The Long Shadow of Lead:
How Early Exposure Shapes Behavior and Community Violence

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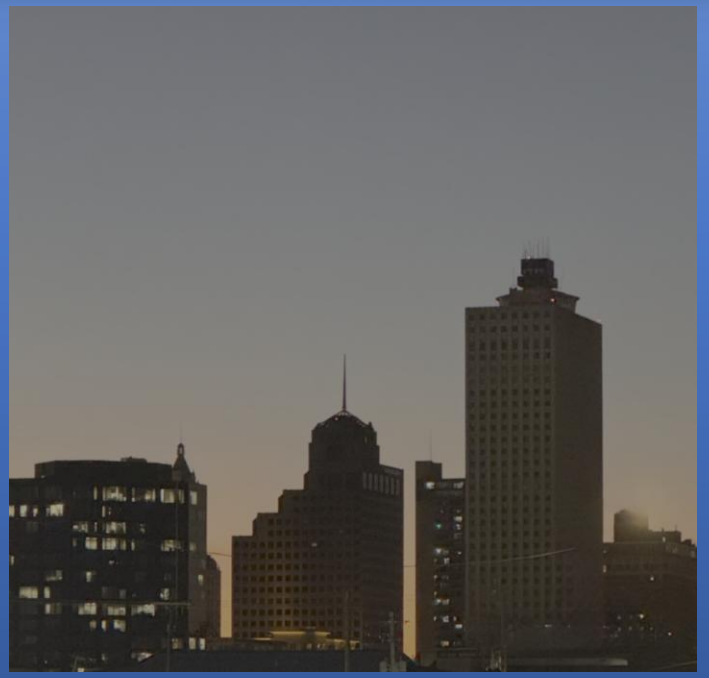

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Agenda

- Reframing Violence: A Pediatric & Environmental Lens
- Lead Exposure: What Still Matters in 2026
- Brain Development & Behavioral Regulation
- The Evidence: Lead and Violence
- Memphis: Place, Risk, and Inequity
- Prevention as Public Safety
- What We Do Next

Lead: The Thesis

- Lead is not the sole cause of violence but can act as a **silent accelerator** that **creates a biological predisposition towards aggression**
- Lead mitigation may be one of the **most cost-effective** long-term public safety strategies
  - We must start early
- **If we want a safer Memphis in 2045, we must address its toxic legacy in 2026**

Lead: Framing Structural Inequity

- **Not Random**
  - Lead risk maps closely onto maps of historical disinvestment and neglected infrastructure
- Environmental Racism
  - Communities of color bear a disproportionate burden of legacy lead exposure
  - Housing “choice” for many is limited to areas with **high neurotoxic risk**
- Health Equity
  - Environmental justice is a prerequisite for neighborhood safety

Why This Topic Belongs in Our Discussion

- Lead exposure is a pediatric problem with lifelong and community-wide consequences
- Violence is often framed through criminal justice or policing lenses
  - But it can also be framed as **preventable early brain injury**
- Childhood lead poisoning is a public health, education, and public safety issue
- "**Child lead poisoning is a pandemic-** essentially the largest mass poisoning in history…and is still expanding."

Kanarak MS. Lead Contamination in Milwaukee Schools- the latest episode in an ongoing toxic pandemic. *N Engl J Med*. 2025;393:524-526.

Key Framing

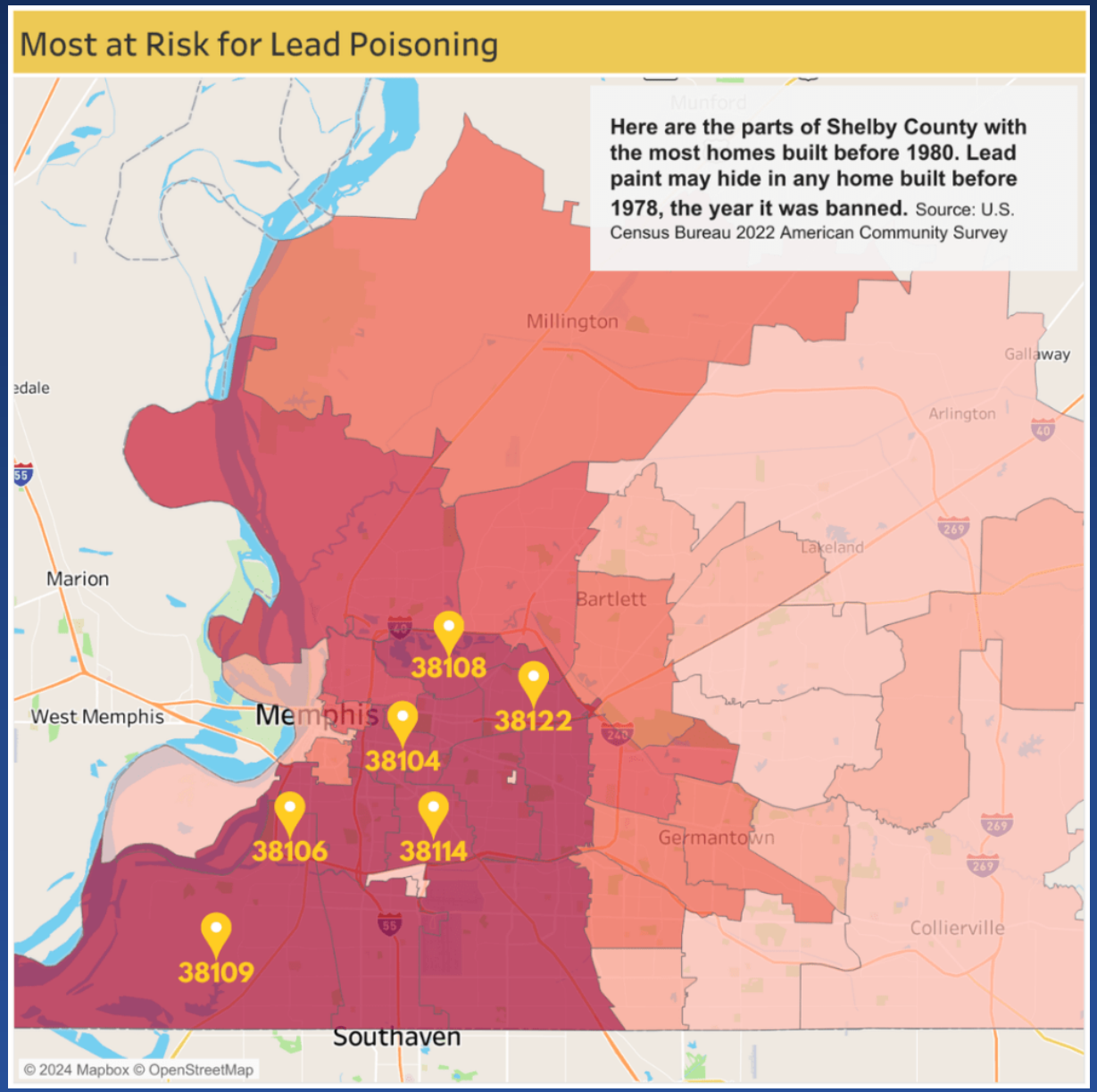
- This story is not deterministic or stigmatizing
- This is about:
  - Risk
  - Probability
  - Population-level effects
  - Prevention
- Lead exposure reflects structural and environmental inequities, not individual failure

Lead Exposure is Still a Problem

- Childhood lead exposure has fallen dramatically since the 70s
- **But it has not disappeared**
- Many children are still exposed through
  - Older housing
  - Contaminated dust and soil
  - Water infrastructure
  - Industrial and environmental sources
- The burden is unequally distributed
- Lead burden overlaps with:
  - Older housing
  - Disinvestment
  - Under-screening
  - Poor education outcomes
  - Community violence

The Memphis Landscape

- Housing Risk
  - Over **208,000 homes** in Shelby County were built before the 1978 lead paint ban
  - Weak local housing code enforcement for lead-based paint violations
  - City and county remediation programs face challenges in landlord engagement
  - Not enough contractors have EPA certification
- Regional Concentration
  - **11 of the top 20 high risk ZIP codes in TN are located in Memphis**
  - High density areas of North and South Memphis are primary areas of concern
  - Manufacturing and logistics hubs
- Systemic Failures
  - Lead poisoning is a failure of policy, not a failure of individual caregiving
- Resource Gaps
  - Communities with the highest rates of violence often have high rates of lead poisoning and low rates of lead testing



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Why Pediatricians? Why Healthcare Leaders?

- Lead is an Early Warning System
- Pediatricians see the poisoning **20 years** before the arrest
- Pediatric care can integrate:
  - Screening
  - Environmental history
  - Developmental follow-up
- Clinicians can advocate for safer housing and infrastructure
- Pediatricians are trusted messengers

Lead: Human Exposure

- The **Paint** Legacy
  - Microscopic dust from deteriorating pre-1978 paint is the #1 modern risk.
  - Homes and schools: 2/3 of MSCS schools are pre-1978 (35 have pre-K and K).
- The **Soil** Reservoir
  - Residual lead from gasoline that never biodegraded and remains in urban dirt.
- The **Water** Infrastructure
  - Aging lead service lines (LSLs) connecting older Memphis homes to the water main.
- Inhalation & Ingestion
  - Dust from home renovations can poison a child in days.

Lanphear B, Navas-Acien A, Bellinger DC. Lead Poisoning. N Engl J Med. 2024 Oct 31;391(17):1621-1631. doi: 10.1056/NEJMra2402527. PMID: 39476342.

Other Sources We Can't Ignore

- Lead Exposure Is Not Just Paint and Pipes
  - Food and spices: contaminated cinnamon, turmeric, and some **imported foods** have caused pediatric lead poisoning
  - Cosmetics and remedies: products such as kohl, sindoor, azarcon/greta, and some imported powders can contain lead
  - Consumer products: imported pottery, cookware, **toys**, jewelry, and folk remedies remain important sources
  - Recent example: the **cinnamon applesauce pouch** outbreak showed that children can present with elevated lead levels **even when no housing source is found**
- Bottom line:
  - If the home investigation is negative, keep asking what the child is eating, using, wearing, or taking

Lead: The Progress Paradox

- The Success
  - U.S. blood lead levels have dropped by over 95% since the 1970s.
- The Danger
  - **Even these "lower" modern levels are 10–100x higher than pre-industrial human baselines.**
- The Complacency Trap
  - Many think the problem is "solved," yet we are finding toxic levels in Memphis schools today.
  - **The problem is less visible, but not gone**
- The Residual 5%
  - The hardest-to-reach populations are now the ones most affected.

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The No Safe Level Era

- **There is no known safe level of lead for a child's brain**
- CDC lowered the blood lead reference value from 5.0 to 3.5 µg/dL in 2021
- The reference value is based on the 97.5th percentile of blood lead levels among U.S. children ages 1–5
- Children at or above 3.5 µg/dL represent the highest-exposure 2.5% of young children nationally
- **Children can appear asymptomatic and still be harmed**
- **The steepest losses in IQ and behavioral control may occur at the lowest measurable levels**

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Centers for Disease Control and Prevention. CDC Updates Blood Lead Reference Value. Updated April 2, 2024.

Biology of Ingestion

- Why Young Children Are So Vulnerable
  - Hand-to-mouth behavior
  - Higher GI absorption
  - More permeable blood-brain barrier
  - Rapid brain development
  - Bone storage, recirculation
  - Iron and calcium deficiency (common) increase absorption
  - **Once lead induced damaged occurs it is largely irreversible**

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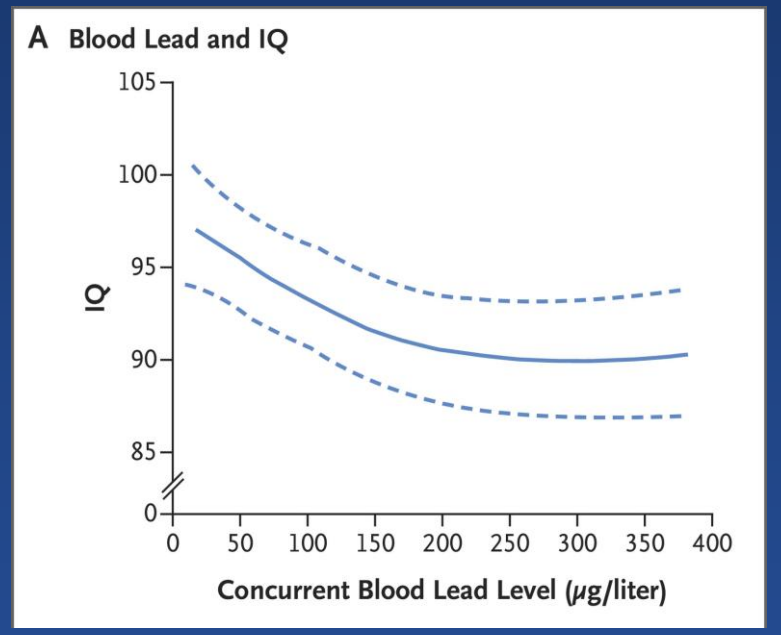
Lead: Clinical Risks

- Neurocognitive: **lower IQ**, learning problems, speech/language delay
- Behavioral: **ADHD symptoms**, irritability, poor regulation, **aggression**
- Physical: hypertension, kidney effects, delayed puberty
- Lead exposure can be misread as “behavior problems” or “bad parenting”



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When the Brain's Brakes Fail

- Self-Regulation
  - Executive function = planning, focus, self-monitoring
  - Inhibitory control = the brain's "stop signal"
- **Not a Choice**
  - Self-regulation is a developmental and biological capacity that must be built, not just a moral decision.
- The Crisis
  - Lead fundamentally sabotages this development by interfering with the systems that make self-regulation possible.

The Prefrontal Cortex

- The Brain's "Brakes”
  - The PFC is responsible for weighing consequences and empathy.
- Conflict Resolution
  - A healthy PFC allows a person to walk away from a provocation.
  - Helps with judgement, empathy and impulse control.
- Target Site
  - Lead specifically concentrates in the frontal regions of the brain.
  - Part of our brain and the most vulnerable to toxins.

Neurotoxic Impact

- Synaptic Pruning
  - Lead disrupts the healthy "cleaning" of brain connections.
- Gray Matter Loss
  - Lead exposure is directly linked to permanent thinning of the brain's frontal cortex.
- Wiring Errors
  - It creates "noisy" signaling, making it harder for the brain to process calm information in a crisis.
- Dopamine Disruption
  - Interfering with the reward system, making children more prone to risk-seeking.

Lead Leaves a Structural Signature

- Visual Proof
  - Higher childhood lead exposure was associated with reduced adult brain volume
- Frontal Vulnerability
  - Volume loss was especially notable in prefrontal regions involved in judgment, impulse control, and decision-making
- These findings came from MRI follow-up of adults with documented childhood lead exposure
- Why It Matters
  - **This is not just behavioral — it is structural**

Cecil KM, Brubaker CJ, Adler CM, et al. Decreased Brain Volume in Adults with Childhood Lead Exposure. PLoS Med. 2008;5(5):e112. doi:10.1371/journal.pmed.0050112.

How This Shows up in Childhood

- Attention problems
- Poor frustration tolerance
- Emotional reactivity
- School difficulty
- Externalizing behavior
- Social and behavioral struggles

The Behavioral Pathway

- Lead Exposure →Altered Neurodevelopment →Executive Dysfunction →Impulsive Aggression/Higher Behavioral Risk.
- **Early signs** may include tantrums, impulsivity, and poor frustration tolerance
- In **school**, this may appear as discipline problems, exclusion, or suspension
- Peer rejection and social isolation can worsen developmental trajectory
- What looks “behavioral” may reflect **earlier neurotoxic injury**

Lead and Adversity

- Lead is more toxic when layered onto:
  - Trauma
  - Chronic stress
  - Poverty
  - Housing instability
  - Poor nutrition
- Bottom line:
  - **Lead does not act alone — it acts as a threat multiplier.**

Important Nuance

- No Mono-Causal Link
  - Lead doesn't *force* a person to be violent
  - But it **lowers the "activation energy"** required for an outburst.
- Statistical Risk
  - It's about **increasing the *probability* of violence across a population**.
- The Agency Debate
  - Biology plays a role
  - But so do buffering supports: relationships, environment, etc.

Conceptual Model

- Biological Risk (Lead) + Environmental Stress (Poverty/Trauma) = Increased Behavioral Vulnerability.
- The Intervention Point
  - We can't fix poverty overnight, but **we *can* fix the paint and the pipes**.
- The "Protective Shield”
  - Cleaning the environment makes all other violence interventions (mentoring, therapy) more effective.

What Does the Evidence Show?

- Research has Linked Early Lead Exposure with Later:
  - Aggression
  - Conduct problems
  - Antisocial behavior
  - Delinquency
  - Arrest/Violent offenses
- Consistent Across Multiple Study Designs:
  - Ecological Studies
  - Longitudinal Cohorts
  - Biomarker Studies
  - Natural Experiments

Landmark Study 1: Reyes (2007)

- The Findings
  - **Estimated that the 1970s phase-out of leaded gasoline explains 56% of the drop in violent crime in the 1990s**.
- National Scale
  - Not just in one city; it was a nationwide statistical signal.
- **The Lag Effect**
  - Showing that crime fell *only after* the lead-poisoned generation aged out of their peak crime years.
  - U.S. lead exposure phased out in the 1970s
  - Violent crime declined in the 1990s.
  - **Environmental policies take two decades to show up in crime statistics.**

Reyes JW. Environmental Policy as Social Policy? The Impact of Childhood Lead Exposure on Crime. NBER Working Paper No. 13097. 2007.

Landmark Study #2: Needleman (2002)

- The Bone Lead Study
  - Analyzed lead levels in the bone of adjudicated delinquent youth.
- The Result
  - Delinquent teens had significantly higher lead burdens than their non-delinquent peers in the same city.
  - **Youth with higher bone lead levels were 4x more likely to be delinquent than controls.**
- The Authority: Dr. Herbert Needleman was a pioneer in pediatric lead research and a Nobel-nominated scientist.
  - **Helped shift the conversation from IQ alone to behavior and conduct**

Needleman HL, McFarland C, Ness RB, Fienberg SE, Tobin MJ. Bone lead levels in adjudicated delinquents. A case control study. Neurotoxicol Teratol. 2002 Nov-Dec;24(6):711-7. doi: 10.1016/s0892-0362(02)00269-6. PMID: 12460653.

Landmark Study #3: Wright (2008)

- Cincinnati Lead Study
  - Prospective longitudinal cohort following children with documented lead exposure
- Key Finding
  - **Higher childhood blood lead levels predicted increased odds of later criminal arrest, especially for violent and drug-related offenses**
- Why It Matters
  - This directly links pediatric exposure data to later criminal justice outcomes
- Takeaway
  - The lead–violence relationship is not just theoretical — it has been observed in real children followed over time

Wright JP, Dietrich KN, Ris MD, Hornung RW, Wessel SD, Lanphear BP, Ho M, Rae MN. Association of prenatal and childhood blood lead concentrations with criminal arrests in early adulthood. PLoS Med. 2008 May 27;5(5):e101. doi: 10.1371/journal.pmed.0050101. PMID: 18507497; PMCID: PMC2689664.

Additional Studies Reinforce the Signal

- Population-Level and Natural Experiment Data Show the Same Signal
- Nevin (2007): higher historical lead exposure tracked with higher later violent crime across cities and countries
- Feigenbaum & Muller: cities with lead pipes and acidic water had higher homicide rates about 20 years later
- Aizer & Currie: higher preschool lead levels were associated with more school suspension and juvenile justice involvement
- Billings & Schnepel: intervention after elevated lead reduced later antisocial outcomes

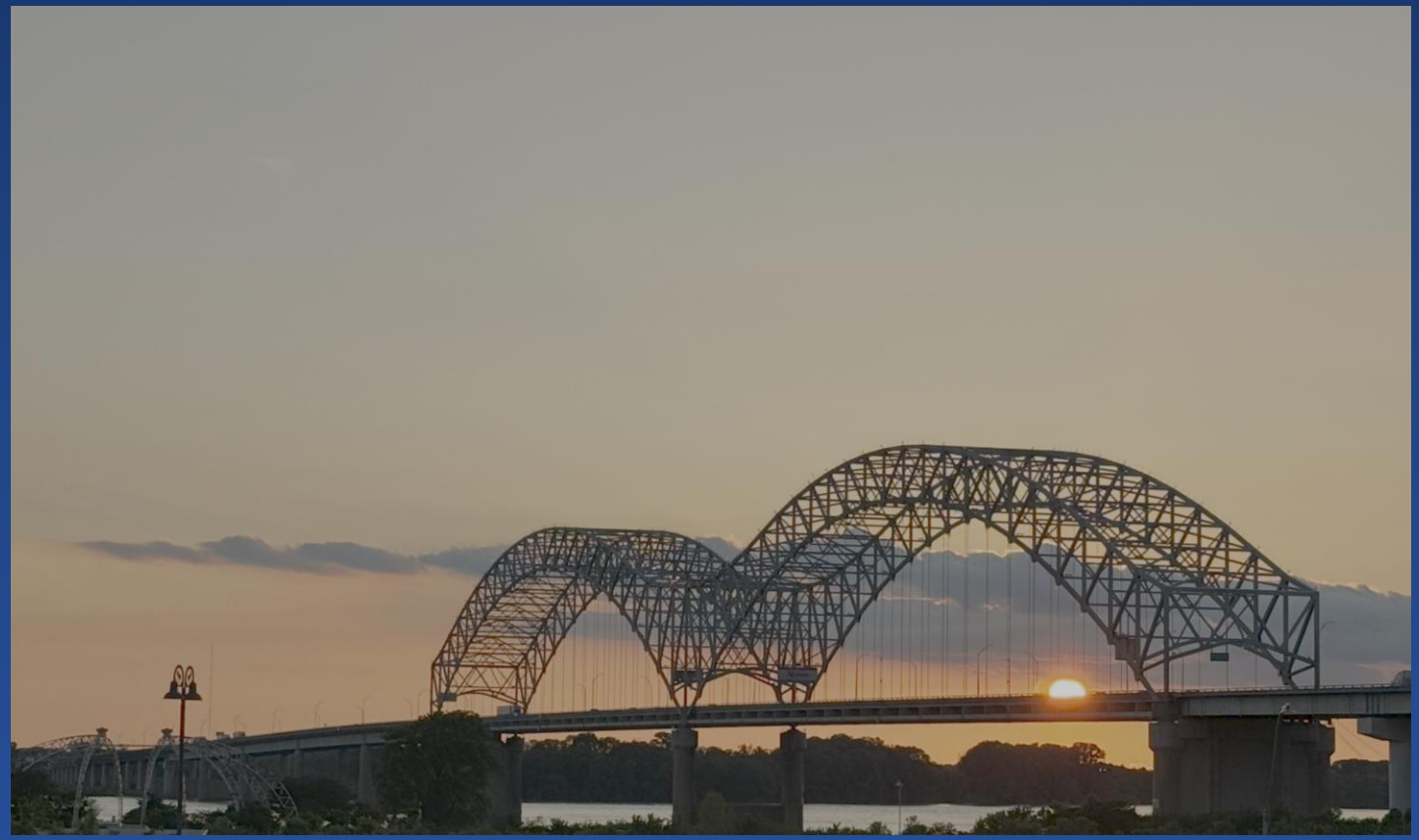
Nevin, Environmental Research, 2007
Feigenbaum & Muller, Explorations in Economic History, 2016
Aizer et al., Journal of Human Resources, 2018
Billings & Schnepel, J Econ Behav Organ, 2018

More Recent Evidence: The Signal Persists

- A 2022 meta-analysis of 24 studies (542 estimates) suggests declining lead exposure may explain ~15% of the U.S. homicide decline (1989–2014)
- In a longitudinal birth cohort, each 5 µg/dL higher childhood blood lead level was associated with higher odds of later criminal conviction
- Across study designs — including cohort studies, natural experiments, and population analyses — the relationship between lead exposure and later behavioral outcomes remains consistent

Higney et al., Reg Sci Urban Econ, 2022
Beckley et al., JAMA Pediatr, 2018

What Does this Mean for Memphis?



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The Memphis Screening Gap

- The Numbers
  - In 2023, **389 children tested positive** for lead in Shelby County
  - Currently, roughly **only 15%** of Shelby County children under age 6 are screened annually.
- The "Missing" Kids
  - This means ~85% of our children have unknown lead status, and hundreds or even thousands more are likely **poisoned but untreated**.
- Screening Failure
  - We are missing children during the most important window for prevention, developmental follow-up, and environmental intervention.

The Screening Gap is Bigger than Memphis

- Tennessee Testing Rates
  - Tennessee screening rates averaged roughly 17.9% from 2017–2019
  - Rates fell during the pandemic to 16.9% in 2020 and 16.1% in 2021
  - Screening has improved since, but remains far below where it should be
- National Context
  - Nationally, only a small percentage of young children have BLLs ≥ 3.5 µg/dL
  - But because there is no safe level, even “small percentages” represent meaningful developmental harm
- Why This Matters
  - **Lower testing does not mean lower exposure — it often just means we are missing more children.**
  - **Reduced testing can create a false sense that the problem is improving.**

Tennessee Department of Health. Childhood Lead Poisoning Prevention Program (CLPPP) Fact Sheet, 2023.

Memphis: Lead in the News

- “The pediatricians still don’t really grasp the severity of it.”
  - Sharon Hyde, manager of the Green & Healthy Homes Initiative’s anti-lead efforts in Shelby County
- In 2024, local reporting explicitly asked whether lead remediation could reduce crime in Memphis
- Framed lead as not only a health and housing issue, but a public safety issue
- This reflects a broader shift:
  - from punishment to prevention
  - from crime response to early brain protection
- This conversation is happening in Memphis

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Memphis: Lead in the News

- Testing School Water Sources
  - Routine testing in 2025-26 revealed lead in water at 24 MSCS schools.
- Severe Levels
  - Highlighting Invictus Academy (765 ppb) and Whitehaven Elementary (581 ppb).
- Ongoing Concern
  - Many parents in Memphis are still unaware their children were drinking lead-contaminated water last year.
- Gaps in Care
  - No current requirements in TN around testing water in childcare centers.

Lead Pipes: MLGW Response

- The $110M Plan
  - MLGW is in the middle of a 10-year project to replace ~15,000 lead service lines.
- Progress
  - Approximately 600 lines were replaced in early 2026.
- The Private-Side Fix
  - MLGW now offers to replace the "private" portion of the line for residents—a huge policy win for equity.
  - Funding for ~400 replacements per year, but will need ~$10M/yr x 5yrs to cont.
- Why It Matters
  - This is not just infrastructure — it is pediatric brain protection

The Child at Risk

- Test the child
  - Especially at 12 and 24 months
- Identify the source
  - Home, water, renovation dust, soil, daycare/visiting home
- Reduce absorption
  - Optimize iron and calcium
- Support development
  - Monitor speech, behavior, attention, school readiness
- Don’t stop at the lab value
  - An elevated blood lead level should trigger an environmental response, not just repeat testing

Lead Abatement and Water Safety

- High-impact interventions in the home
  - Lead-safe home inspection / risk assessment
  - Repair or stabilize deteriorating paint
  - Use EPA lead-safe contractors for renovation
  - Wet-clean dust-prone surfaces
  - Replace or remediate windows, trim, and friction surfaces
  - Test drinking water when indicated
  - Use certified filters and cold water for drinking/cooking/formula
  - Boiling does not remove lead
  - Don’t forget soil: bare dirt, porches, and play areas can remain important exposure sources

U.S. Environmental Protection Agency. Basic Information about Lead in Drinking Water. Updated 2026.

Protective Factors: After Exposure

- Iron and calcium sufficiency may reduce ongoing absorption
- Early intervention services improve developmental outcomes
- High-quality early education supports executive function and school readiness
- Stable, responsive caregiving helps buffer stress and support self-regulation
- Positive childhood experiences and early relational health matter
- Safe, predictable, nurturing relationships can help protect developmental pathways

Lanphear BP, Navas-Acien A, Bellinger DC. Lead Poisoning. N Engl J Med. 2024;391(17):1621-1631.

What Memphis Can Build Now

- Expand lead-safe housing inspection and remediation
- Increase access to free home and water testing
- Strengthen rental accountability and landlord transparency
- Prioritize older housing stock in highest-risk ZIP codes
- Improve pediatric screening and closed-loop follow-up
- Pair abatement with:
  - Housing stabilization
  - Blight reduction
  - Early childhood supports
  - Developmental services

TN Is Tightening Lead Safety Requirements

- New requirements for schools and childcare centers include:
  - Lower allowable lead dust clearance levels
  - Mandatory reporting of clearance results to TDEC
  - Use of EPA-certified lead-safe contractors
  - Advance parent notification before renovations that disturb lead paint
- Applies to child-occupied facilities serving children <6
  - Childcare centers
  - Pre-K classrooms
  - K/Pre-K school settings
- Implementation

  TDEC has 90 days after final signature to roll out the new requirements
- Bottom line
  - These protections are important — and overdue.

Why Prevention Pays

- One estimate suggests ~$1.80 returned for every $1 invested in future criminal justice and special education costs.
- Savings come through:
  - Education
  - Health
  - Productivity
  - Criminal justice
- Lead-safe cities are safer and less costly cities

Billings SB, Schnepel KT. Life After Lead: Effects of Early Interventions for Children Exposed to Lead. Am Econ J Appl Econ. 2018;10(3):315-344.

Take Action

- Ensure universal testing at 12 and 24 months
- Expand point-of-care lead testing in pediatric settings
- Educate clinicians and systems leaders on the urgency of this crisis
- Build systems to track and follow up positive tests
- Refer exposed children to early intervention, developmental, and behavioral supports
- Ask specifically about nontraditional lead sources

Memphis Resources

- **Community / public health resources**
  - Memphis Lead Coalition
  - Green and Healthy Homes Initiative
  - Young, Gifted & Green
  - Shelby County Health Department
  - Tennessee Department of Health
  - CDC Childhood Lead Poisoning Prevention Program

- Local contact points
  - City of Memphis Lead-Safe Program
    - 901-636-5323
  - Shelby County Lead Hazard Control Program
    - 901-222-7605
  - Free MLGW water testing
    - 901-320-3962 / waterlab@mlgw.org
  - Free child lead testing through Shelby County Health Department
    - 901-222-9582

Prevention Is Violence Prevention

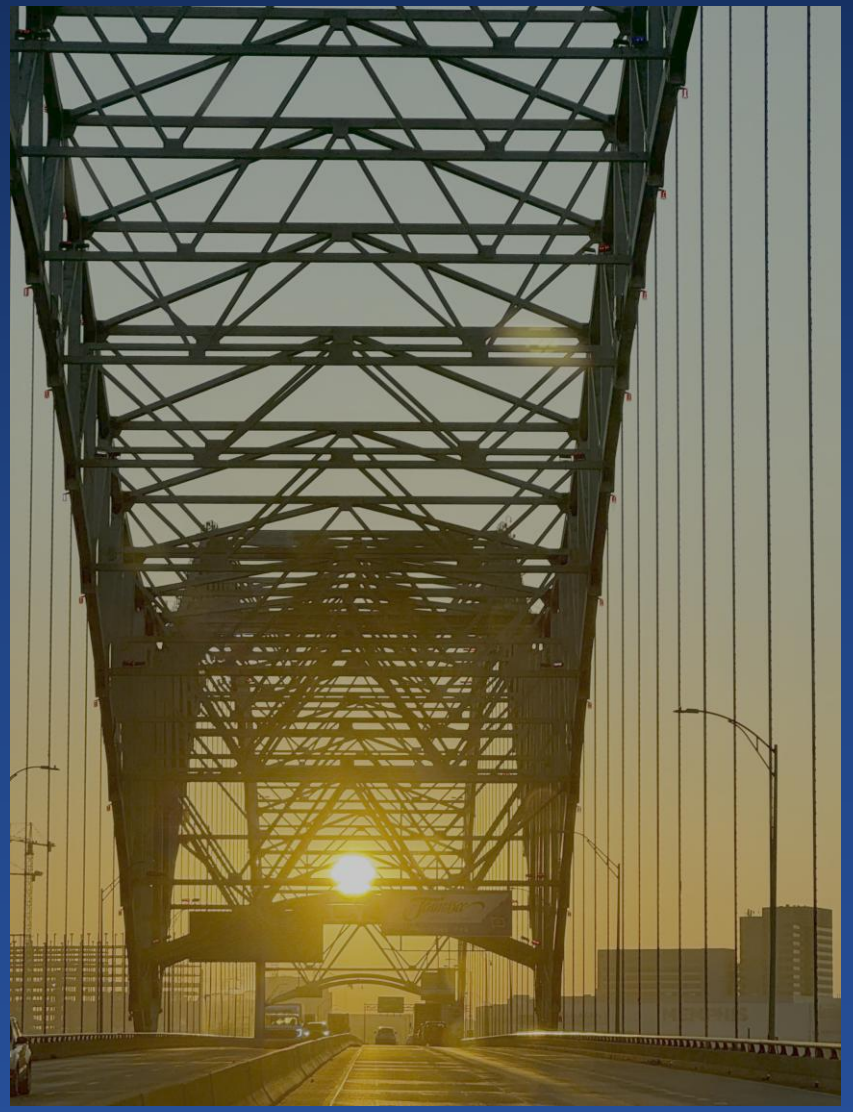
- Lead-safe housing protects brain development
- Screening identifies risk before the damage compounds
- Developmental and relational buffering can change long-term trajectories
- Environmental justice is part of public safety

- “…it became clear that children are the human monitors for environmental lead in their schools.”

Kanarak MS. Lead Contamination in Milwaukee Schools- the latest episode in an ongoing toxic pandemic. *N Engl J Med*. 2025;393:524-526.

Closing Thoughts

- Reducing lead exposure is **one of the earliest, most upstream violence prevention strategies we have**
- The shadow of lead is long—but it is not inevitable.
- Prevention today shapes safer (and brighter!) communities tomorrow



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- Questions?

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