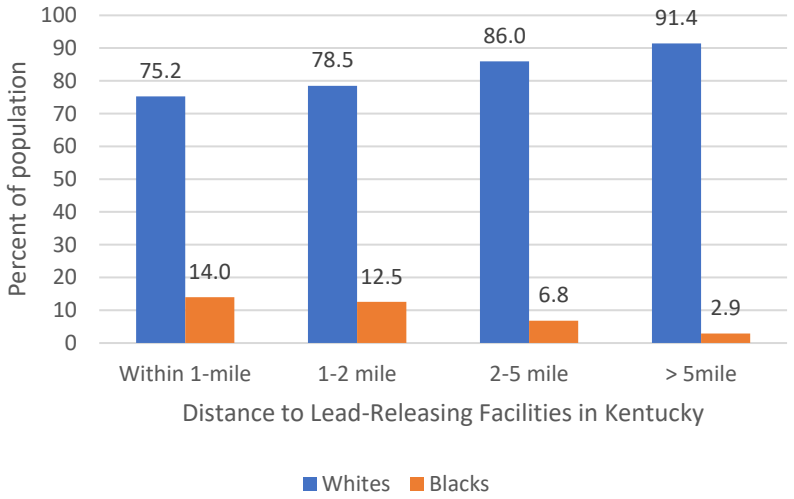
Calculating County-Level Population-Weighted Lead Exposure

- Where E_j denotes population-weighted annual lead exposure for demographic group *j* in a **county**; e_i represents lead exposure in **census tract** *i* and *n* is the total number of tracts in a county; p_{ij} represents the population count of demographic group *j* in census tract *i*.
- The population for demographic group *j* in census tract *i* divided by the total population of group *j* in a county (the denominator) – will produce the proportion or population weight that is used to adjust the RSEI-derived lead concentration by census tract.
- The sum of lead exposures for all census tracts within a county adjusted by populations will be the **county-level population-weighted lead exposures** for a demographic group.

$$E_j = \frac{\sum_{i=1}^{n} e_i p_{ij}}{\sum_{i=1}^{n} p_{ij}}$$

Demographic Makeups by Distance to TRI Facilities

- Proportions of population that is black and white were calculated for four distance intervals
- An inverse distance relationship can be observed between percent of population that is black and distance to TRI facilities
- On the contrary, as distance increase, the percent of population that is whites increases.



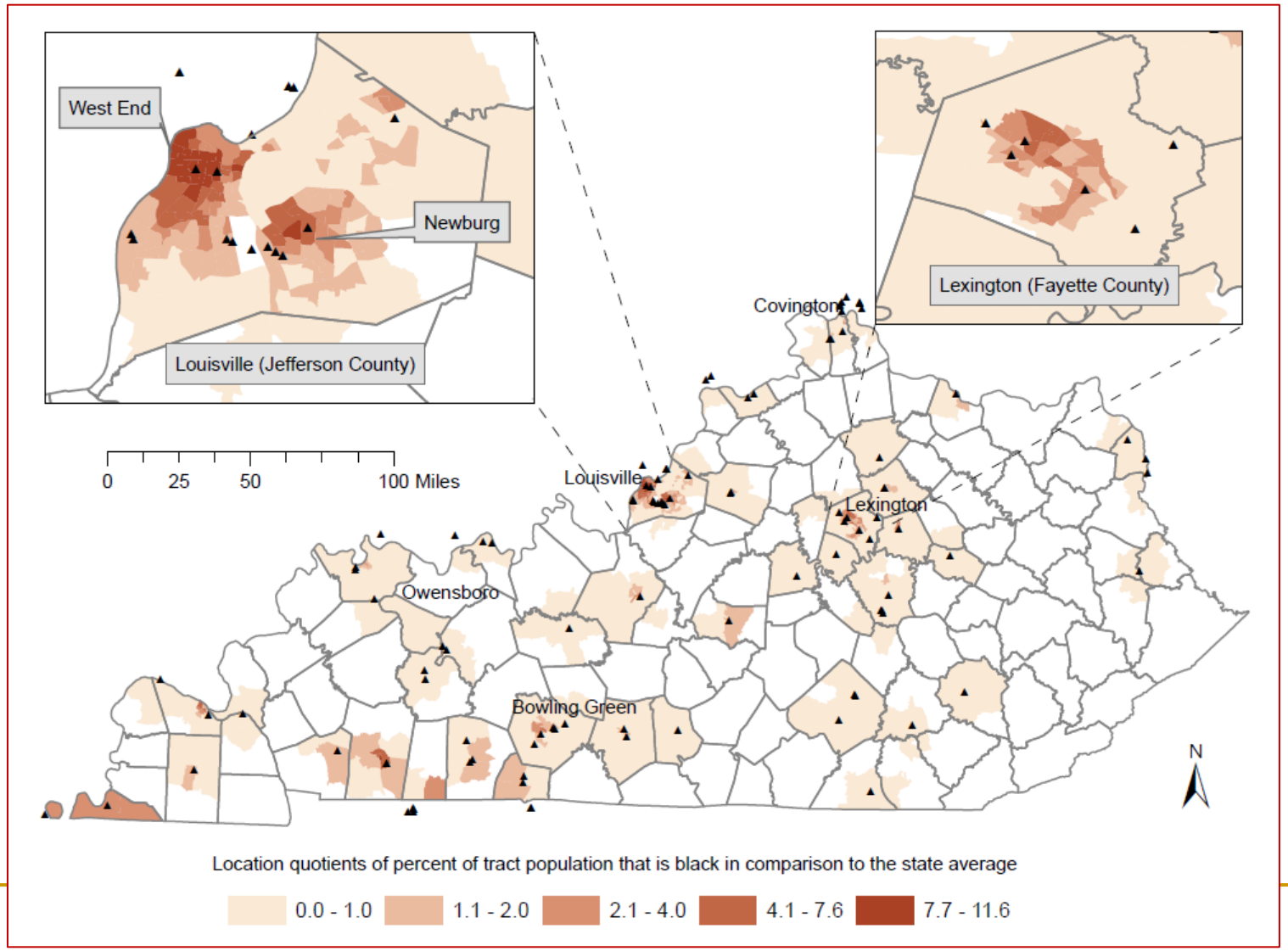
Proximity to Facilities and Racial Makeup

Correlation Analysis of Inequalities in Proximity and Exposure to Lead

- A negative correlation was identified between blacks (%) and distance to TRI facilities while it is positive for whites and vice versa for whites.
- Median household income was positively correlated with distance to TRI facility; tracts with higher poverty rates were closer to TRI facilities.

Exposure / Race/income	Distance to TRI	Lead concentrations
Blacks (%)	-0.240 ***	0.029
Whites (%)	0.284 ***	-0.031
Median household income	0.197***	-0.079*
Below poverty (%)	-0.189***	0.049

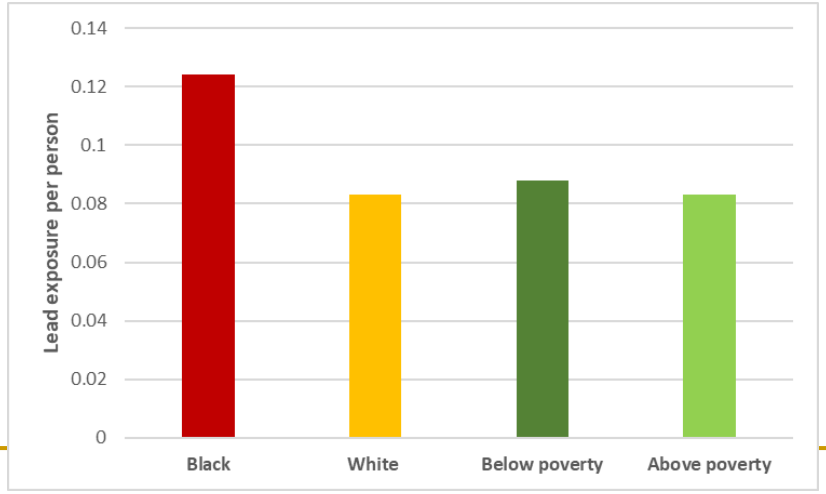
Map of Location Quotients of Percent Blacks in Census Tracts Near TRI Facilities Compared with State Average in Kentucky



Comparisons of Population-Weighted RSEI Lead Exposure

- Blacks were exposed to higher levels of airborne lead in comparison to their white counterparts
- Low-income residents were exposed to higher levels of airborne lead than their more affluent counterparts

Racial and Economic Disparities in Population-Weighted Lead Exposure



Lead Exposure across NCHS Locales

- Metropolitan areas have higher levels of lead exposures than non-metropolitan areas
- Large central counties (urban) had higher levels of exposure than suburban counties (fringe metro).
- Blacks had higher levels of exposure than whites at all locales.

NCHS urban-rural locale	# Counties	Toxicity-weighted exposure	Population-weighted for black	Population-weighted for white	Population-weighted for lower income	Population-weighted for higher income
Large central metro	1	0.279	0.002	0.001	0.002	0.001
Large fringe metro	13	0.154	0.007	0.006	0.007	0.006
Medium metro	11	0.216	0.022	0.016	0.021	0.016
Small metro	10	1.153	0.585	0.374	0.403	0.373
Non-metropolitan	74	0.017	0.024	0.020	0.019	0.020

Conclusions

- This study demonstrates the lingering presence of lead due to continuing pollutant releases into the environment from industrial facilities and the persistence of racial and economic disparities in lead exposure.
- Black populations and low-income communities are at greater risks for lead exposure because they live near TRI facilities that release toxic lead into the air.
- Findings from this study can help enhance our understanding of the **ubiquitous but unequal** distribution of lead exposures and potentially guide public health policies to eliminate the long-lasting environment injustice problem.

Discussions

- In this study, only airborne lead data were analyzed. However, lead exposure could be attributable to releases to water and land.
  - Therefore, future research should account for multiple sources of lead exposure including lead in air, water, as well as soils, housing, etc.
  - Future research should use multi-year average data for RSEI.
- Another direction for future research is to investigate the health effects of airborne lead exposure especially racial/ethnic disparities.