TRI: Identifying Potential Health Impacts

USING RISK-SCREENING ENVIRONMENTAL INDICATORS (RSEI) DATA TO UNDERSTAND ASSOCIATIONS BETWEEN AIRBORNE LEAD EXPOSURE AND CHILDHOOD COGNITION

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Collaborators

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POLICY AND PRACTICE

1887
Recognition of childhood lead poisoning

1904
Lead poisoning linked to paint

1909
France, Belgium, Austria ban lead interior paint

1922
League of Nations bans lead interior paint (but not the U.S.)

1951
Baltimore bans the use of lead paint in housing

1978
Lead-Based Paint Banned in the US

1976 - 1996
Leaded gasoline phaseout

1986 – current
Regulations regarding plumbing

EXPOSURE TRENDS OVER TIME

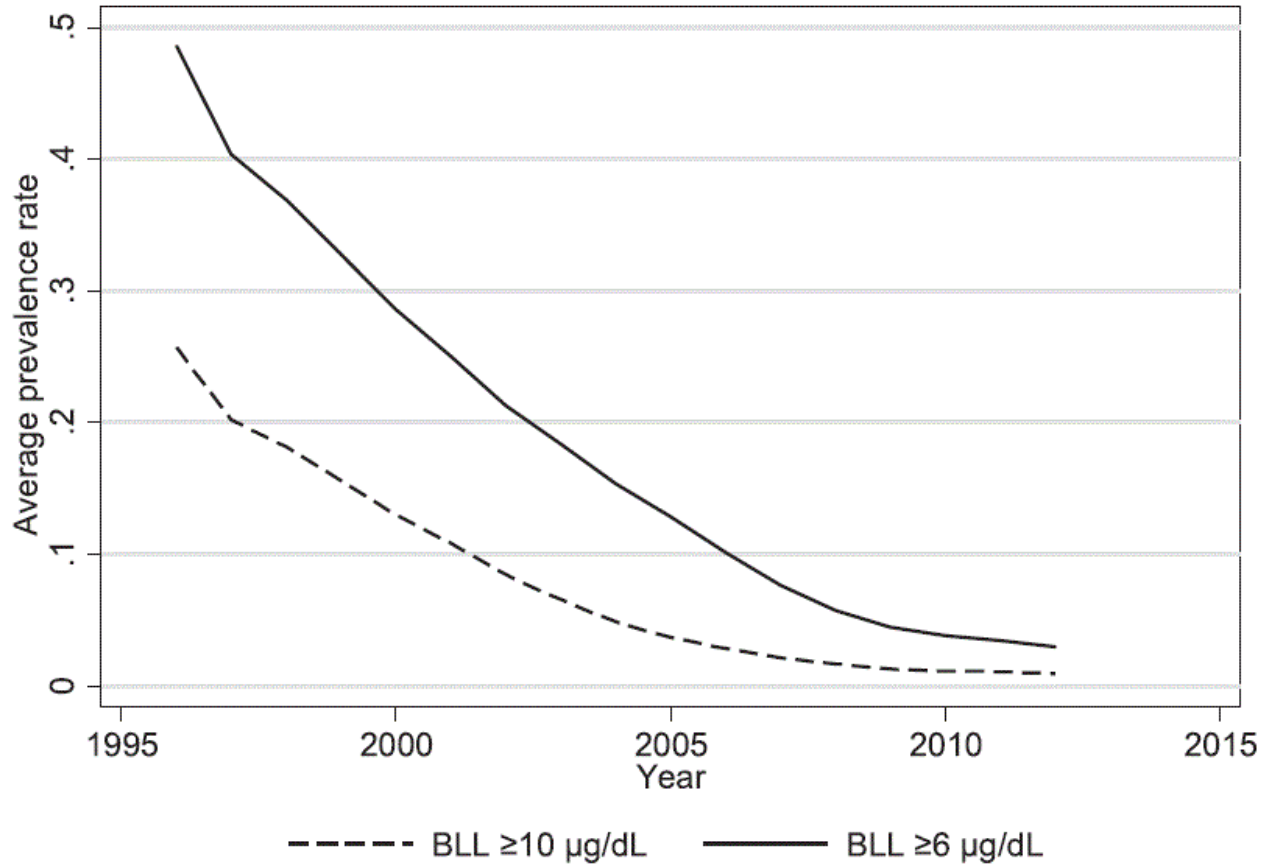


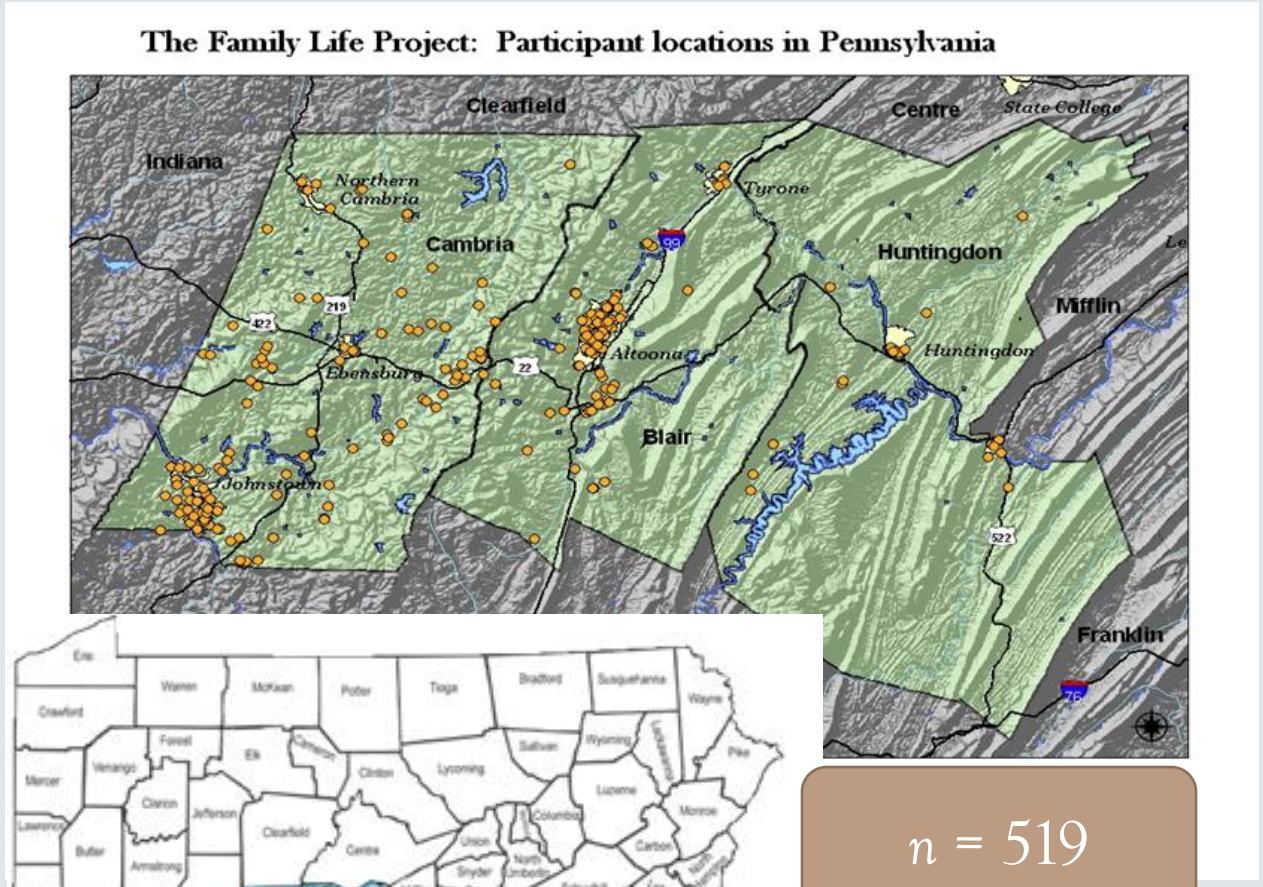
Fig. 2. Average Block-Group Prevalence Rates of Elevated BLL, 1995-2013.

Toxic Inequality in Chicago Neighborhoods, 1995-2013 (Sampson & Winter, 2016)

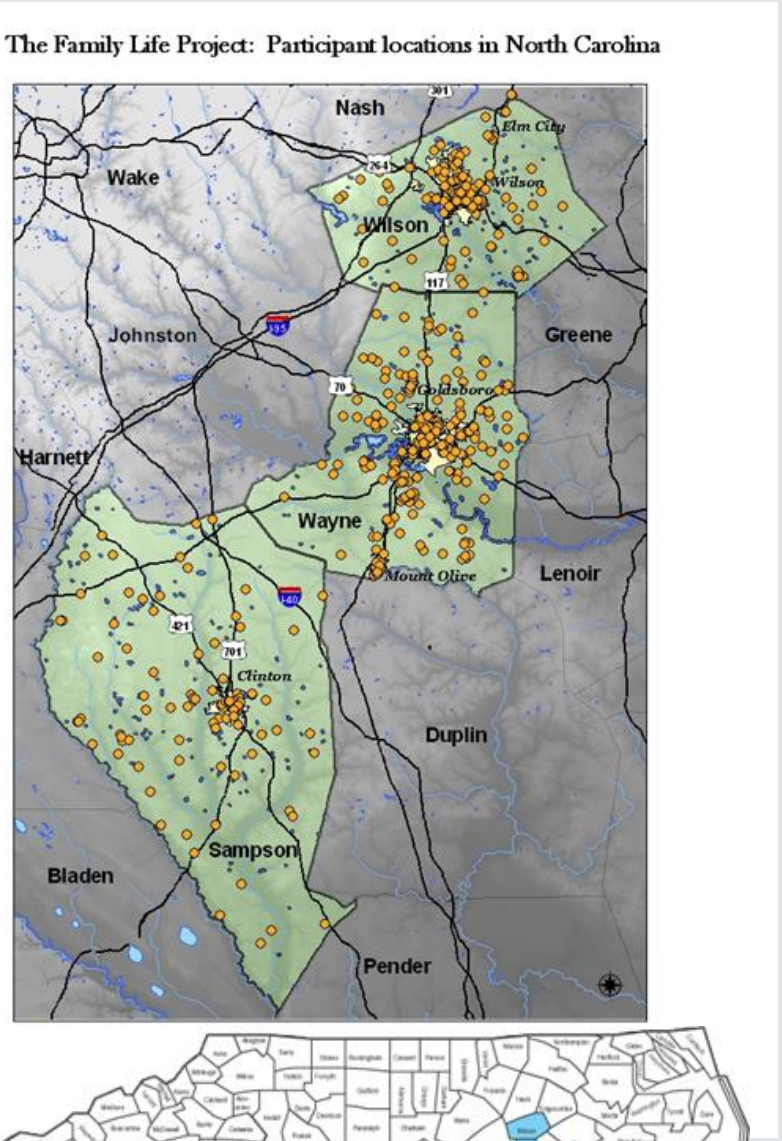
LEAD AND NEUROTOXICITY

- Neurotoxic effects of lead increasingly evident
  - *Cognitive impairments*
  - *Behavioral- antisocial/impulsive*
- Research contributed to revisions in CDC threshold recommendations
- Current perspective- **no** safe level of lead exposure

THE FAMILY LIFE PROJECT



$n = 519$



$n = 773$

THE FAMILY LIFE PROJECT

TABLE 6

SCHEDULE OF DATA COLLECTION

Birth	2 months	6 months	9, 12 months	15 months
Hospital	**Home Visit**	**2 Home Visits**	*Phone Calls*	**2 Home Visits**
		Child Care Visit		**Child Care Visit**

18, 21 months	24 months	27, 30, 33 months	36 months
Phone Calls	**2 Home Visits**	*Phone Calls*	**2 Home Visits**
	Child Care Visit		**Child Care Visit**

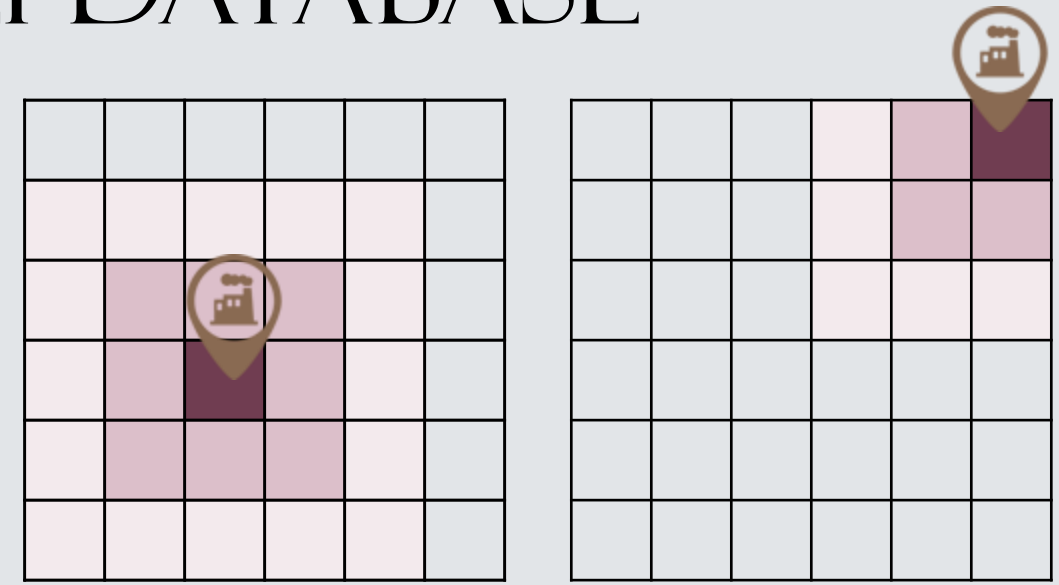
Outcome Variables

IQ (WPPSI)
- @ 3yrs

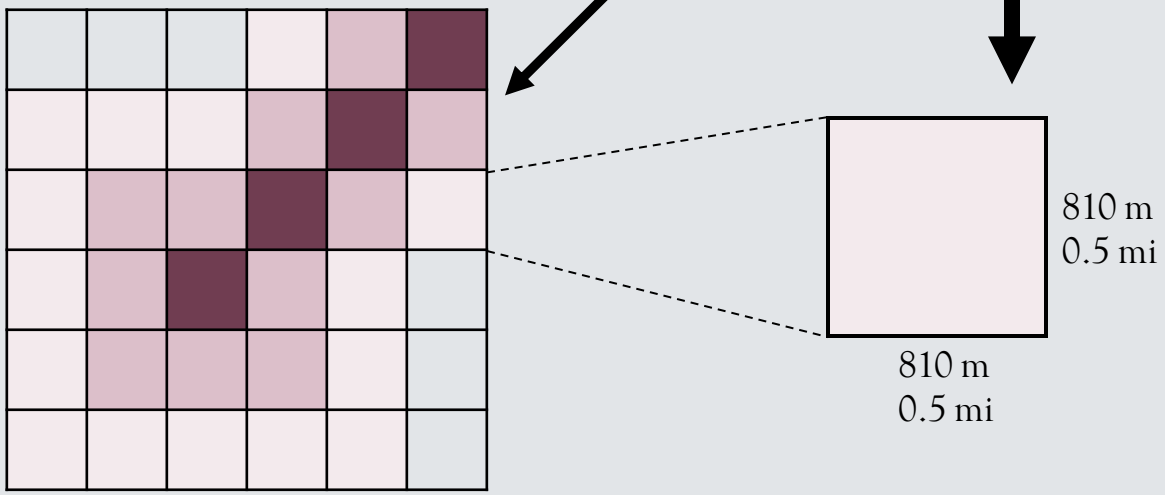
Executive Function
- @ 3yrs
- @ 4yrs
- @ 5yrs

RSEI DATABASE

Approximates the impact region of toxic releases



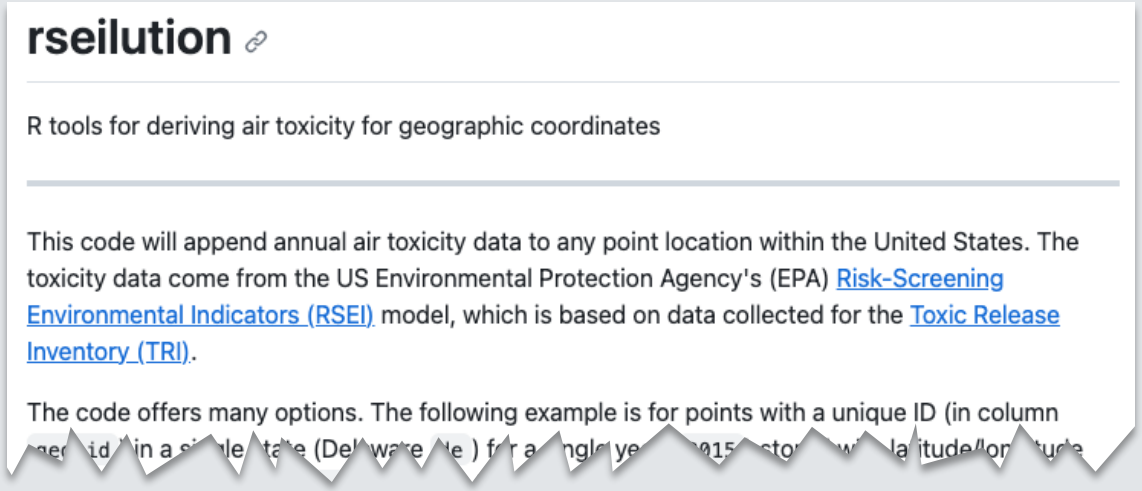
Aggregates across multiple toxic releases



Chemical	Concentration (μg/m³)	ToxConc (conc x toxicity)
Abamectin		
…		
Lead		
…		
Total		

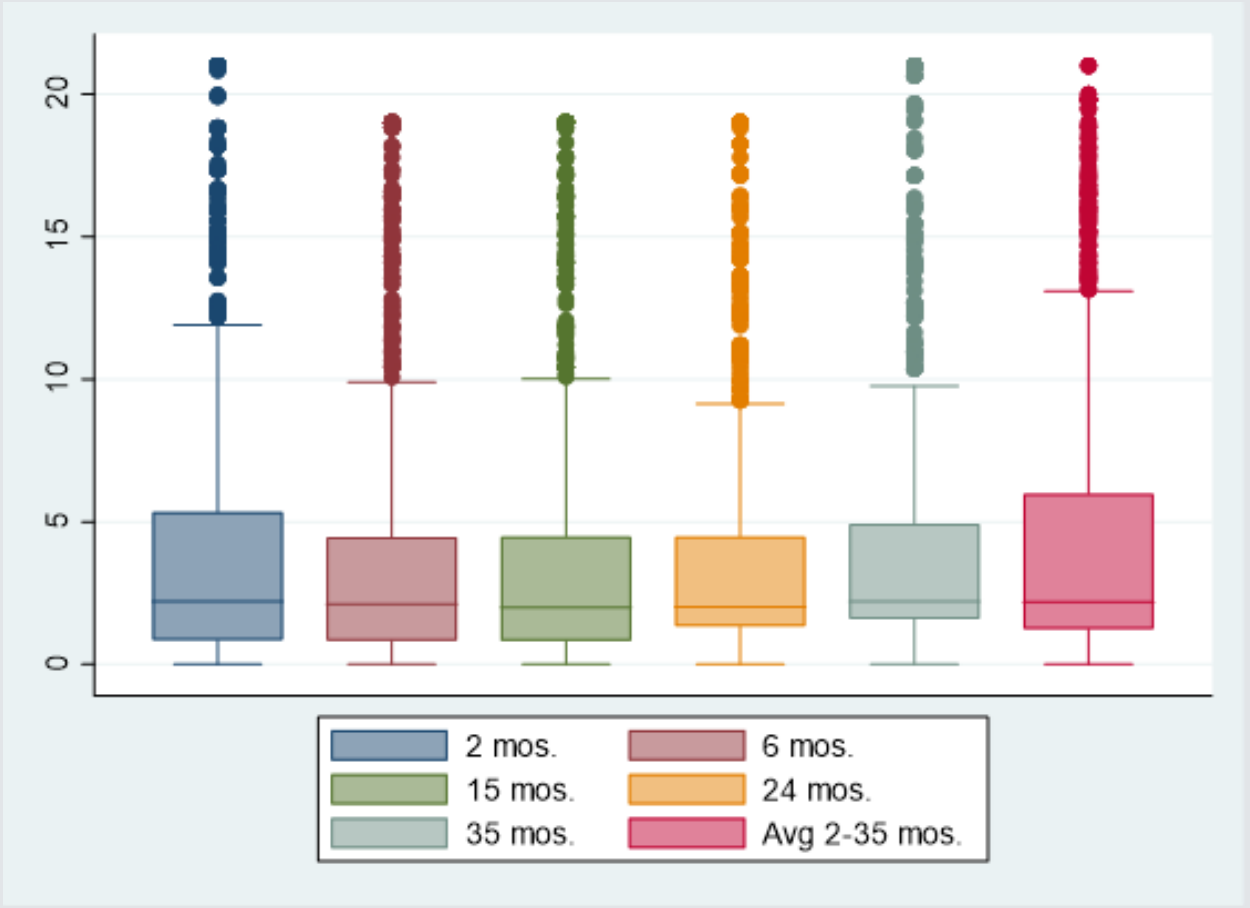
ALIGNING HOME LOCATIONS WITH RSEI

- RSEI data is massive
  - *Millions of RSEI cells needed to cover the US*
  - *Each with hundreds of attributes every year*
- Cannot distribute child locations
  - *Need to match child's location to RSEI on the local machine*
  - *Thousands of point locations across the US, multiple years*
- Developed a flexible R script
  - *Takes a list of latitude/longitude coordinates*
  - *Appends the RSEI data for the requested year(s)*



https://github.com/dfolch/rseilution

EXPOSURE DISTRIBUTIONS



2003 - 2007

INSTRUMENTAL VARIABLE APPROACH

- A valid instrument is identified that
  - *Is correlated with children's exposure*
  - *Does not share common causes with children's cognitive outcomes*
  - *Has no effect on child outcomes except through the potential effect on exposure*

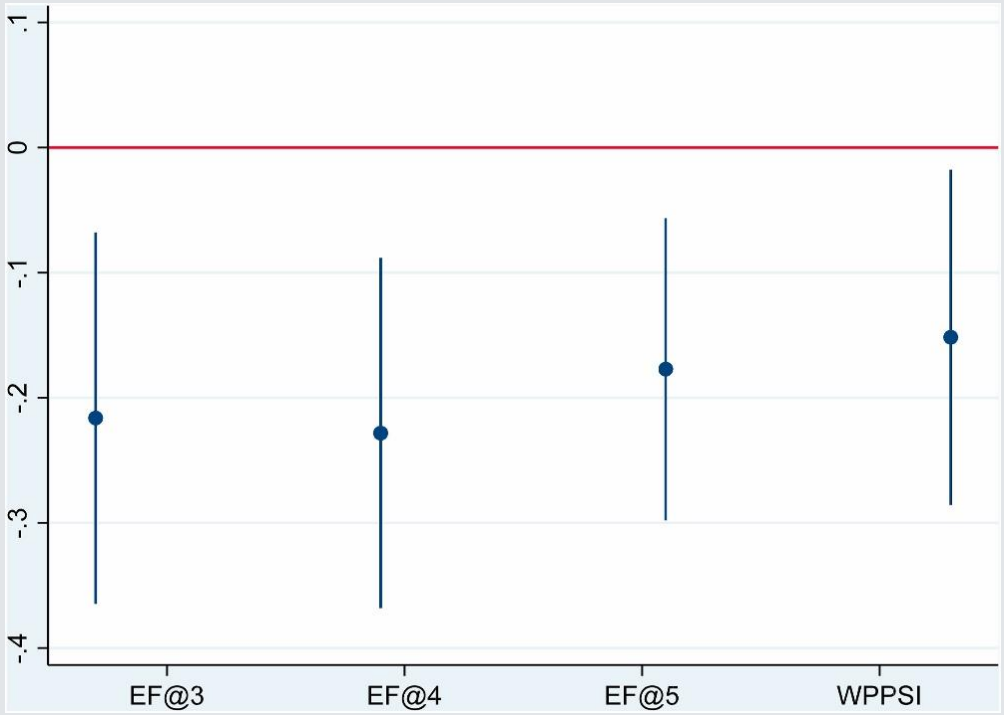
- Census tract manufacturing density
  - *Is correlated with airborne lead exposure*
  - *Is not related to children's cognitive outcome except through lead exposure*
  - *Include additional confounds*
    - Child sex, child race, income/needs, caregiver education, biological father presence, caregiver IQ, caregiver hostility, caregiver depression, child low birth weight, regional poverty, child second-hand smoke exposure

RESULTS

Table 5. Coefficients of airborne lead exposure from IV 2SLS model.

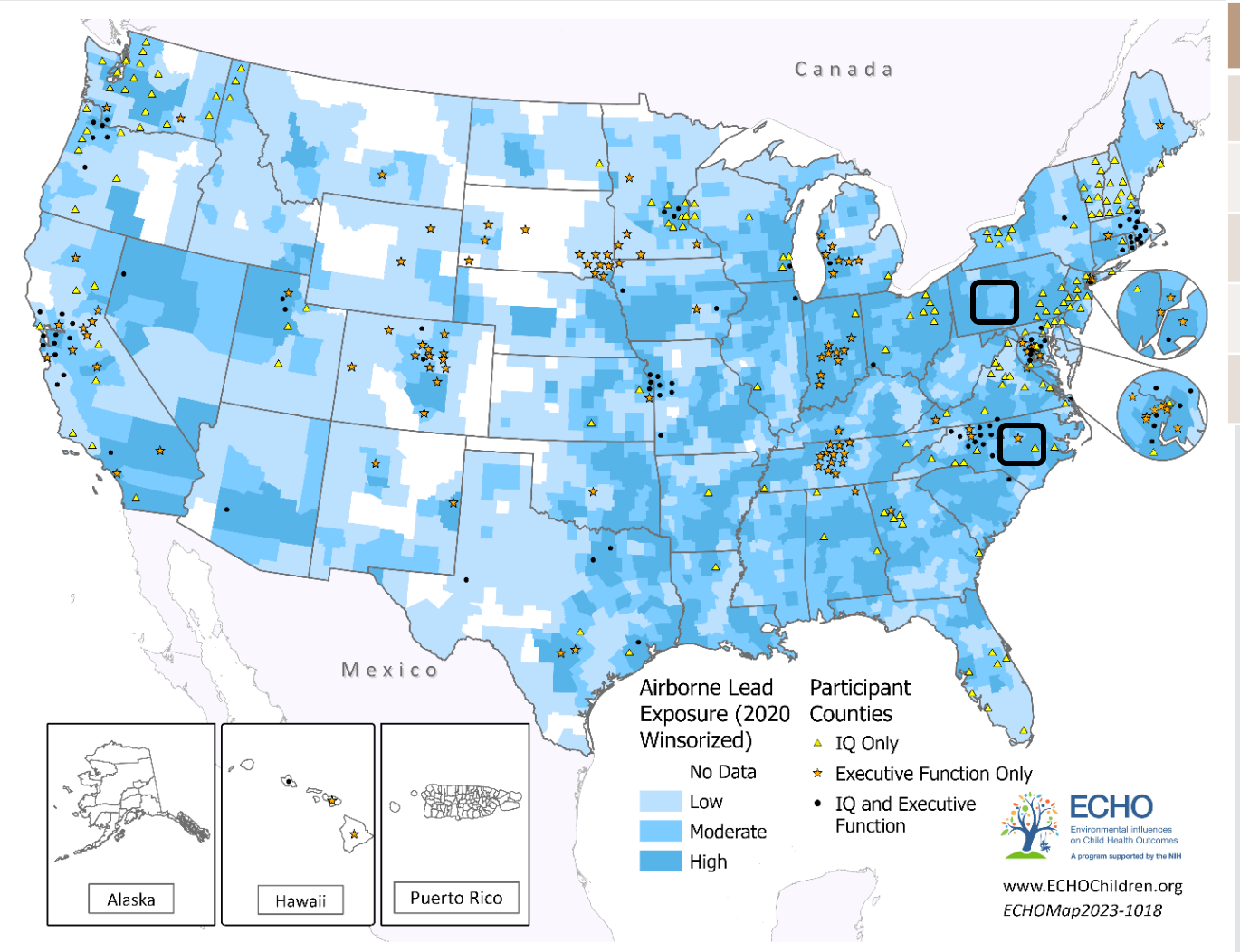
	Lead exposure, (fitted value)	
	Coefficient	**SE**
Outcomes		
Executive Function (3 years)	−0.213**	0.008
Executive Function (4 years)	−0.227**	0.007
Executive Function (5 years)	−0.178**	0.006
WPSSI (3 years)	−0.152*	0.212

NOTE: Coefficients are standardized beta coefficients. Standard errors are clustered at the tract level.

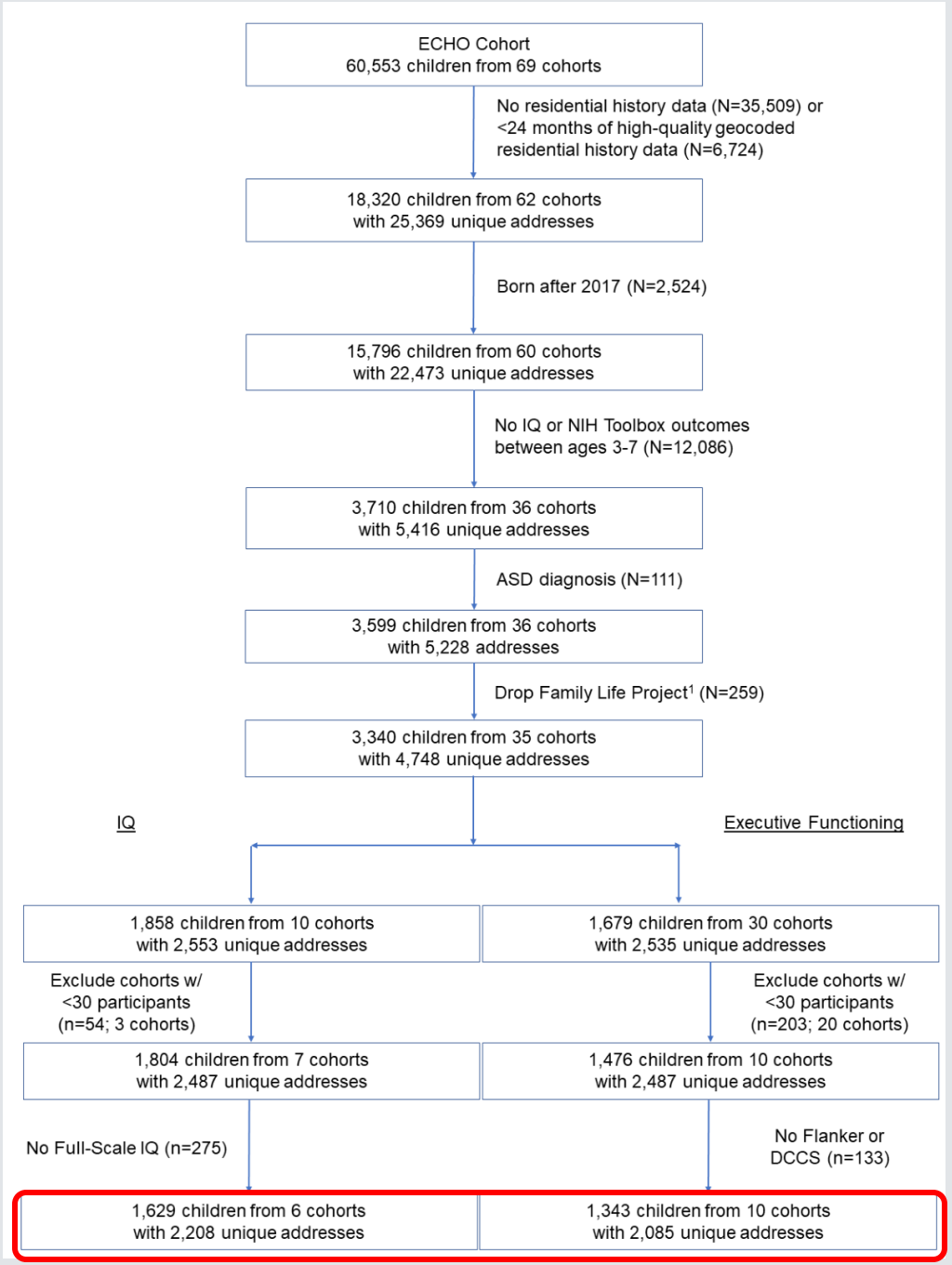


Gatzke-Kopp et al., 2021. https://doi.org/10.1016/j.healthplace/2021.102517

ENVIRONMENTAL CHILDHOOD HEALTH OUTCOMES (ECHO)



Region	IQ sample	EF sample
Midwest	141 (8.7%)	208 (15.5%)
Northeast	1,164 (71.5%)	167 (12.4%)
South	35 (2.2%)	196 (14.6%)
West	289 (17.7%)	772 (57.5%)
	1,629	**1,343**



1,629 children
6 cohorts
2,208 addresses

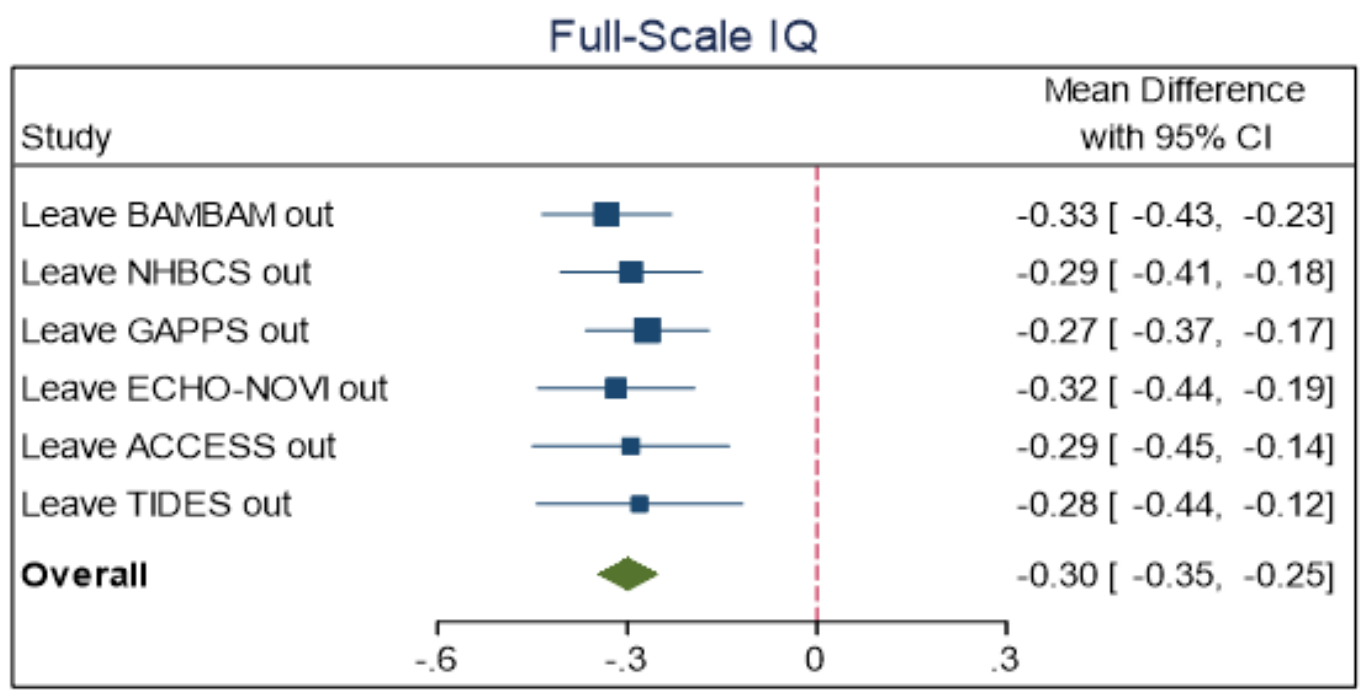
1,343 children
10 cohorts
2,085 addresses

RESULTS

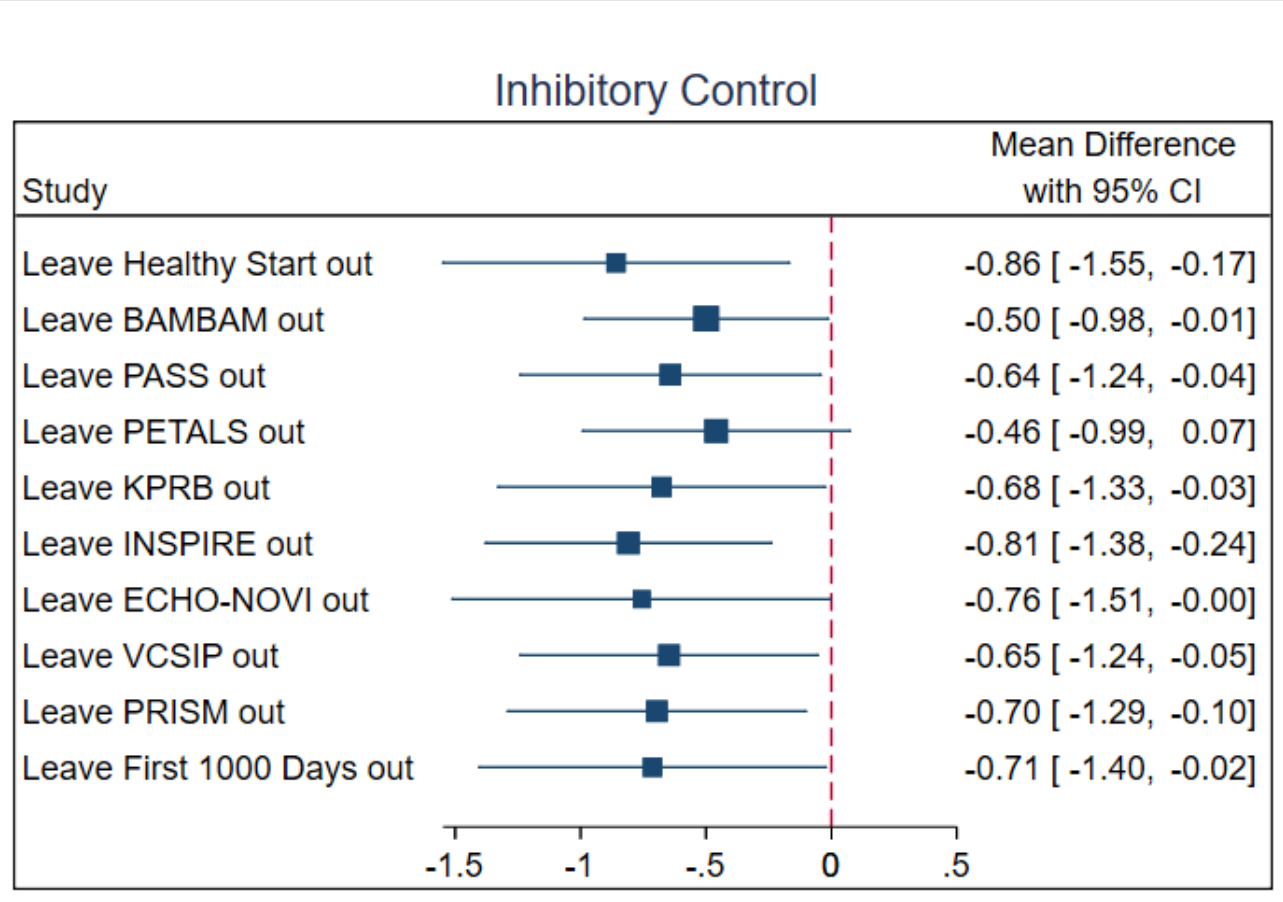
		Executive Function	
	Full-Scale IQ b (95% CI)	**Inhibitory Control (Flanker) b (95% CI)**	**Cognitive Flexibility (DCCS) b (95% CI)**
Total sample	1,629	1,241	1,298
per unit Δ airborne lead	**-0.31 (-0.41, -0.20)**	**-0.67 (-1.25, -0.08)**	-0.09 (-0.55, 0.37)
per IQR Δ airborne lead	**-0.74 (-1.00, -0.48)**	**-1.13 (-2.13, -0.14)**	-0.15 (-0.93, 0.62)

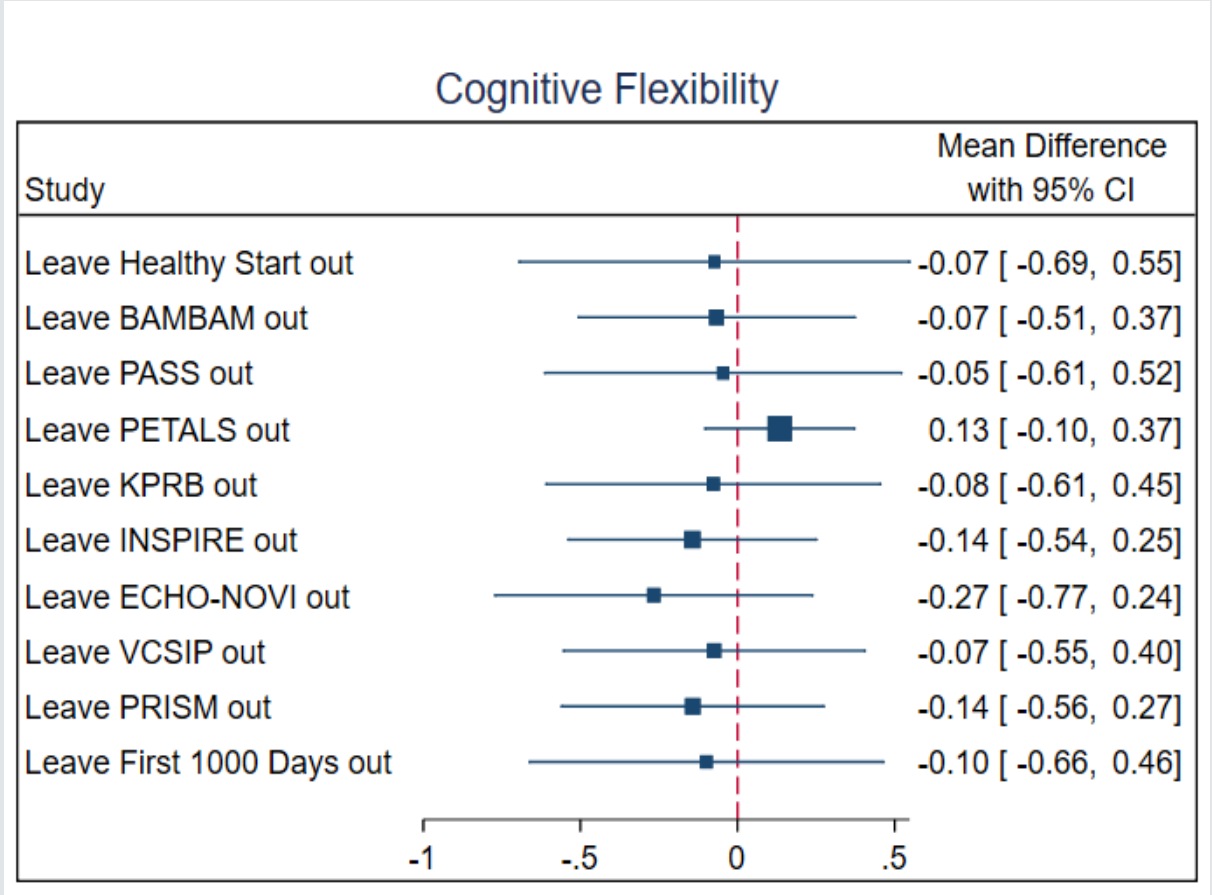
Covariates: child sex, birth year, preterm status, low birthweight status, age at assessment (IQ only), maternal age at delivery, maternal prenatal smoking status, regional socioeconomic vulnerability, urbanicity, pre-1980s housing stock,

ROBUSTNESS


Full-Scale IQ
Study
Mean Difference with 95% CI
Leave BAMBAM out
-0.33 [-0.43, -0.23]
Leave NHBCS out
-0.29 [-0.41, -0.18]
Leave GAPPS out
-0.27 [-0.37, -0.17]
Leave ECHO-NOVI out
-0.32 [-0.44, -0.19]
Leave ACCESS out
-0.29 [-0.45, -0.14]
Leave TIDES out
-0.28 [-0.44, -0.12]
Overall
-0.30 [-0.35, -0.25]
-.6
-.3
0
.3

ROBUSTNESS


Inhibitory Control
Study
Mean Difference with 95% CI
Leave Healthy Start out
-0.86 [-1.55, -0.17]
Leave BAMBAM out
-0.50 [-0.98, -0.01]
Leave PASS out
-0.64 [-1.24, -0.04]
Leave PETALS out
-0.46 [-0.99, 0.07]
Leave KPRB out
-0.68 [-1.33, -0.03]
Leave INSPIRE out
-0.81 [-1.38, -0.24]
Leave ECHO-NOVI out
-0.76 [-1.51, -0.00]
Leave VCSIP out
-0.65 [-1.24, -0.05]
Leave PRISM out
-0.70 [-1.29, -0.10]
Leave First 1000 Days out
-0.71 [-1.40, -0.02]
-1.5
-1
-.5
0
.5


Cognitive Flexibility
Study
Mean Difference with 95% CI
Leave Healthy Start out
-0.07 [-0.69, 0.55]
Leave BAMBAM out
-0.07 [-0.51, 0.37]
Leave PASS out
-0.05 [-0.61, 0.52]
Leave PETALS out
0.13 [-0.10, 0.37]
Leave KPRB out
-0.08 [-0.61, 0.45]
Leave INSPIRE out
-0.14 [-0.54, 0.25]
Leave ECHO-NOVI out
-0.27 [-0.77, 0.24]
Leave VCSIP out
-0.07 [-0.55, 0.40]
Leave PRISM out
-0.14 [-0.56, 0.27]
Leave First 1000 Days out
-0.10 [-0.66, 0.46]
-1
-.5
0
.5

SEX STRATIFIED MODELS

	Full-Scale IQ b (95% CI)	**Inhibitory Control (Flanker) b (95% CI)**	**Cognitive Flexibility (DCCS) b (95% CI)**
Male participants	836	635	657
per unit Δ airborne lead	**-0.60 (-0.81, -0.38)**	**-0.93 (-1.76, -0.11)**	-0.12 (-0.80, 0.56)
per IQR Δ airborne lead	**-1.46 (-1.99, -0.92)**	**-1.58 (-2.98, -0.19)**	-0.20 (-1.54, 0.99)
Female participants	793	606	641
per unit Δ airborne lead	0.13 (-0.05, 0.31)	-0.42 (-0.85, 0.01)	0.08 (-0.28, 0.43)
per IQR Δ airborne lead	0.32 (-0.12, 0.76)	-0.71 (-1.43, 0.02)	0.13 (-0.47, 0.73)

SUMMARY

- Regional variation in airborne lead in the first 3-5 years of life is associated with decrements in children's cognitive functioning
- Effects may be more pronounced among male children
- In addition to the implications for these findings on environmental policies, additional research could examine individual or family-level factors mitigate this association (e.g. nutrition) that could also inform policy and practices for child health.

STRATEGIC HIRING INITIATIVE IN ENVIRONMENTAL HEALTH SCIENCES

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