

NEUROPSYCHIATRIC EFFECTS OF CHILDHOOD LEAD POISONING

Diana Felton MD

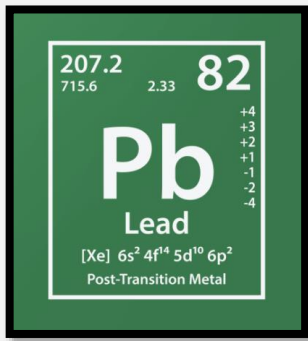
DOH Toxicologist

April 7, 2020

BH ECHO

OUTLINE

- Childhood Lead Poisoning Background
- Numbers
- Health Effects
- Neuropsychiatric Sequelae
- What can you do?



CHILDHOOD LEAD POISONING

- Lead: no biological role in the body
- Even low levels of lead are associated with adverse effects in infants and children
- 2012 CDC lowered reference value blood lead level (BLL) to 5 mcg/dL
- Remains a public health concern because of persistent lead hazards in the environment



LEAD SOURCES

Past: Lead-based Paint, Leaded Gasoline

- **Lead dust** - deteriorated lead-based paint, contaminated soil
- Take-home lead from parent's occupation or hobby: pipework, shipyard, stained glass, etc
- Fishing weights and home smelting
- (Drinking water)





OTHER SOURCES

- Jewelry and antique toys
- Imported cookware: ceramic dishes from China, pottery from Mexico
- Foreign cosmetics (kohl, sindoor, kajal, surma)
- Imported Southeast Asian Spices (turmeric)
- Dietary supplements
- Ayurvedic medications
- Religious powders and objects
- Firearms marksmanship



LEAD – IS IT STILL A PROBLEM?

- 2017: Estimated 500,000 American children under 6 have BLL >4.9 mcg/dL
- Higher burden for certain populations
- Each lead-exposed child is estimated to incur an average of \$5600 in medical and special-education costs
- Cognitive impairments related to lead are estimated to cost \$50.9 billion annually in lost productivity



HAWAII CHILDHOOD LEAD POISONING PREVENTION PROGRAM (HI-CLPPP)

- Refunded in October 2017 in a three year collaborative agreement with the Centers for Disease Control and Prevention (CDC)
 - Unfunded since 2003
- Housed in the Hawaii Department of Health (DOH)
 - Children with Special Health Needs Branch (CSHNB)
 - Hazard Evaluation and Emergency Response Office (HEER)
- Works closely with the Public Health Nursing Branch (PHNB) and Lead-Based Paint Program in the Indoor and Radiological Health Branch (IRHB)



Strategy 1: Strengthen Blood Lead Level Testing

Update blood lead testing and follow-up guidelines for health care providers

Increase blood lead testing of children under age 6 years



Strategy 2: Improve Follow-up for Lead-Exposed Children

Provide technical support and subject matter expertise

Connect lead-exposed children to needed services



Strategy 3: Strengthen Population-Based Interventions

Develop educational materials, conduct trainings and research

Statewide outreach, education, and prevention

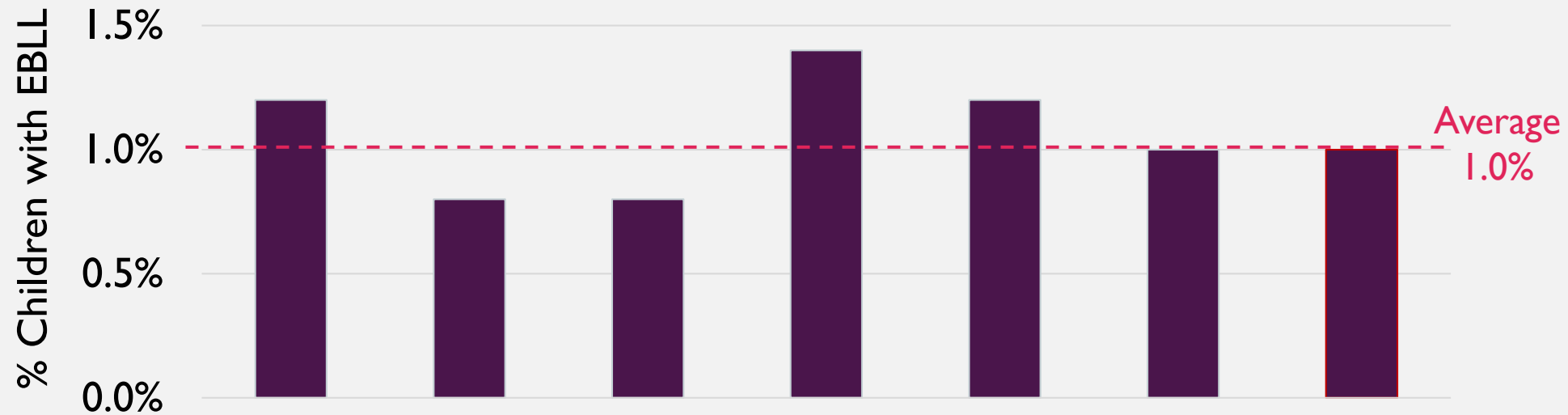


Strategy 4: Strengthen Surveillance

Develop and implement a Maven lead surveillance data system

Analyze and report surveillance data

PERCENT OF TESTED CHILDREN IN HAWAII UNDER AGE 6 YEARS WITH ELEVATED BLOOD LEAD LEVELS (EBLL \geq 5 MCG/DL), BY YEAR



	2013	2014	2015	2016	2017	2018	2019
Total # tested children with EBLL	93	91	139	234	195	160	182
Total # tested children	7,513	11,862	17,525	16,073	15,750	16,539	17,664
% tested children with EBLL	1.2%	0.8%	0.8%	1.4%	1.2%	1.0%	1.0%

HEALTH EFFECTS
- LEAD -
CHRONIC

Often asymptomatic

Neurotoxin – “no safe level”

Problems with learning, school performance, IQ, attention, behavior

Decreased hearing, delayed puberty

Anemia if severe

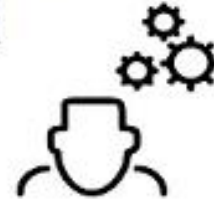
May not be aware unless they are tested

Neurocognitive effects

Decreased Academic Achievement



Decreased IQ



Decreased performance on specific developmental measures

e.g attention, executive functioning, language, learning, memory, visual-spatial skills

Impaired:

- Speech & hearing functions
- Fine & gross motor skills



Increased incidence of ADHD & behavioral disorders



Decreased reading readiness at the start of kindergarten & increased reading disability

Decreased brain volumes



Increased cognitive decline later in life



DEVELOPMENTAL DELAYS

- Deficits in **abstract thinking, attention, executive functioning, conceptual reasoning, visuospatial perception, social behavior, gross and fine motor skills, and speech and language**
- Poor school assessment scores (even in students with BLLs between 5 $\mu\text{g}/\text{dL}$ and 9 $\mu\text{g}/\text{dL}$ and when controlling for other predictors of school performance)
 - 13% of reading failure
 - 14.8% of mathematical failure

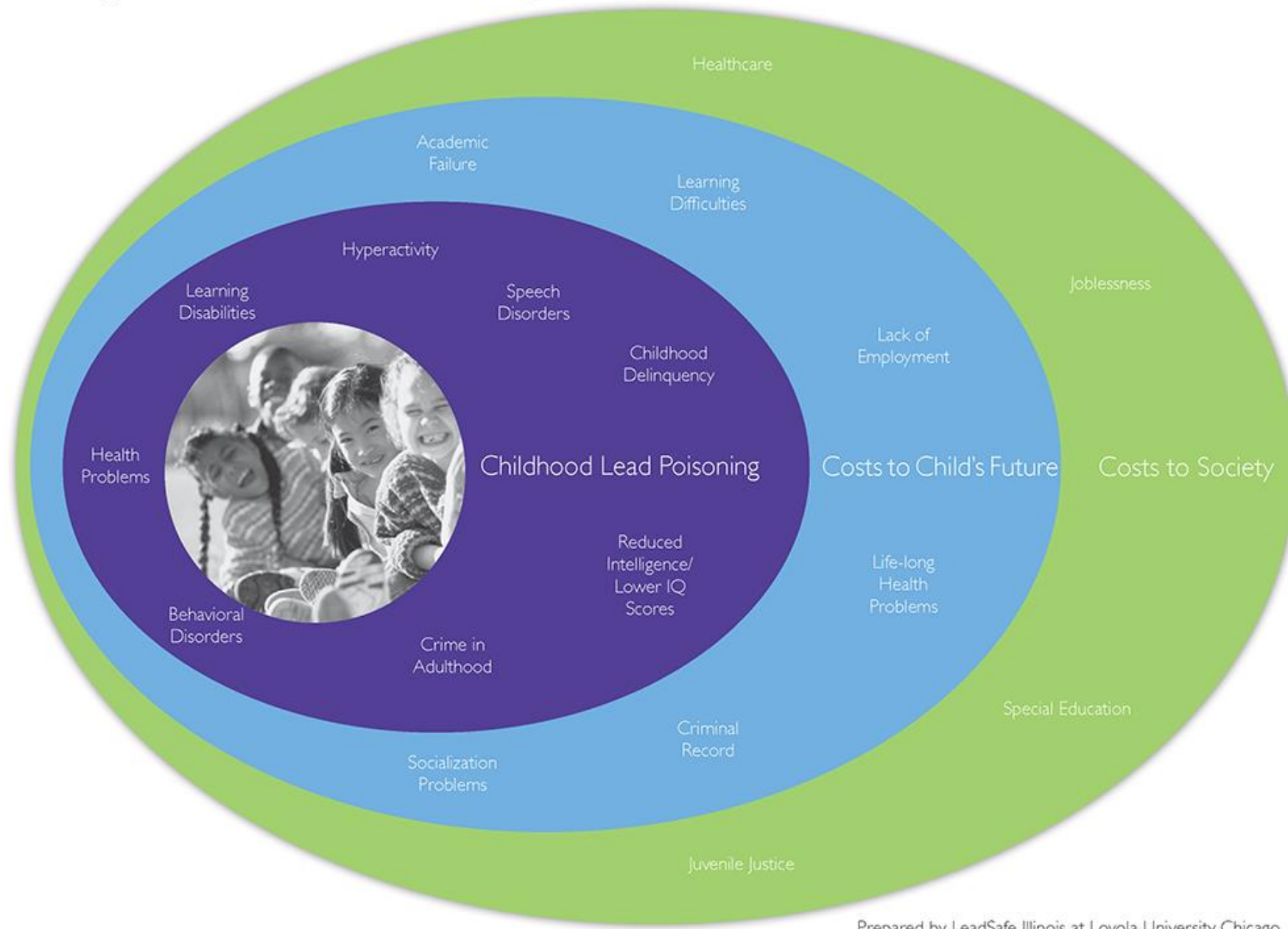
- Evens, A., et al (2015). The impact of low-level lead toxicity on school performance among children in the Chicago Public Schools: A population-based retrospective cohort study. Environmental Health
- US Office of Special Education Programs Topical Issue brief Intervention IDEAS for Infants, Toddlers, Children, and Youth Impacted by Lead Exposure 2016

Table 1. Studies on Lead and Educational Outcomes

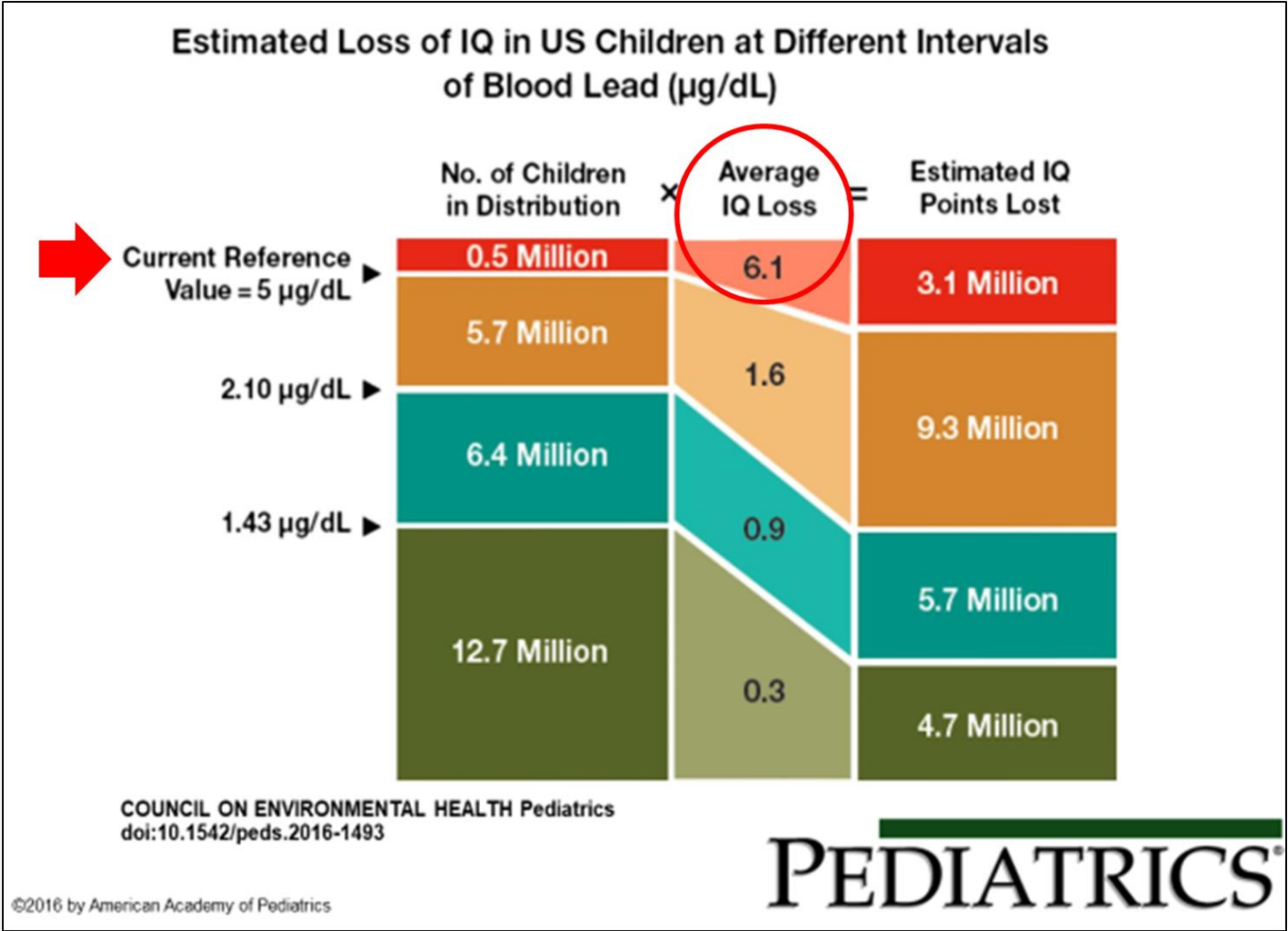
Blood Lead Levels	Educational Impact	Size of Study	Location of Study
≤ 3 µg/dL	Decreased end of grade test scores	More than 57,000 children	North Carolina (Miranda et al. 2009) ¹
4 µg/dL at 3 years of age	Increased likelihood learning disabled classification in elementary school	More than 57,000 children	North Carolina (Miranda et al. 2009) ¹
	Poorer performance on tests	35,000 children	Connecticut (Miranda et al. 2011)
5 µg/dL	30% more likely to fail third grade reading and math tests	More than 48,000 children	Chicago (Evens et al. unpublished data)
	More likely to be non-proficient in math, science, and reading	21,000 children	Detroit (Zhang et al. 2013)
5-9 µg/dL	Scored 4.5 points lower on reading readiness tests	3,406 children	Rhode Island (McLaine et al. 2013)
≥10 µg/dL	Scored 10.1 points lower on reading readiness tests	3,406 children	Rhode Island (McLaine et al. 2013)
10 and 19 µg/dL	Significantly lower academic performance test scores in 4th grade	More than 3,000 children	Milwaukee (Amato et al. 2012)
≥ 25 µg/dL	\$0.5 million in excess annual special education and juvenile justice costs	279 children	Mahoning County, Ohio (Stefanak et al. 2005)

Educational Interventions for Children Affected by Lead, CDC National Center for Environmental Health, April 2015

The Ripple Effects of Childhood Lead Poisoning



AVERAGE IQ LOSS



DOES
CHILDHOOD
LEAD POISONING
INCREASE RISK OF
MENTAL HEALTH
PROBLEMS AS AN
ADULT?



No clear answer



How do cognitive, behavioral
and other effects affect the
burden of psychiatric disease?

PSYCHIATRIC SEQUELAE OF CHILDHOOD LEAD POISONING

- Each 5- $\mu\text{g}/\text{dL}$ increase in childhood blood lead level was associated with a 1.34-point increase in general psychopathology, driven by internalizing and thought disorder symptoms.



JAMA Psychiatry

[View Article](#) ▶

[JAMA Psychiatry](#). 2019 Apr; 76(4): 418–425.

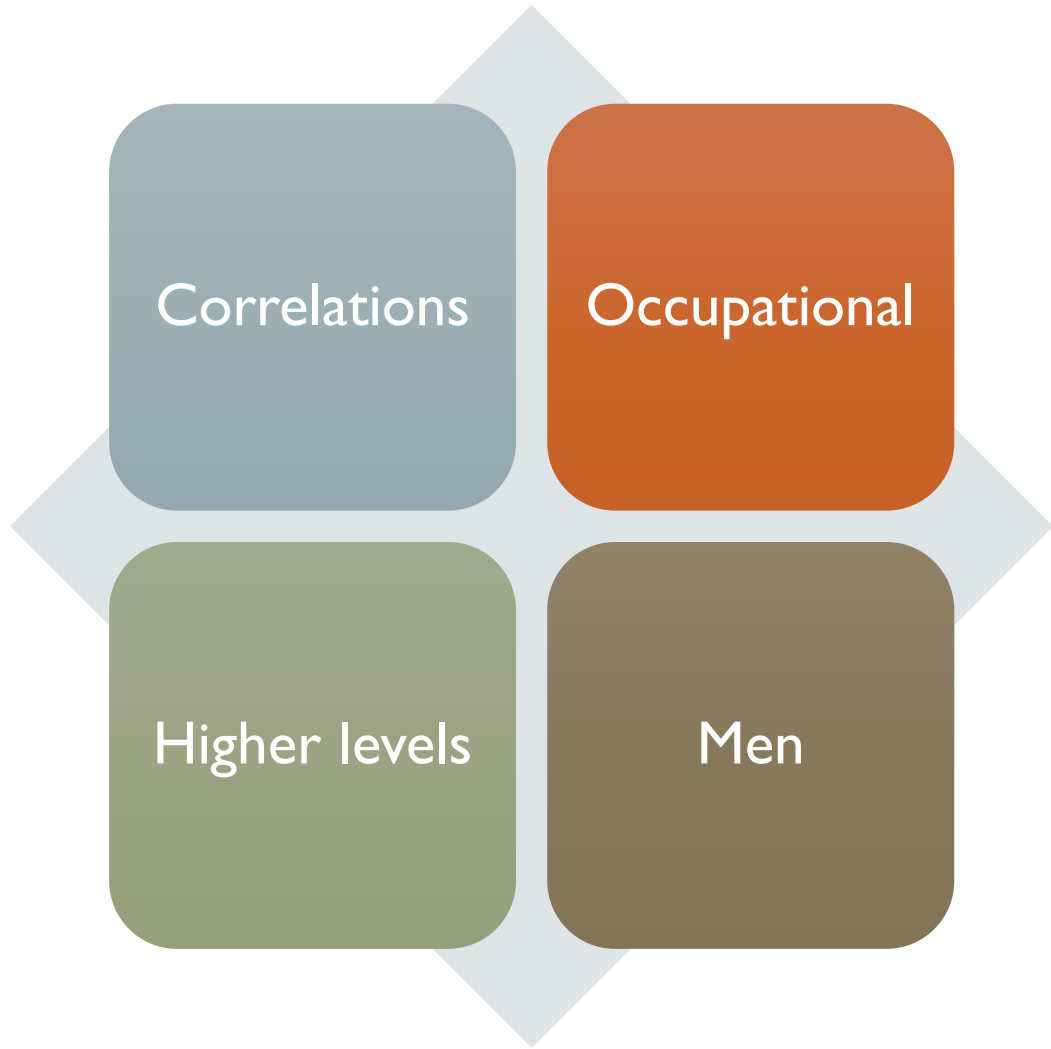
PMCID: PMC6450277

Published online 2019 Jan 23. doi: [10.1001/jamapsychiatry.2018.4192](https://doi.org/10.1001/jamapsychiatry.2018.4192)

PMID: [30673063](https://pubmed.ncbi.nlm.nih.gov/30673063/)

Association of Childhood Lead Exposure With Adult Personality Traits and Lifelong Mental Health

[Aaron Reuben](#), MEM,¹ [Jonathan D. Schaefer](#), MA,¹ [Terrie E. Moffitt](#), PhD,^{1,2,3,4} [Jonathan Broadbent](#), PhD,⁵ [Honalee Harrington](#), BA,¹ [Renate M. Houts](#), PhD,¹ [Sandhya Ramrakha](#), PhD,⁶ [Richie Poulton](#), PhD,⁶ and [Avshalom Caspi](#), PhD^{1,2,3,4}



WHAT ABOUT
ADULTS EXPOSED
TO LEAD?

[Arch Gen Psychiatry. 2009 Dec; 66\(12\): 1313–1319.](#)

PMID: [19996036](#)

doi: [10.1001/archgenpsychiatry.2009.164](#)

Blood lead levels and major depressive disorder, panic disorder, and generalized anxiety disorder in U.S. young adults

[Maryse Bouchard](#), PhD, MSc, [David C. Bellinger](#), PhD, MSc, [Jennifer Weuve](#), MPH, ScD, [Julia Matthews-Bellinger](#), PhD, MD, [Stephen E. Gilman](#), ScD, [Robert O. Wright](#), MD MPH, [Joel Schwartz](#), PhD, and [Marc G. Weisskopf](#), PhD

[J Occup Environ Med. 2003 Nov;45\(11\):1144-51.](#)

Relationship of bone and blood lead levels to psychiatric symptoms: the normative aging study.

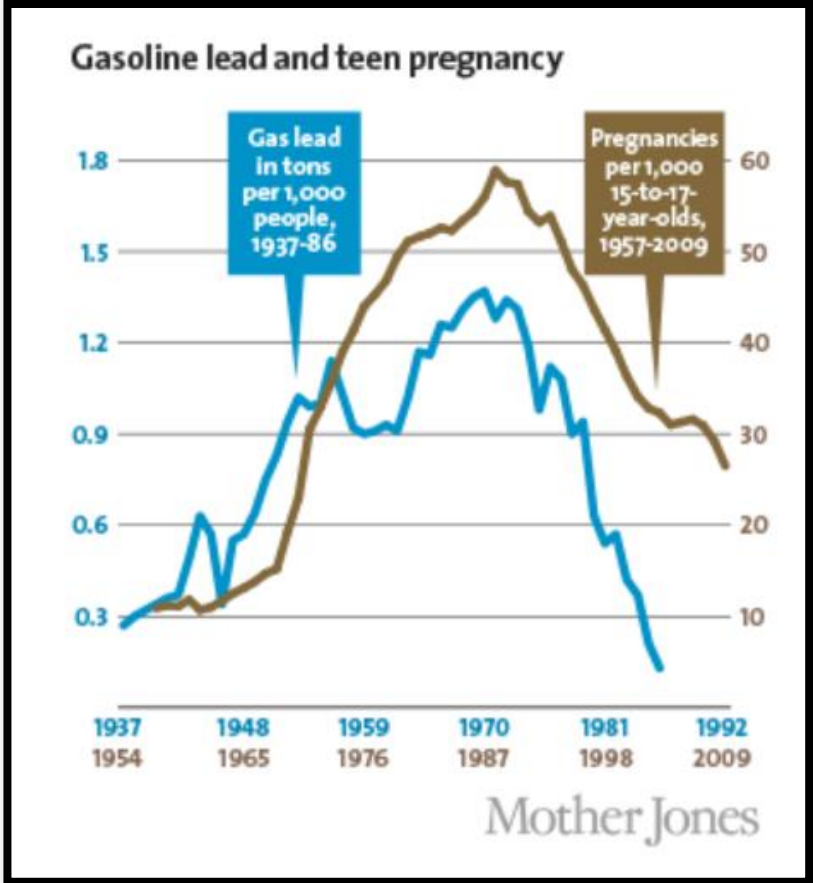
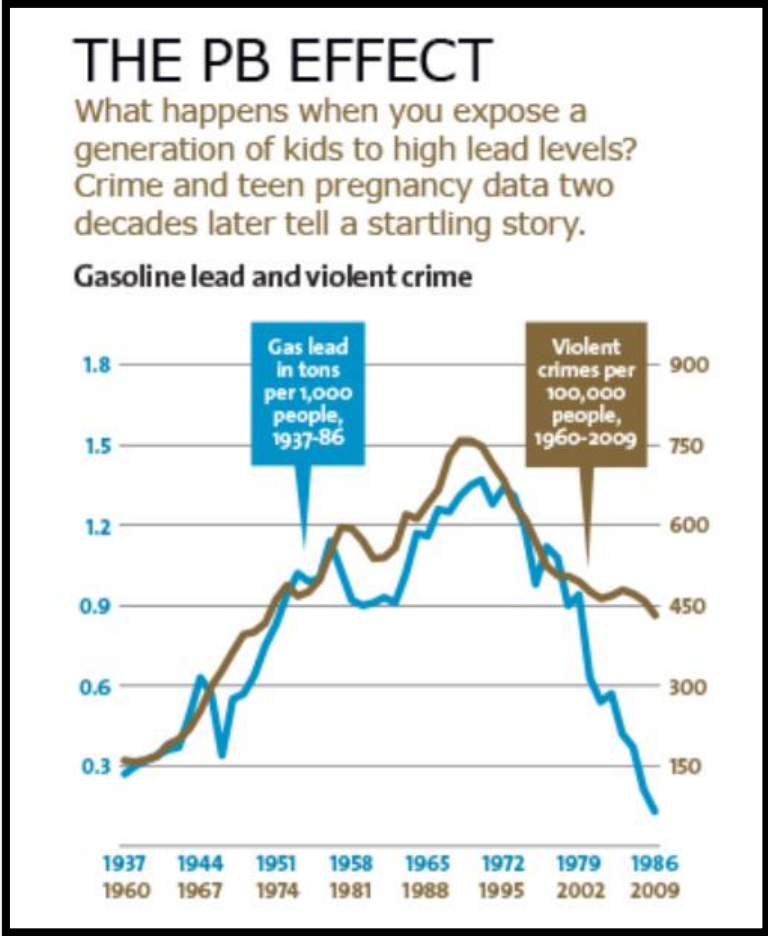
[Rhodes D](#)¹, [Spiro A 3rd](#), [Aro A](#), [Hu H](#).

Lead: America's real criminal element

www.motherjones.com/environment/2016/02/lead-exposure-gasoline-crime-increase-children-health/

Graphs: Rick Nevin

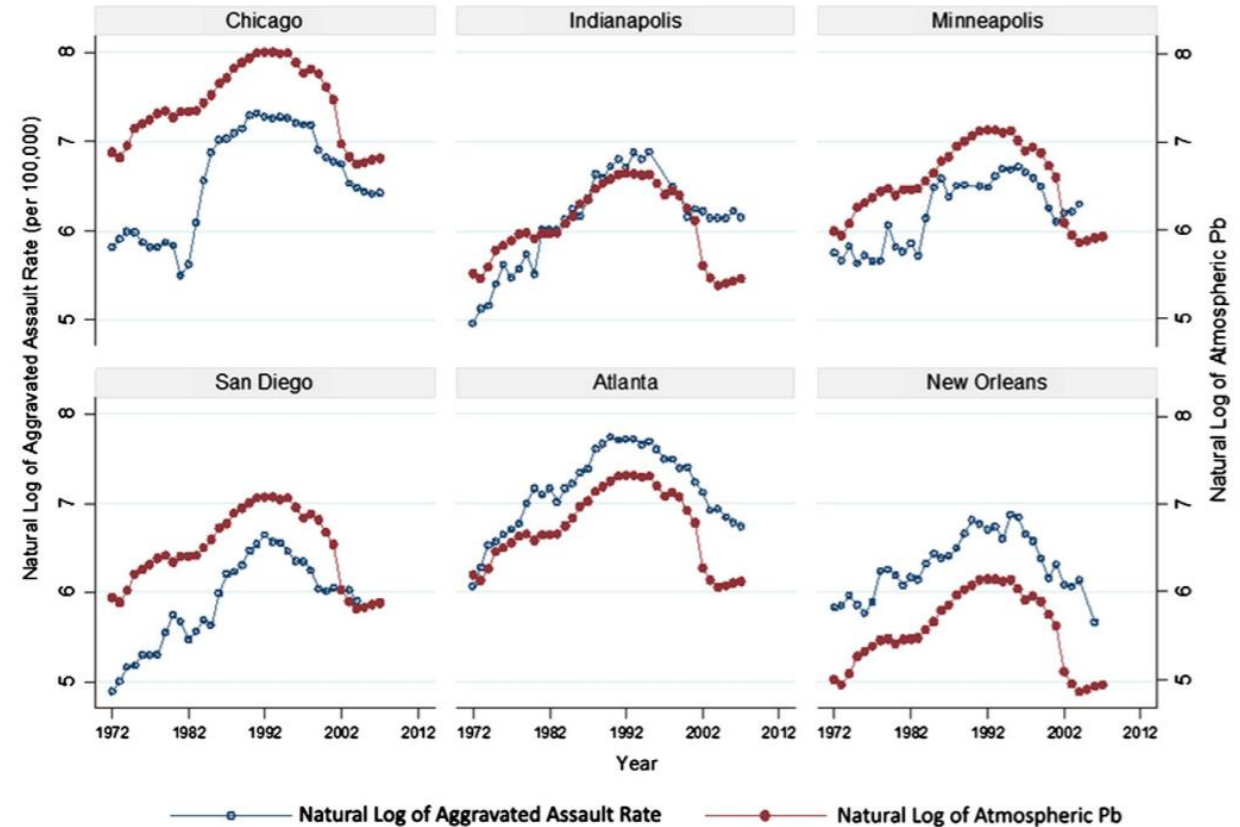
FROM MOTHER JONES 2016



Mother Jones

VIOLENCE

- From Mielke and Zahran The urban rise and fall of air lead (Pb) and the latent surge and retreat of societal violence. Environment International. 2012



WHAT CAN BE
DONE?

KIDS

- Attentive Home Environment
- Educational Interventions aimed at improving learning and developmental outcomes
- Pre-school/Head Start
- Child Find, IDEA Part B or Part C
- From the AAP:

BLL \geq 5 $\mu\text{g}/\text{dL}$ before age 6 years: annual developmental surveillance and screening at 3, 4 and 5

American Academy
of Pediatrics



DEDICATED TO THE HEALTH OF ALL CHILDREN®

WHAT CAN BE
DONE?

ADULTS

American Economic Journal: Applied Economics 2018, 10(3): 315–344
<https://doi.org/10.1257/app.20160056>

Life after Lead: Effects of Early Interventions for Children
Exposed to Lead[†]

By STEPHEN B. BILLINGS AND KEVIN T. SCHNEPEL*

“Well coordinated, multi-faceted support services have been shown to improve functional outcomes for adults with a history of childhood lead poisoning.”

WHAT CAN YOU DO?



Be aware and informed of effects of lead poisoning and related benefits of early intervention and educational resources



Be aware of sources of lead and suggest lead testing if client has a potential source



Use HI-CLPPP resources as needed



Refer families to HI-CLPPP for assistance

THANK YOU



<http://lead.hawaii.gov>

Diana Felton, MD
DOH Toxicologist
diana.felton@doh.hawaii.gov
808-586-0963