Childhood Lead Poisoning and Its Impact on Educational Outcomes

Panelists

- Gabriel Filippelli, PdD, Chancellor's Professor of Earth Sciences and Executive Director- Indiana University Environmental Resilience Institute
- Susan Buchanan, MD, MPH, Clinical Associate Professor- University of Illinois Chicago School of Public Health
- Heidi Beidinger-Burnett, PhD, MPH, Associate Professor of the Practice- Eck Institute for Global Health, University of Notre Dame

Moderator

Lindsay Haake, Citizens Action Coalition

ENVIRONMENTAL RESILIENCE INSTITUTE

Identifying and Reducing Environmental Lead Exposures

Gabriel Filippelli
Chancellor's Professor of Earth Sciences
Indiana University-Purdue University Indianapolis (IUPUI)
Executive Director, Indiana University Environmental Resilience Institute
Editor-in-Chief, *GeoHealth*

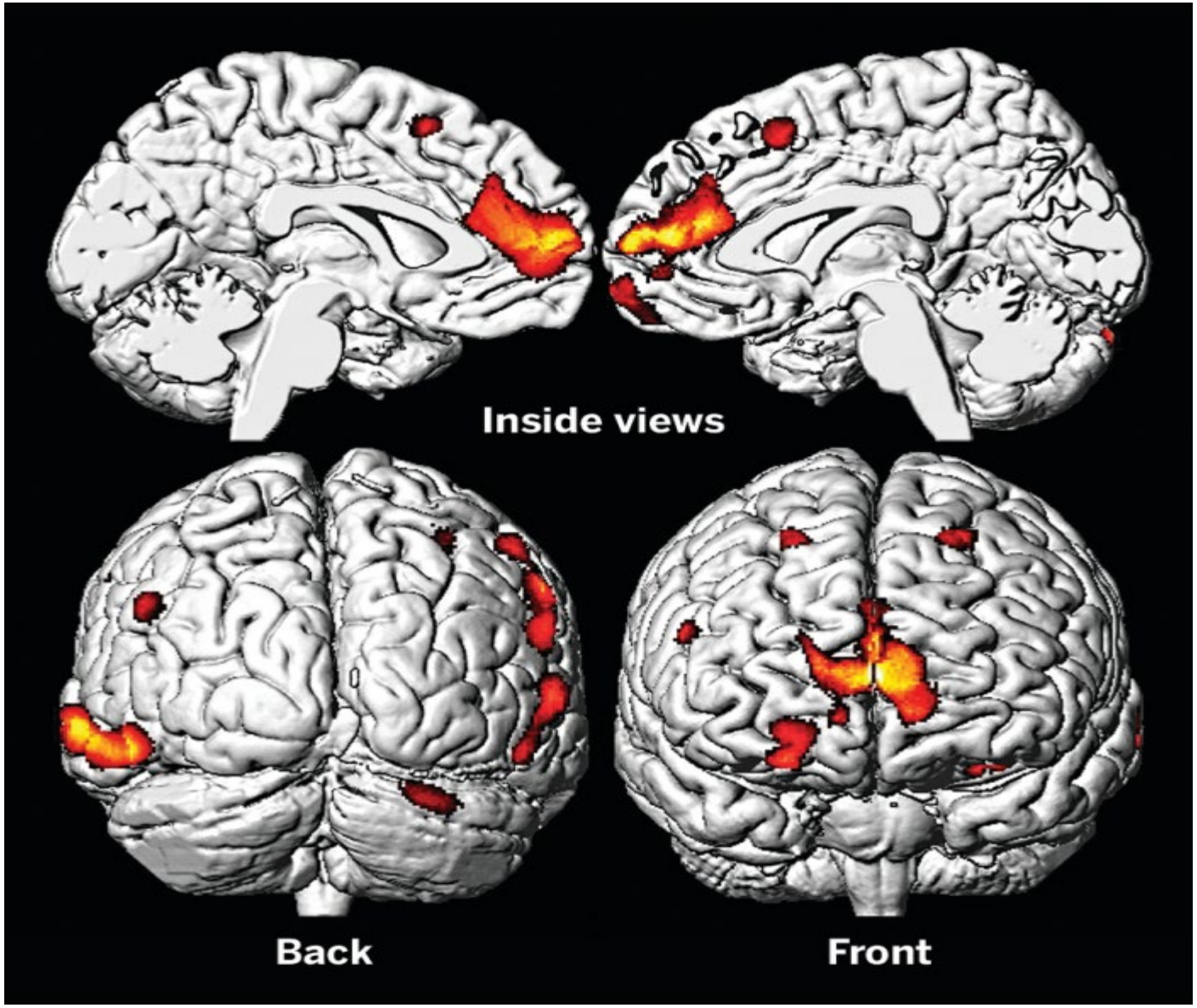
Lead poisoning—costing minds, costing lives

Frontal Cortex
Home of the brain's executive functions

- Memory
- Intelligence
- Impulse control

Shows two things:

1. Lead exposure results in serious poisoning and brain function diminishment
2. Impacts of childhood lead poisoning persist to adulthood

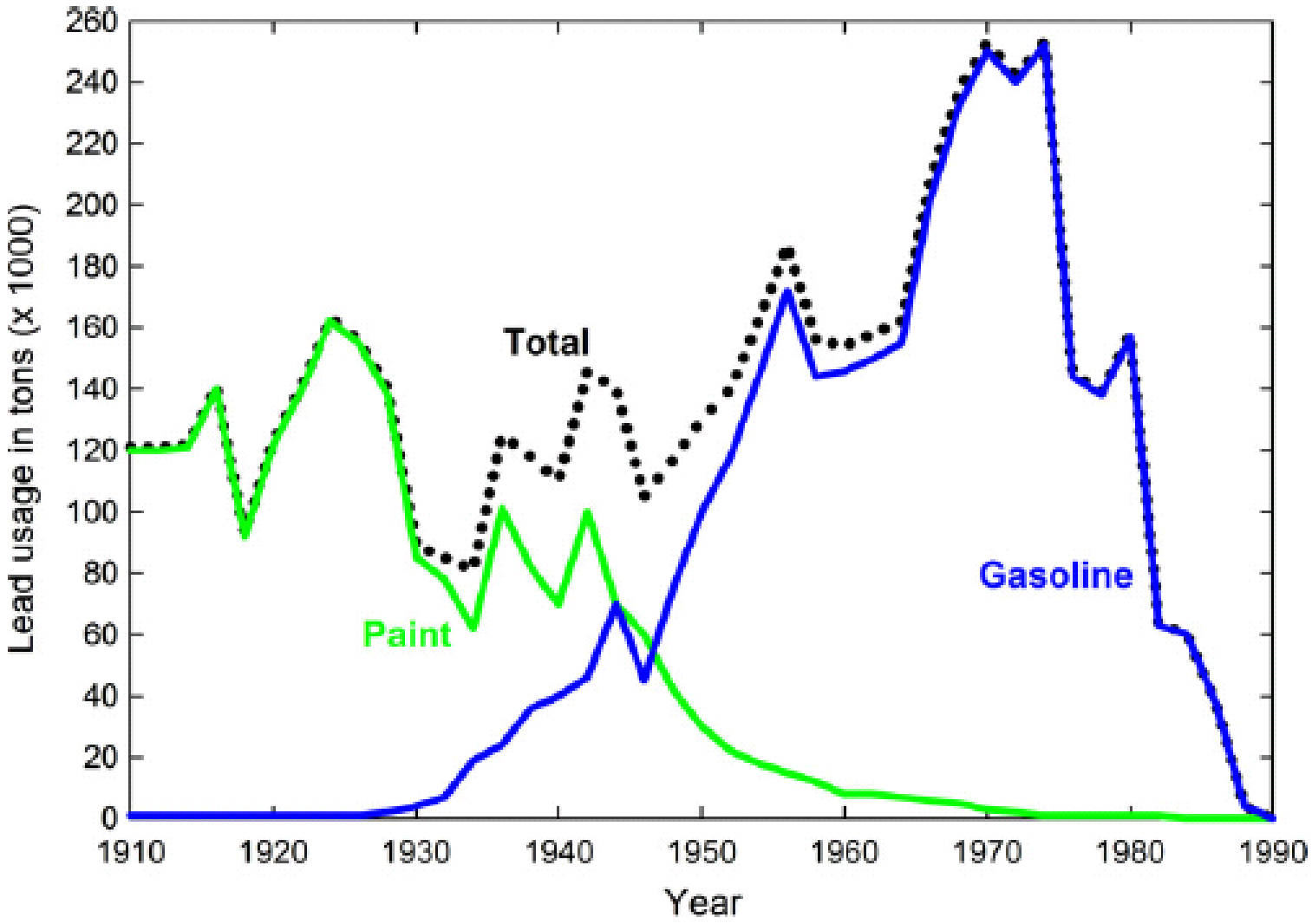


How does lead get into the body?

- Prenatal to 6 years old
  - Less efficient intestinal system, higher lead intake
  - Actively forming brain and neurological system
  - Behavior--exploration with mouth, hands in mouth

- 90% of lead intake stored in bones and teeth
  - Lingering impacts

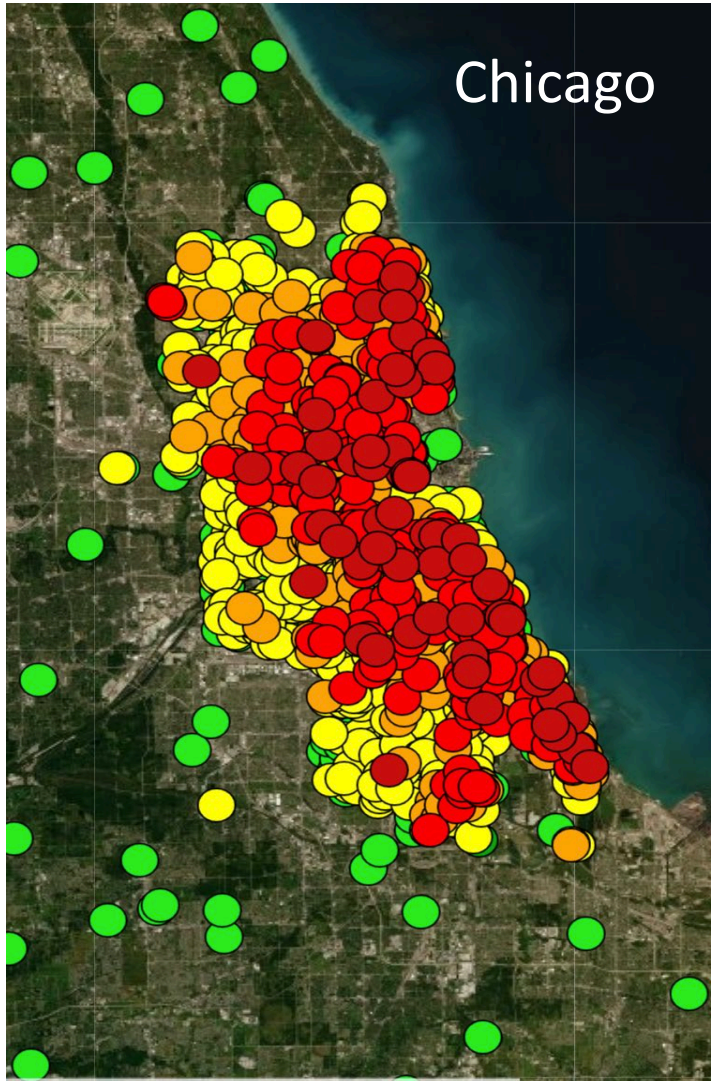
What is the source of lead?

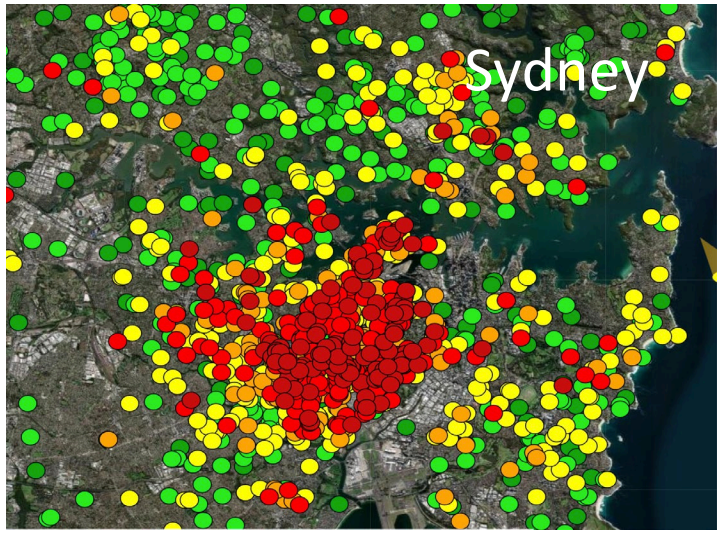


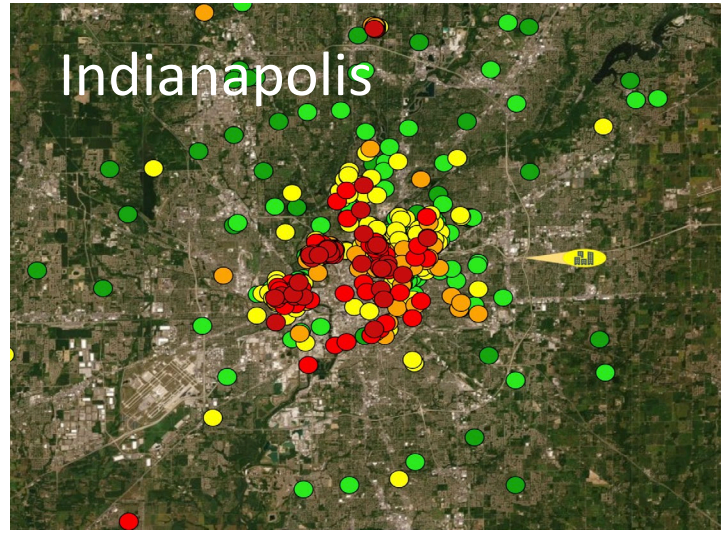
What and where are the lead sources?

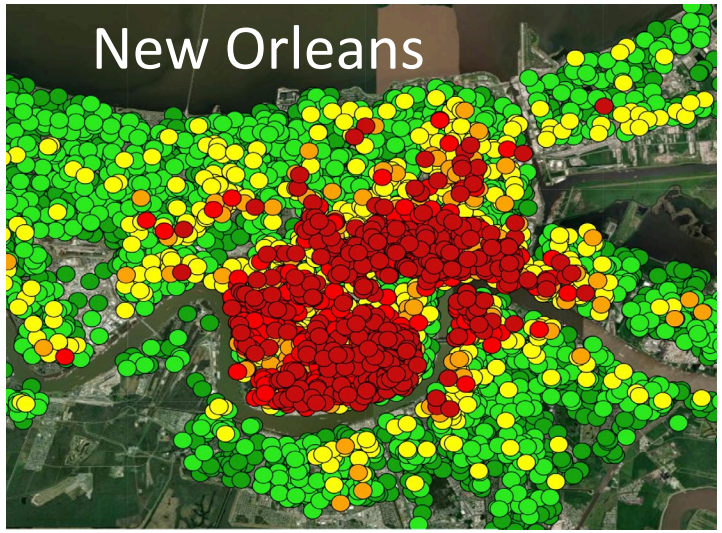
Soils + dust are primary ambient sources

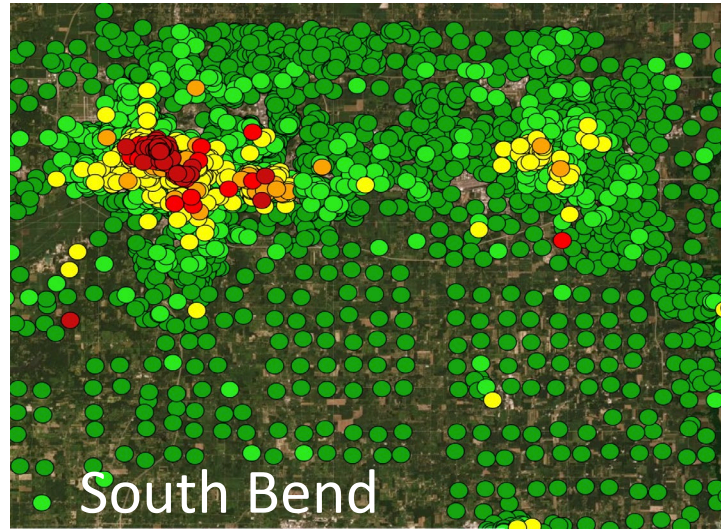
Paint is ultimately a major source of lead to soil, dust





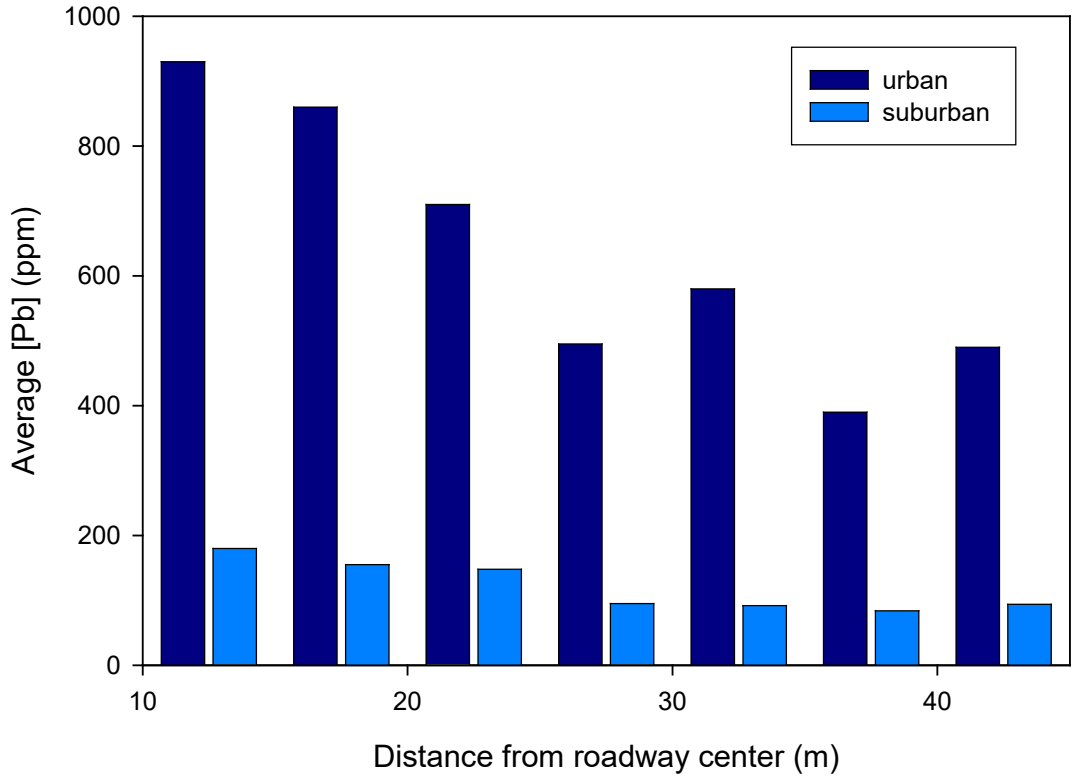






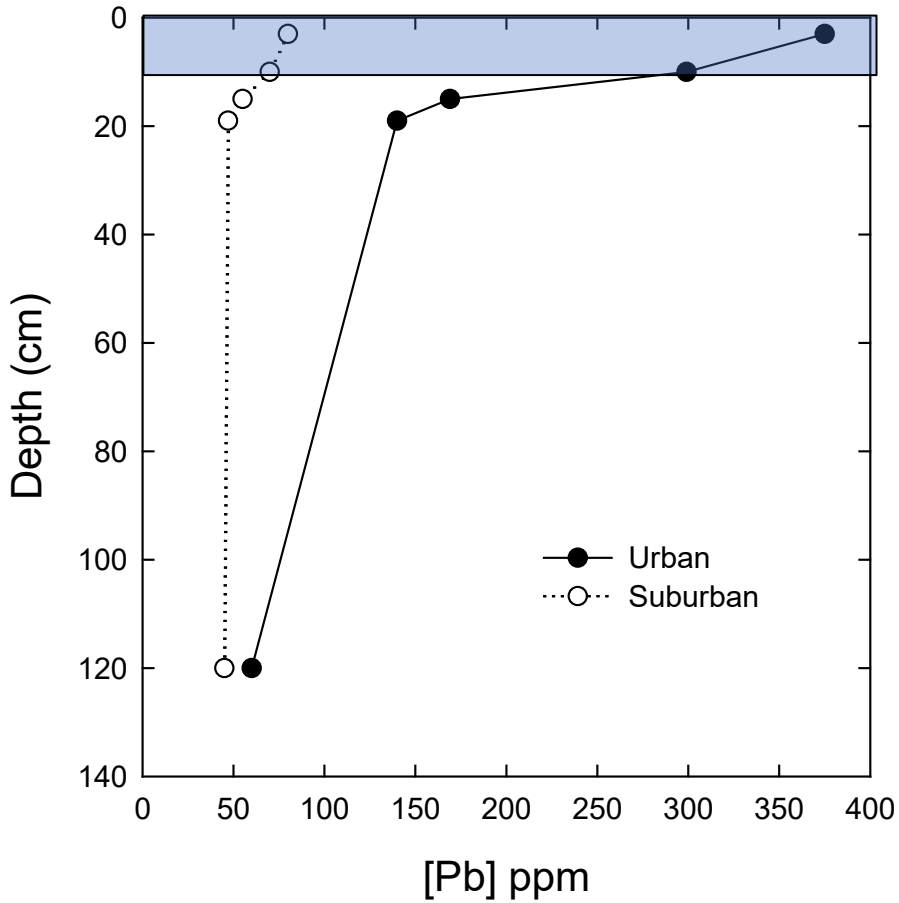
Near Roadways

- Particulates from emissions of leaded gasoline combustion deposit by dry deposition near roadways
- Particulates in bioavailable form
- Lead is retained in surface soils via complexation or physical retention on organic particles

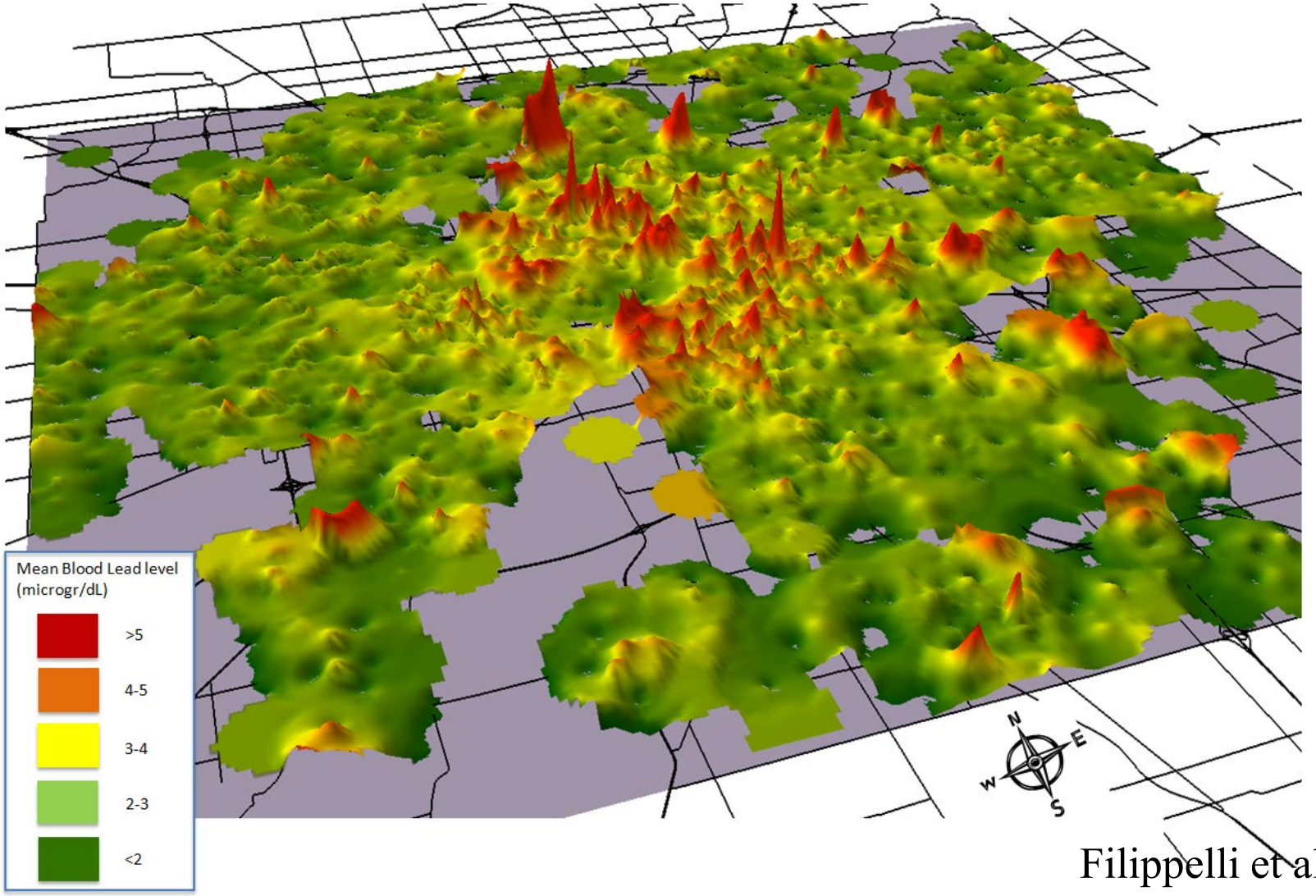


In surface soils

- Surface retention of lead



What is the exposure mechanism for humans?



Filippelli et al. 2015

Lead-contaminated soils from legacy paint, gasoline, and industrial sources

How are we engaging communities to reduce exposure uncertainties?

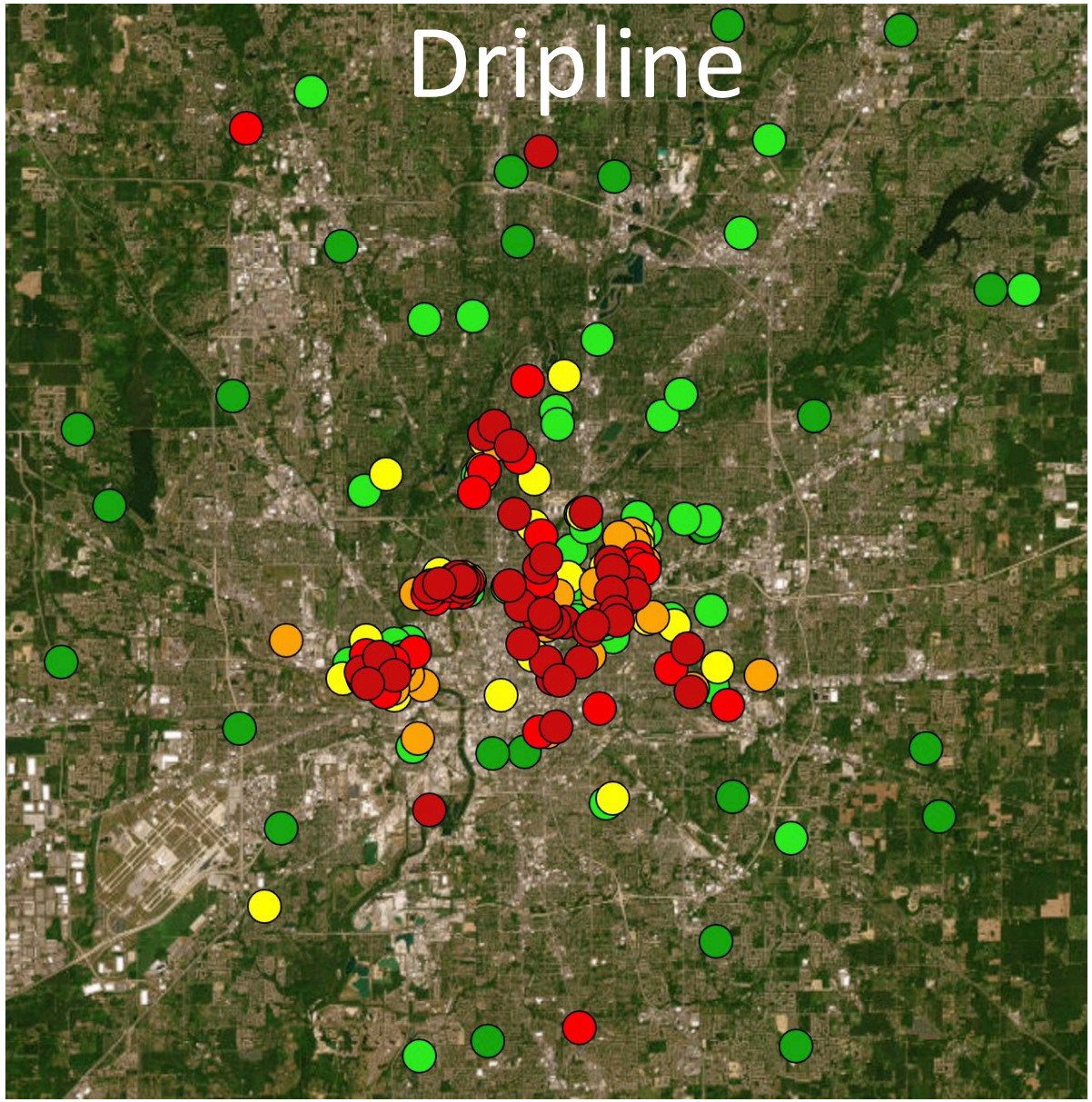
Soil

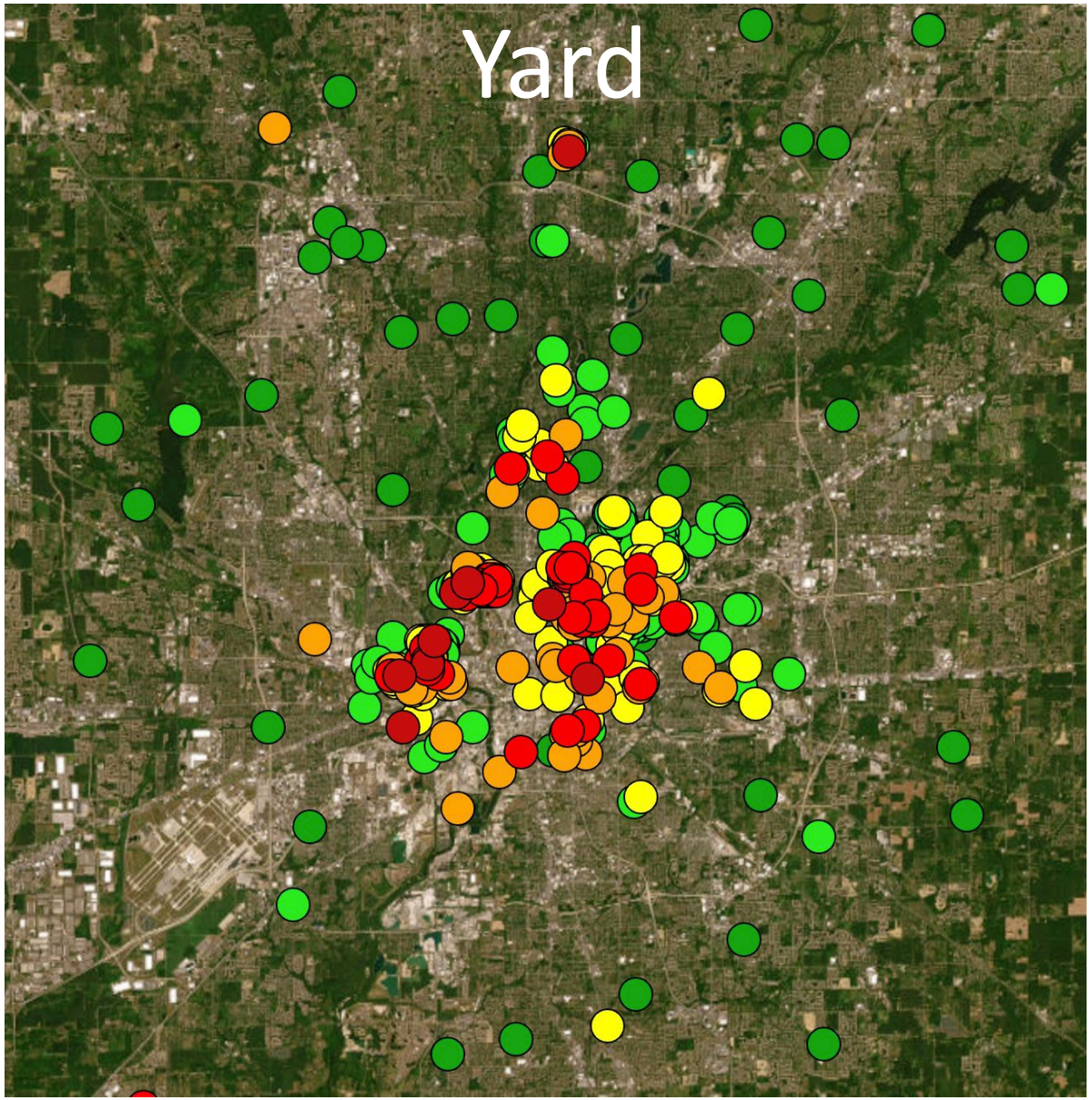
Dust

Paint

Worms

Birds


Dripline


Yard

THE UNIVERSITY OF ILLINOIS AT CHICAGO SCHOOL OF PUBLIC HEALTH

Great Lakes Center for Children's Environmental Health

Health Effects of Exposure to Lead

Susan Buchanan, MD, MPH
University of Illinois at Chicago
School of Public Health
2023

PEHSU Pediatric Environmental Health Specialty Units

Children – our canaries in the coal mine

- Increased breathing: **400** vs **150** mL/min per kg
- Increased food intake: **45** vs **10-15** gm/kg/day
- Water: **28** vs **5-10** gm/kg/day

http://www.alamy.com/stock-photo/national-coal-mining-museum.html

http://performancejourneys.com/what-are-your-canaries-in-the-coal-mine/

Museum of Cannock Chase

Neuron Growth

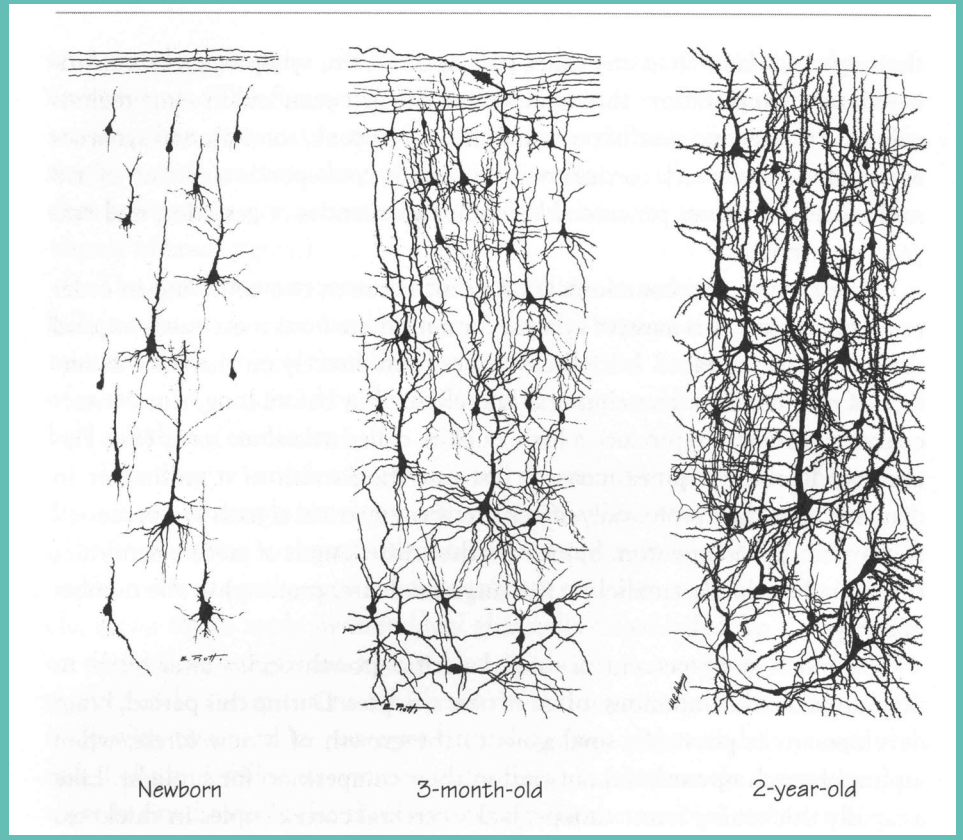


Image from “What’s Going on in There?” by L Eliot, pg 28

MMWR Weekly
June 08, 2001 / 50(22);457-9

Persons using assistive technology might not be able to fully access information in this file. For assistance, please send e-mail to: mmwrq@ the report in the subject line of e-mail.

Fatal Pediatric Lead Poisoning --- New Hampshire, 2000

Fatal pediatric lead poisoning is rare in the United States because of multiple public health measures that have reduced blood lead levels (BLLs) in among children remains high in some neighborhoods and populations, including children living in older housing with deteriorated leaded paint. Thi death of a child from lead poisoning since 1990 (*1*). The investigation implicated leaded paint and dust in a home environment as the most likely so by correcting lead hazards, especially in older housing, and by screening children at risk according to established guidelines (*2*).

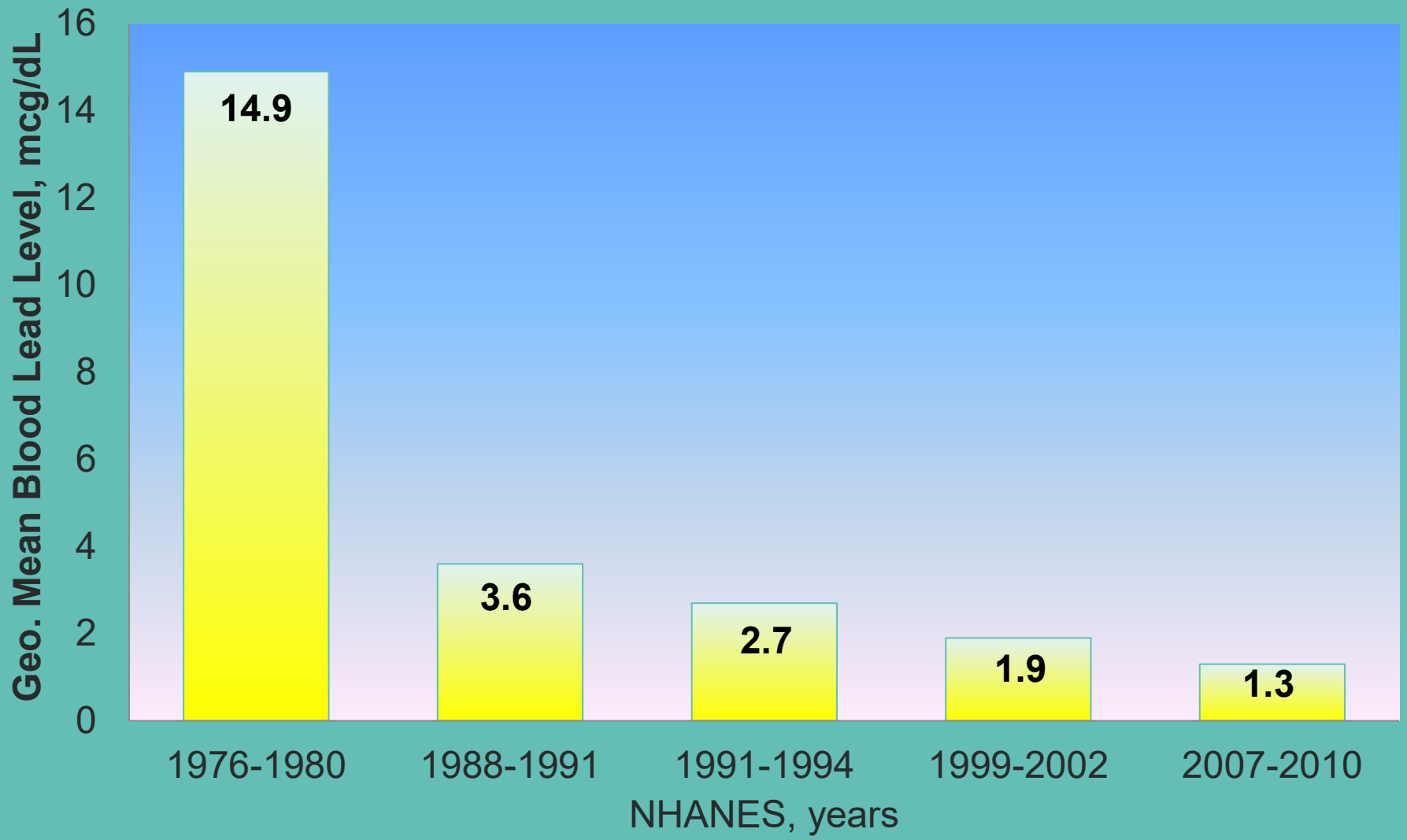
On March 29, 2000, a 2-year-old girl was seen at a community hospital emergency department with a low-grade fever and vomiting of approximate arriving in New Hampshire from Egypt with her Sudanese refugee family 3 weeks earlier. Laboratory findings included a microcytic anemia (hemo occasional basophilic stippling of red blood cells. A throat swab streptococcal antigen screening test was positive. She was discharged from the eme and antiemetic to treat presumed strep throat. However, her vomiting worsened, and she was admitted to the same hospital on April 17, and then tra 19, approximately 5 hours after the transfer, she became unresponsive, apneic, and hypotensive. She was intubated and placed on a ventilator. Comp cerebral edema and dilated ventricles. Later that day, the results of a blood test drawn on April 18 showed a BLL of 391 µg/dL and an erythrocyte p initiated with intramuscular British antilewisite and intravenous calcium ethylenediaminetetraacetic acid. Despite a decrease in her BLL to 72 µg/dL including surgical ventricular drainage, she remained comatose without spontaneous respirations, brain electrical activity, and intracranial blood flo

An autopsy found diffuse cerebral edema. A hair sample lead concentration was 31 µg/g in the distal centimeter and 67 µg/g in the proximal centim the preceding month. Radiographs of the left knee were equivocal for growth arrest lines that can occur in chronic lead poisoning (*3*). A bone marro deficiency.

On April 19, the Manchester Health Department and New Hampshire Department of Health and Human Services (NHDHHS) initiated an investiga

Geometric Mean Blood Lead Levels in Children Ages 1 to 5 years

(National Health & Nutrition Surveys, NHANES 2007-2010)



Dr. Helen Binns

Lead Poisoning at Low Levels Usually Has No Symptoms!

Photo reproduced with permission from Bright Futures; Emeryville, CA

Health Impacts of Lead

CLEAN WATER ACTION
CLEAN WATER FUND

Exposure to high levels of lead can cause severe damage to the brain, blood and kidneys. Children under six are most at risk from lead poisoning. Even low levels of lead exposure have been found to permanently reduce cognitive ability and cause hyperactivity in children.

ADULTS

Brain
Memory loss, lack of concentration, headaches, irritability, depression.

Body
Fatigue, joint and muscle pain

Cardiovascular
High blood pressure

Digestive System
Constipation, nausea and poor appetite

Kidneys
Abnormal function and damage

Nervous System
Damage including numbness and pain in the extremities

Reproductive System
Men: Decreased sex drive and sperm count, and sperm anomalies. Women: Spontaneous miscarriage

CHILDREN

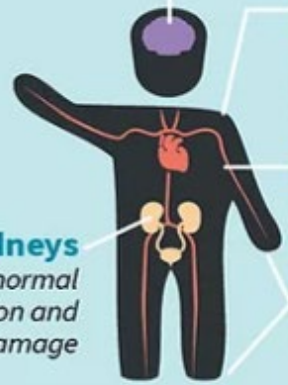
Brain
Behavior problems, lower IQ, hearing loss, learning disabilities

Body
decreased bone and muscle growth

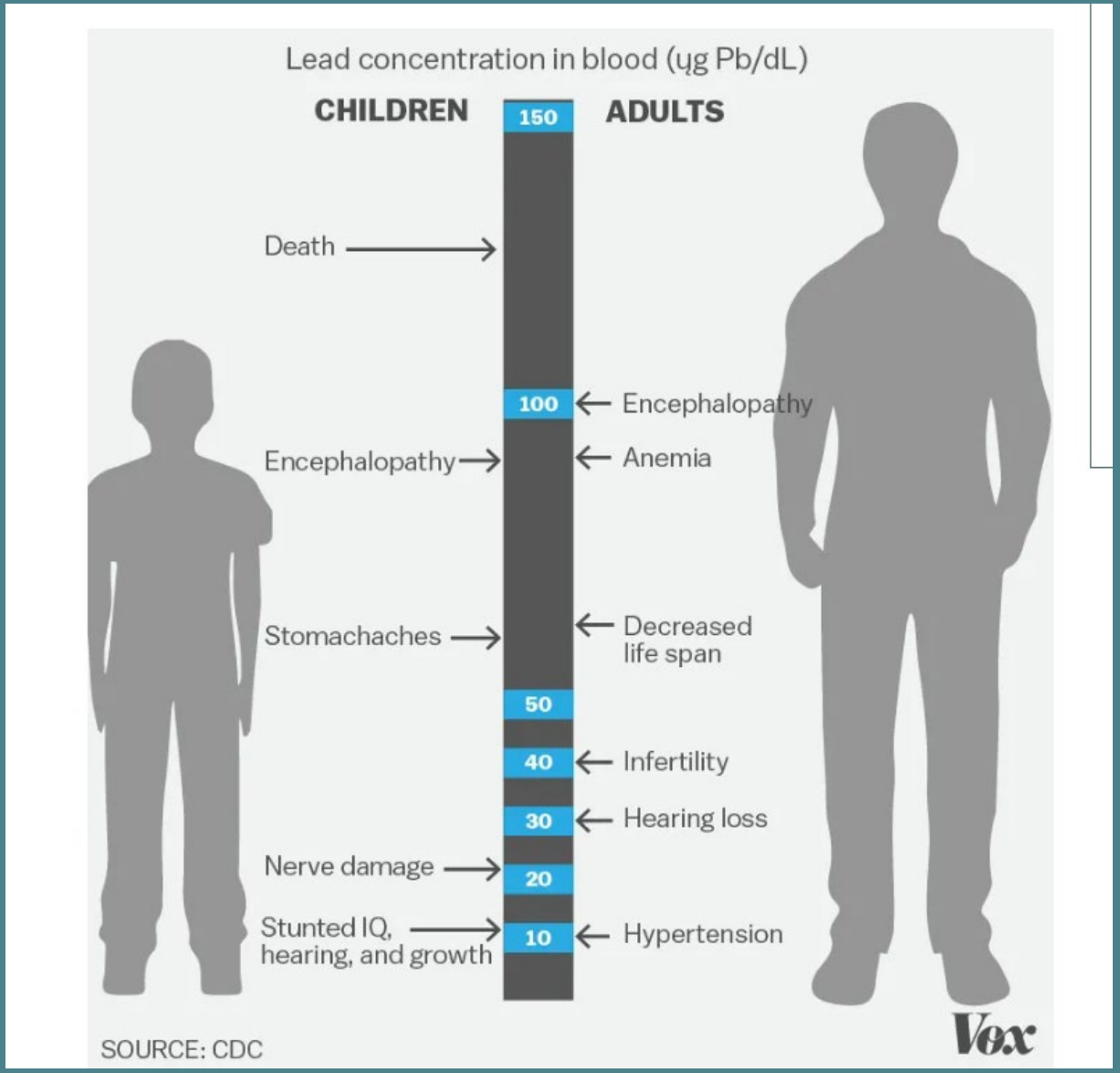
Blood
Anemia

Kidneys
Abnormal function and damage

Nervous System
Damage

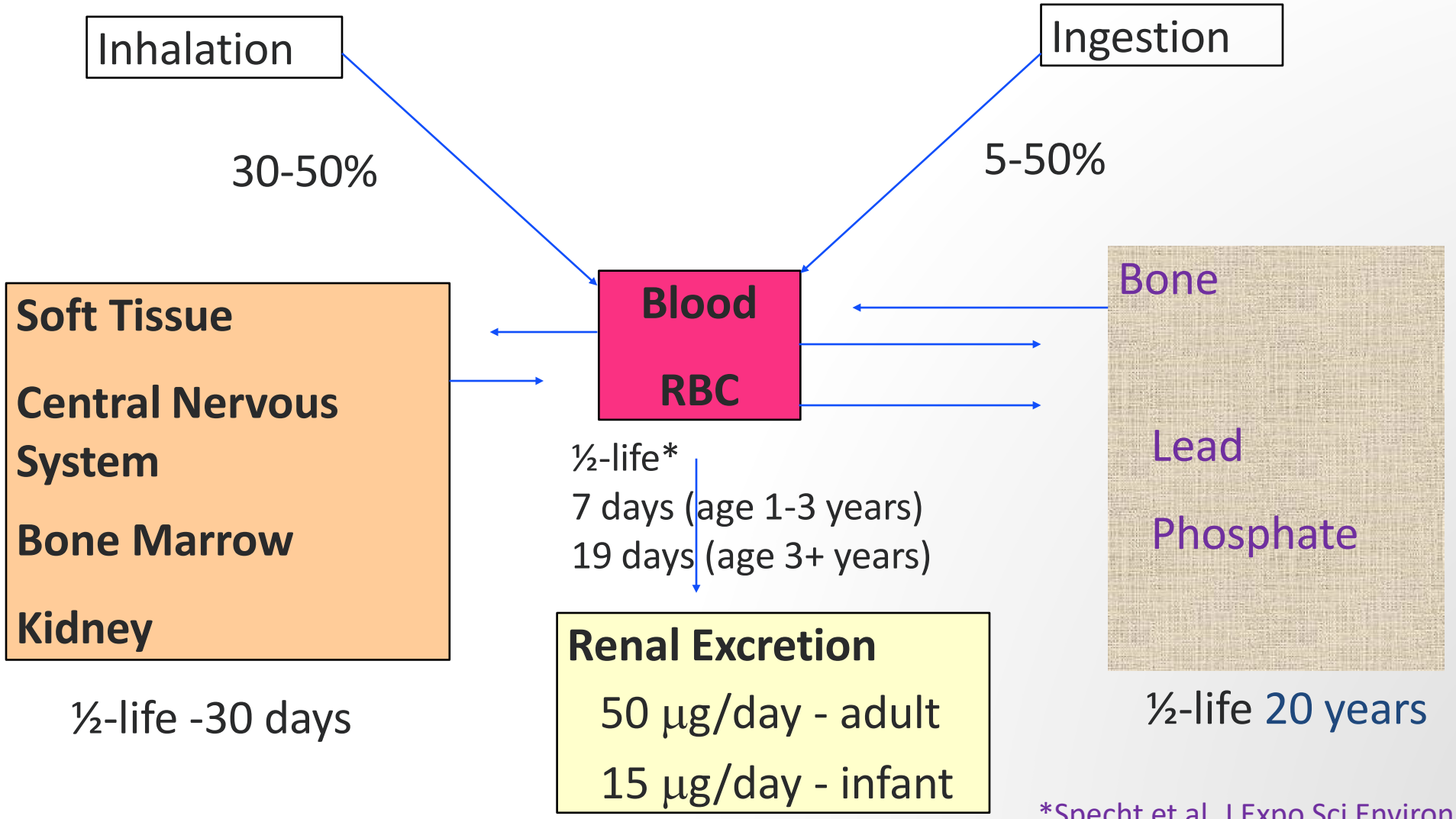


https://www.lbphd.org/lead



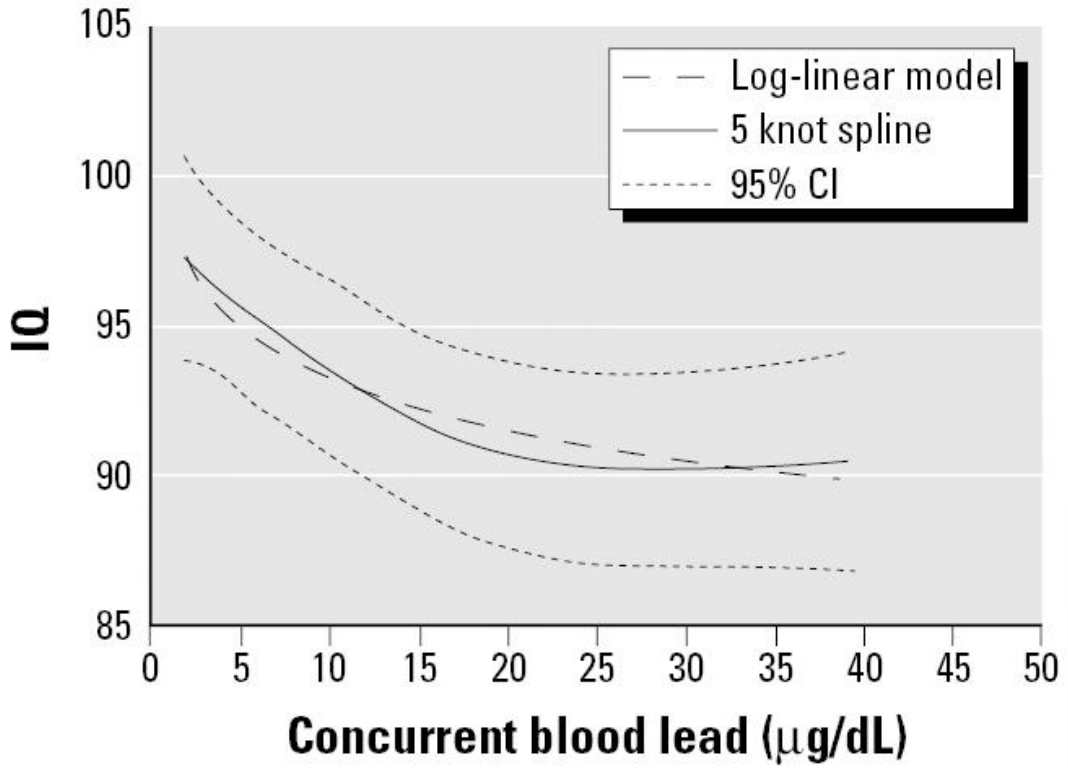
https://www.vox.com/2016/2/19/10972256/the-visual-guide-to-lead-poisoning

Metabolism of Lead



*Specht et al. J Expo Sci Environ Epidemiol 2018

Effects of Blood Lead Levels 2.5 to 30 μg/dL
Reduced IQ → decrease in intellectual and academic abilities



- Pooled analysis, 7 studies
  - N= 1,333
- Increase in lead:
  - from 2.4 to 10 μg/dL →
    - ↓ **3.9** IQ points (95% CI, 2.4-5.3)
  - from 10 to 20 μg/dL →
    - ↓ **1.9** (95% CI, 1.2-2.6)
  - from 20 to 30 μg/dL →
    - ↓ **1.1** (95% CI, 0.7-1.5)

Source: Lanphear et al, *Environ Health Perspect.* 2005 July; 113(7): 894–899.

Lead and ADHD

Boston birth cohort:

- Full sample 3098 (13% ADHD)
- Analytic sample **N=1479**
- Follow-up 8-10 yrs
- 69% black; 16% Hispanic; 8% white; 7% other

Diagnoses:

- 80% no neurodevelopmental dx
- 20% ADHD dx in medical record
  - 11% girls
  - 30% boys

- Blood lead (age 1-4 yrs)
  - 8.9% lead 5-10 µg/dL
  - **91.1%** lead <5 µg/dL

- Model adjusted for:
  - Child Factors: birthweight, preterm birth, mode of delivery, intrauterine infection
  - Maternal factors: smoking during pregnancy, education level, age at delivery, race/ethnicity, parity

Lead effects within child's sex

- Boys (lead 5-10 µg/dL versus <5 µg/dL)
  - **2.5 times** more likely to have ADHD
- Girls – lead level group not significant

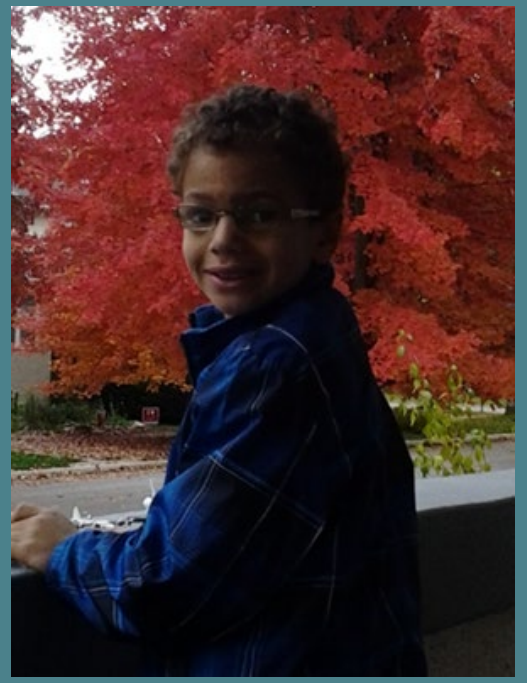
Source: Ji et al, J Pediatric 2018

National Toxicology Program

At blood lead levels < 5µg/dl:

Sufficient evidence for:

- *Attention-related problems*
- *Greater incidence of problem behaviors*
- *Decreased cognitive performance*



National Toxicology Program Monograph on Health Effects of Low-Level Lead 2012

Moving to Lead Level of 3.5

- **1991 -** CDC adopted “level of concern” of **10** µg/dL
- **2012** - CDC concluded that there is no safe level of lead exposure and adopted the use of a “reference value” of **5** µg/dL
- **2021** – CDC issues new “reference value” of **3.5** µg/dL

Lead Poisoning Prevention: Public Health & Policy

Heidi Beidinger-Burnett PhD MPH

University of Notre Dame

June 2023

UNIVERSITY OF NOTRE DAME

LIT ND LEAD INNOVATION TEAM

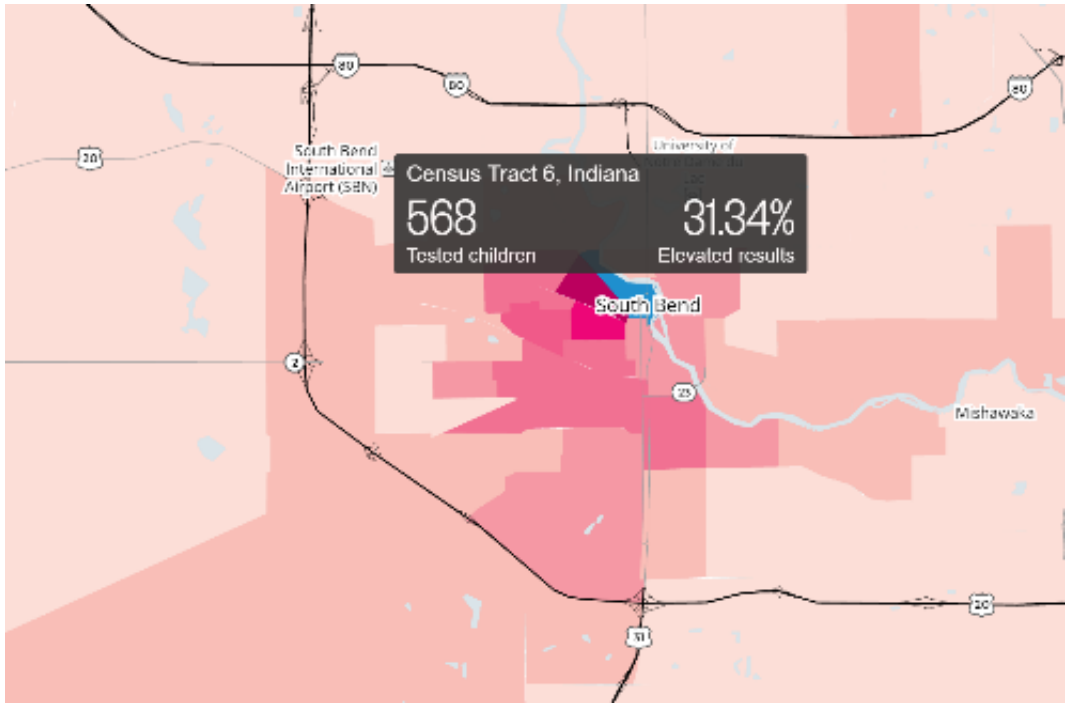
HIGH 37, LOW 23 A11 B1 $2.00

SOUTH BEND'S STUBBORN LEAD PROBLEM

By Ted Booker | South Bend Tribune

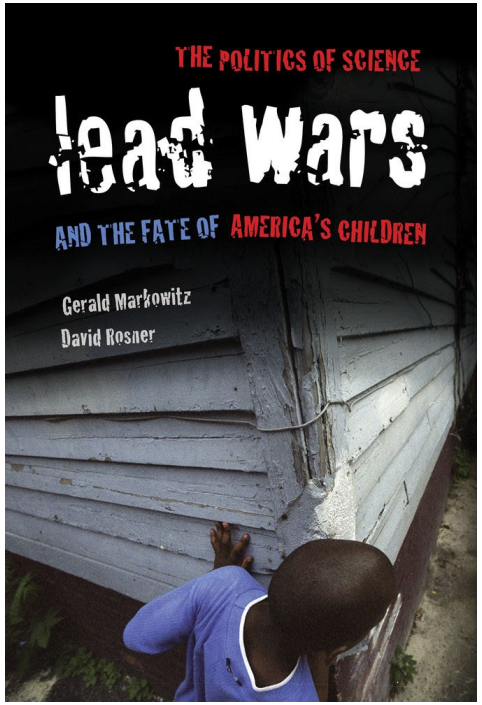
Several Community Meetings – 2017

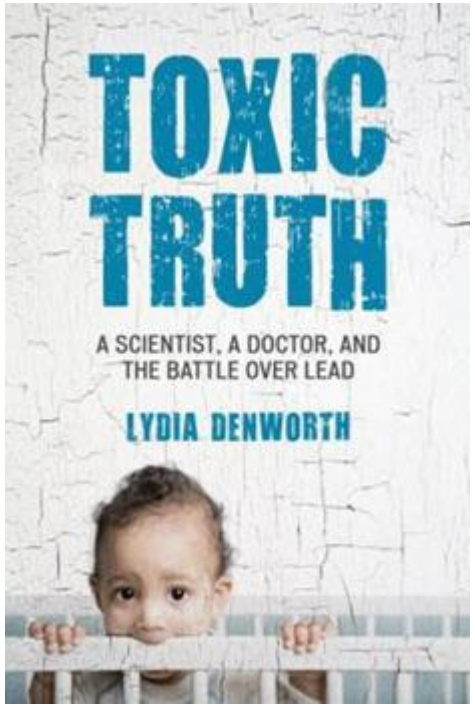
The Poisoning of Children: Lead



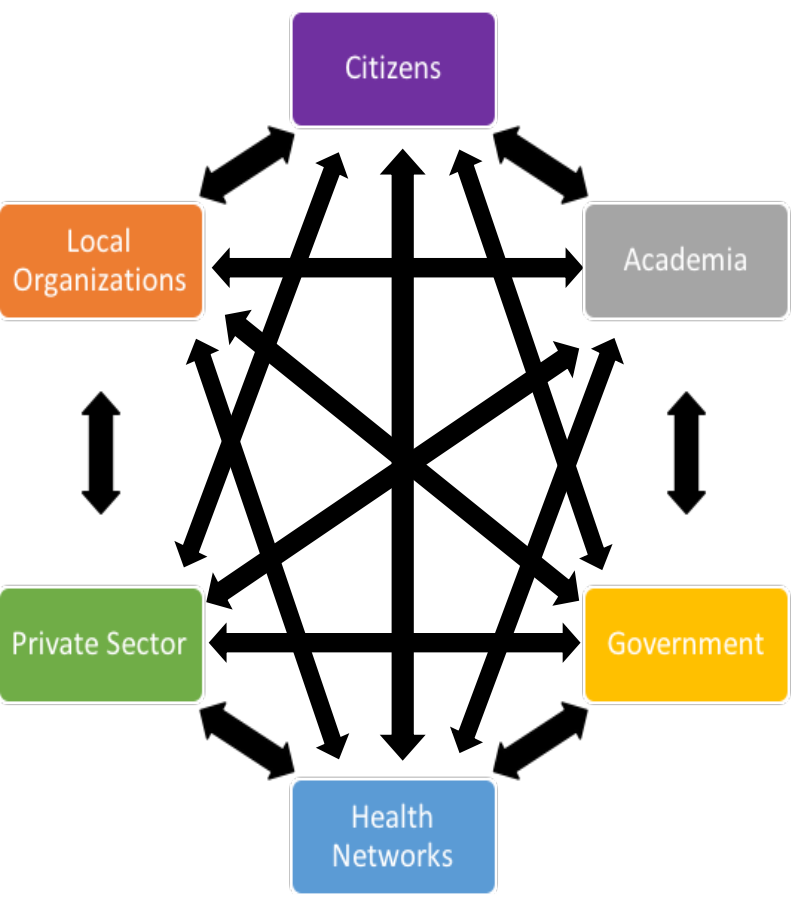
First publication (JAMA) of lead paint poisoning death of child in US: **1914**

Lead paint banned in US: **1978**





Lead Affinity Group
(est. 2017)



Six Prong Approach to Lead Prevention: UNICEF & WHO

- Monitoring and Reporting Systems
- Prevention and Control Measures
- Management, Treatment, and Remediation
- Legislation and Policy
- Global and Regional Action
- Public Awareness and Behavioral Change

Local Policy Changes – Lead Prevention

- St. Joseph County Department of Health
  - Development of strategic plans including lead poisoning prevention (2017 and 2020)
  - Hired ten full-time Community Health Workers (Fall 2020; Summer 2021)
  - Expanded case management of lead poisoned children
  - Eliminated backlog of lead risk assessment requests and mandates
  - Hired Community Health Workers to conduct lead case management & monitoring (2021)
- Near Northwest Neighborhood
  - Hired three part-time Community Health Workers (Fall 2018)
  - Hosts and facilitates Lead Affinity Group (on-going)
- City of South Bend
  - Grants to fund remediation and abatement (Fall 2019)
  - RSVP Ordinance (Feb 2019; with major revision April 2023)
- South Bend School Corporation
  - Policy: lead testing required as part of Kindergarten entrance requirements (Feb 2020)
- ND LIT
  - HUD grant to expand and scale Lead Screening Kit (Jan 2021)

State Policy Changes – Lead Prevention

- Indiana State Department of Health
  - Out of compliance with CDC's **case management guidance** for over 10 years
  - Very low rates of **childhood blood lead testing;** varied from 10-30% each year (2012-2021)
  - All children enrolled in Medicaid are required to receive lead testing at 12 and 24 months of age or as soon as possible between 24 and 72 months of age if they have not previously been tested; in 2021 only 32% were tested

Statewide Lead Coalition – Advocacy and Policy Work

* Hoosier Environmental Council
* Lawmakers
* Health Departments
* Academics/Researchers
* Minority Health Coalition

It is so important to know your child's lead level early because early detection gives families the ability to STOP exposure to the lead and lessen the effects of lead poisoning

Two NEW laws in Indiana to improve lead poisoning prevention (2022):

1. Expand case management for children who have a blood lead level of >=3.5ug/dL
2. Increase lead testing which requires all healthcare providers serving children to offer lead testing to their one- and two-year checkups

ND Lead Innovation Team

- Community engagement and education
- Low-cost screening kit:
- Results direct to residents
- Scalable