

OLD PROBLEM, NEW DATA: CHILDHOOD LEAD POISONING IN NORTH CAROLINA

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NC DIVISION OF PUBLIC HEALTH

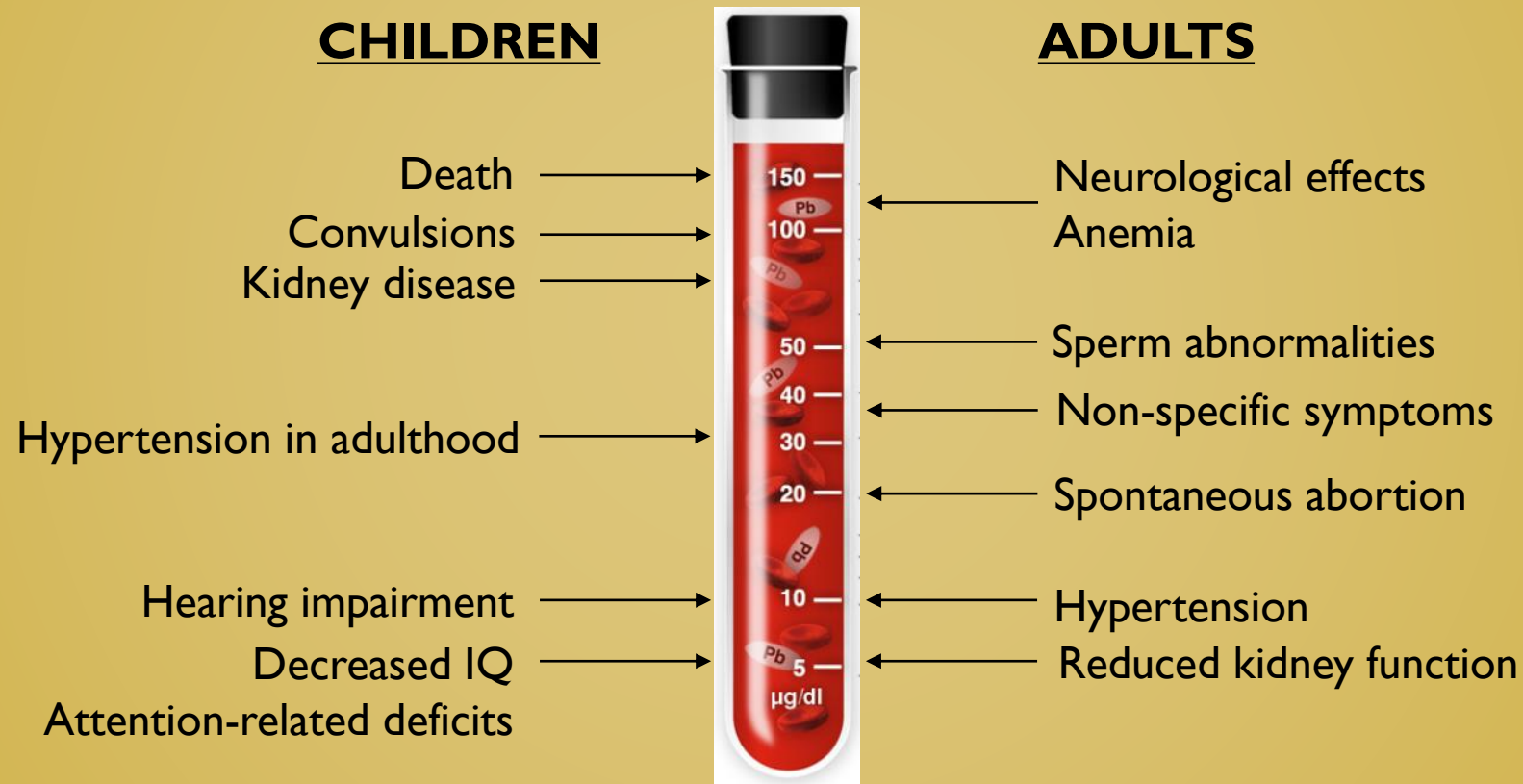
CHILDREN'S ENVIRONMENTAL HEALTH

CHILDHOOD LEAD POISONING PREVENTION PROGRAM

JANUARY 24, 2019



HEALTH EFFECTS OF LEAD



HEALTH EFFECTS SUMMARY

- **Children can develop health effects *without* apparent symptoms**
- **Symptoms can be vague and non-specific (e.g. fatigue, irritability)**
- **Children are more susceptible to lead poisoning than adults**
- **Lead affects every system in the body**
- **The blood lead level may not reflect the total body lead burden**

Prevent Childhood Lead Poisoning

The Impact

535,000

U. S. children ages 1 to 5 years have blood lead levels high enough to damage their health.



24 million

homes in the U.S. contain deteriorated lead-based paint and elevated levels of lead-contaminated house dust.



4 million of these are home to young children.

It can cost

\$5,600



in medical and special education costs for each seriously lead-poisoned child.



Visit www.cdc.gov/nceh/lead to learn more.

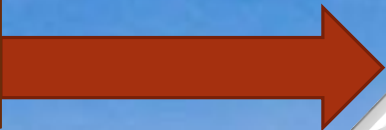
REVIEW OF BLOOD LEAD TESTING RECOMMENDATIONS

- CDC Recommendations:
 - Universal risk screening for all children at 12 and 24 mos. or as soon as possible for any children under 6 yrs. old not previously tested
 - Refugee children (6 mos. to 16 yrs. old) should be tested upon entry into the US and then again upon placement into permanent home if 6 mos. to 6 yrs.
- NC Requirements:
 - Children enrolled in Medicaid, WIC, or Health Choice must be tested at 12 and 24 month well-check visits
 - Lead risk screening via questionnaire is recommended for all children at 12 and 24 months or later if not previously tested

For more information: <http://ehs.ncpublichealth.com/hhccehb/cehu/lead/resources.htm>

Blood Lead Surveillance Iceberg

Home lead investigation



Confirmed $\geq 5 \mu\text{g/dL}$

Confirmatory blood lead sample drawn

Initial test $\geq 5 \mu\text{g/dL}$

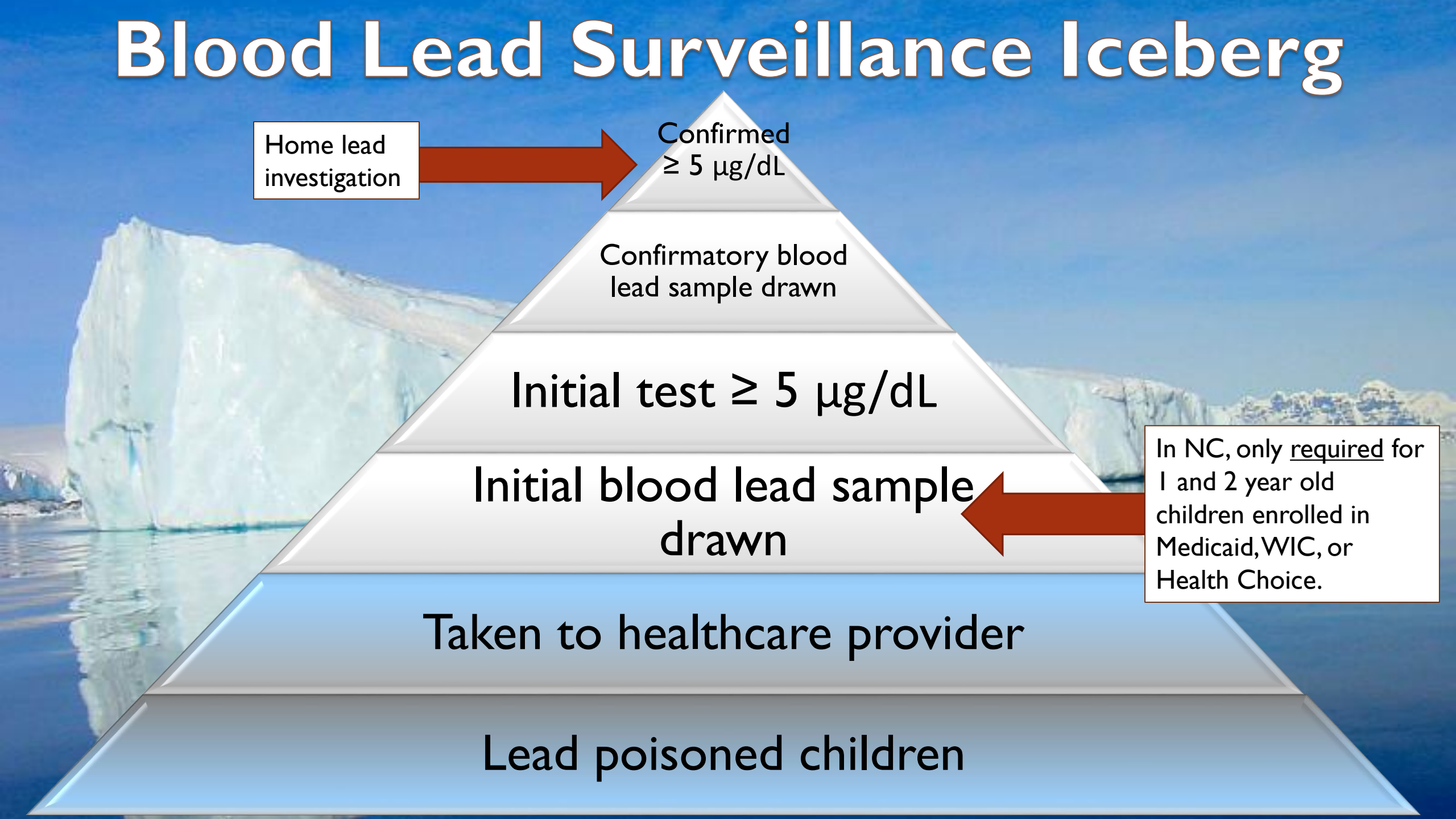
Initial blood lead sample drawn



In NC, only required for 1 and 2 year old children enrolled in Medicaid, WIC, or Health Choice.

Taken to healthcare provider

Lead poisoned children



NC CASE DEFINITIONS

Case is confirmed when 2 consecutive blood lead test results within a 12-month period are:

- $< 5 \mu\text{g/dL}$ = Below the reference value
- $5\text{-}9 \mu\text{g/dL}$ = Elevated blood lead (EBL)
- $\geq 10 \mu\text{g/dL}$ = Confirmed lead poisoning (CLP)



[This Photo](#) by Unknown Author is licensed under [CC BY-NC-ND](#)

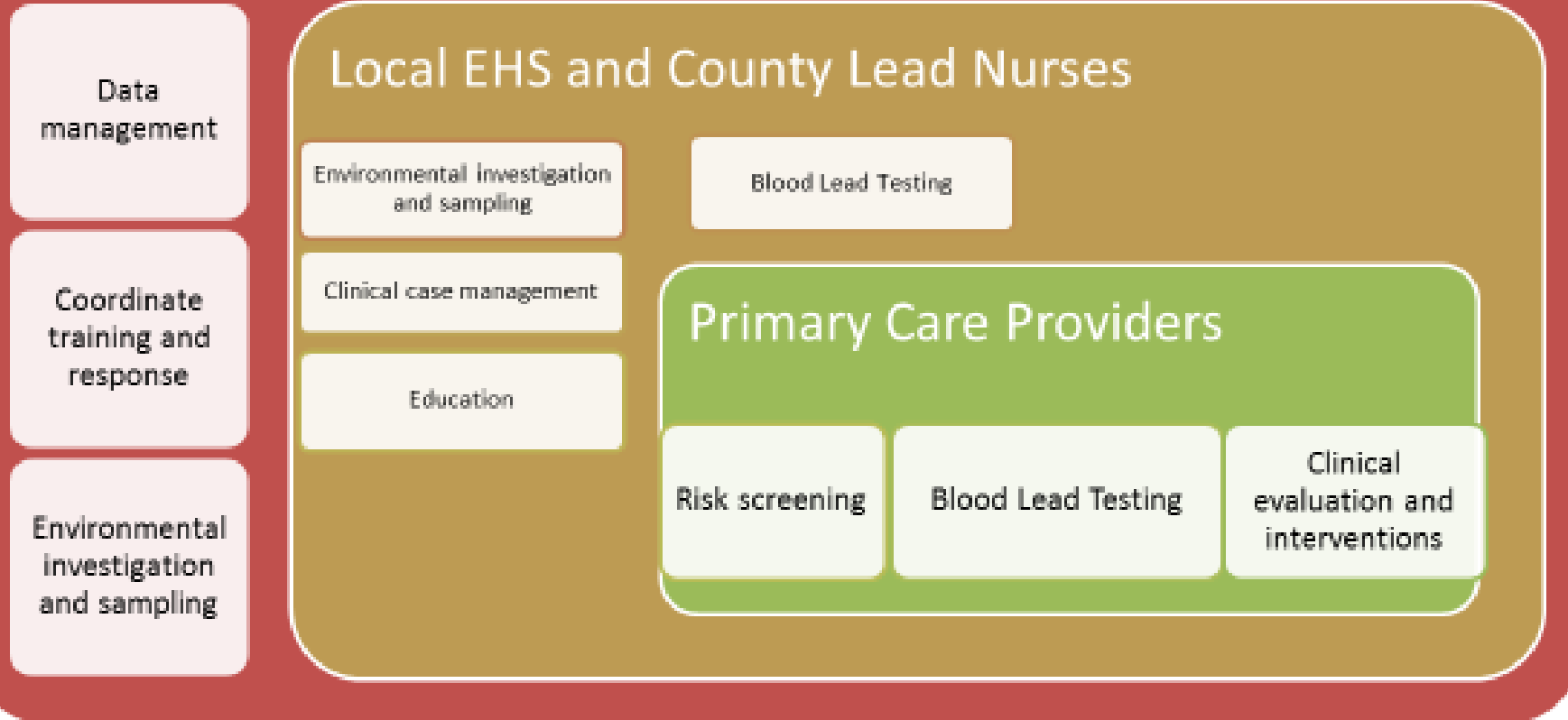
OVERVIEW OF THE NC CHILDHOOD LEAD POISONING PREVENTION PROGRAM

- Pediatric blood lead level surveillance
- Case management and monitoring of follow-up
- Home and daycare inspections
- Target population: children <6
- Coordination of lead poisoning prevention education

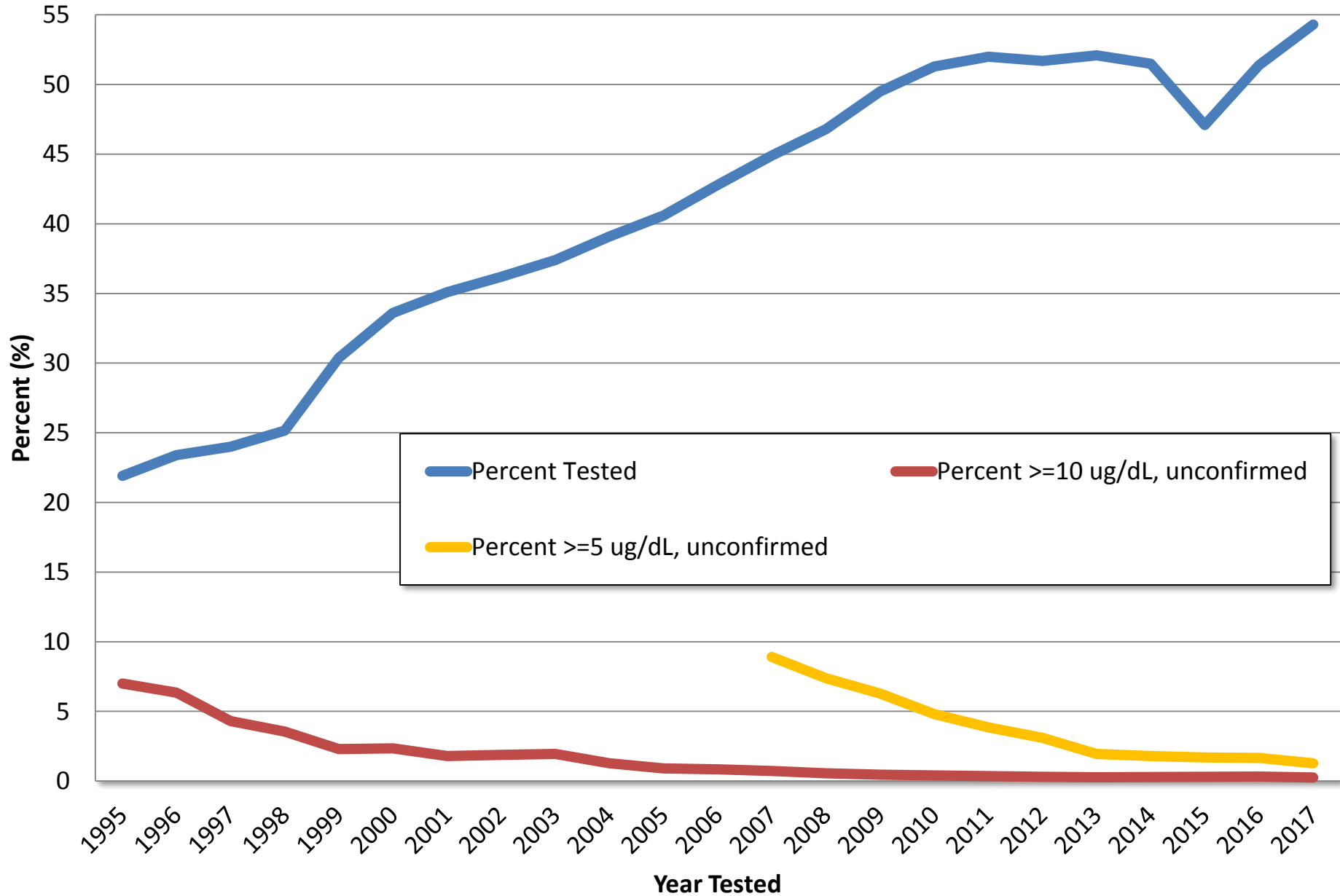


NC Childhood Lead Poisoning Prevention Program

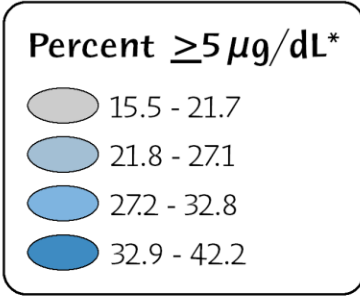
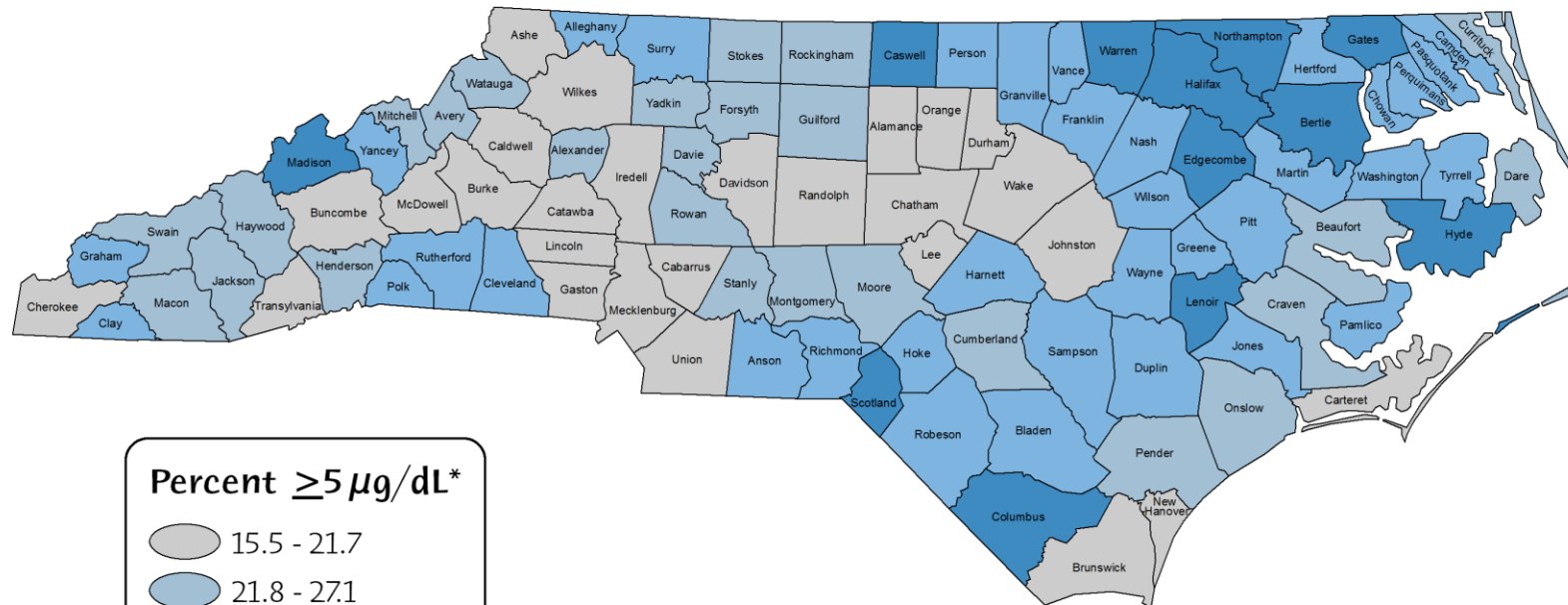
State Childhood Lead Surveillance Team and Regional EHS



Percent of NC Children Tested for Lead Poisoning, 1 and 2 Year-olds



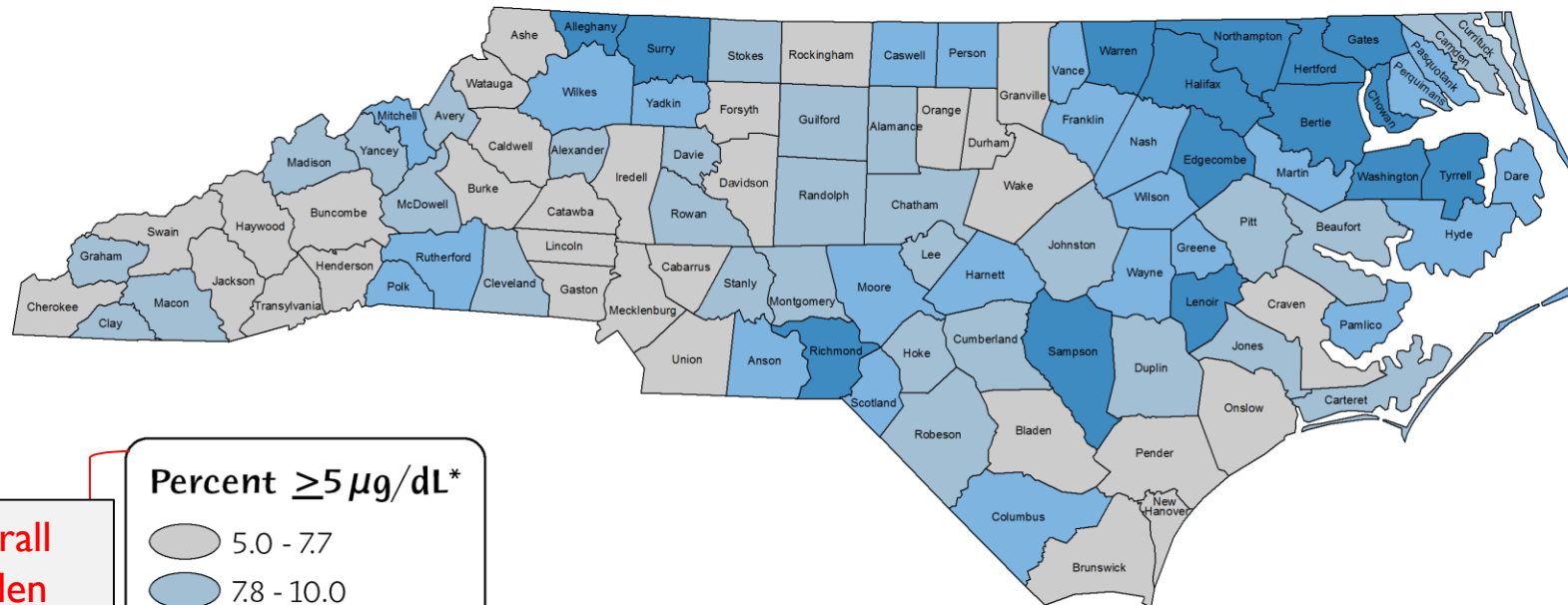
North Carolina Initial Elevated Blood Lead Result for Children (Ages 1-2) 2000 - 2004



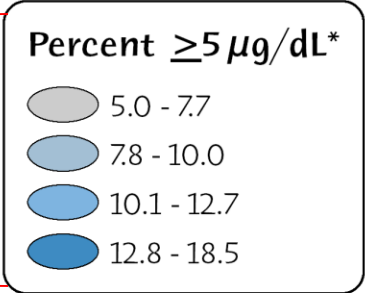
State 24.2

*micrograms per deciliter

North Carolina Initial Elevated Blood Lead Result for Children (Ages 1-2) 2005 - 2009



**Overall
burden
reduced**



State 8.3

*micrograms per deciliter

PERCENT OF PRE-1978 HOUSING IN NC

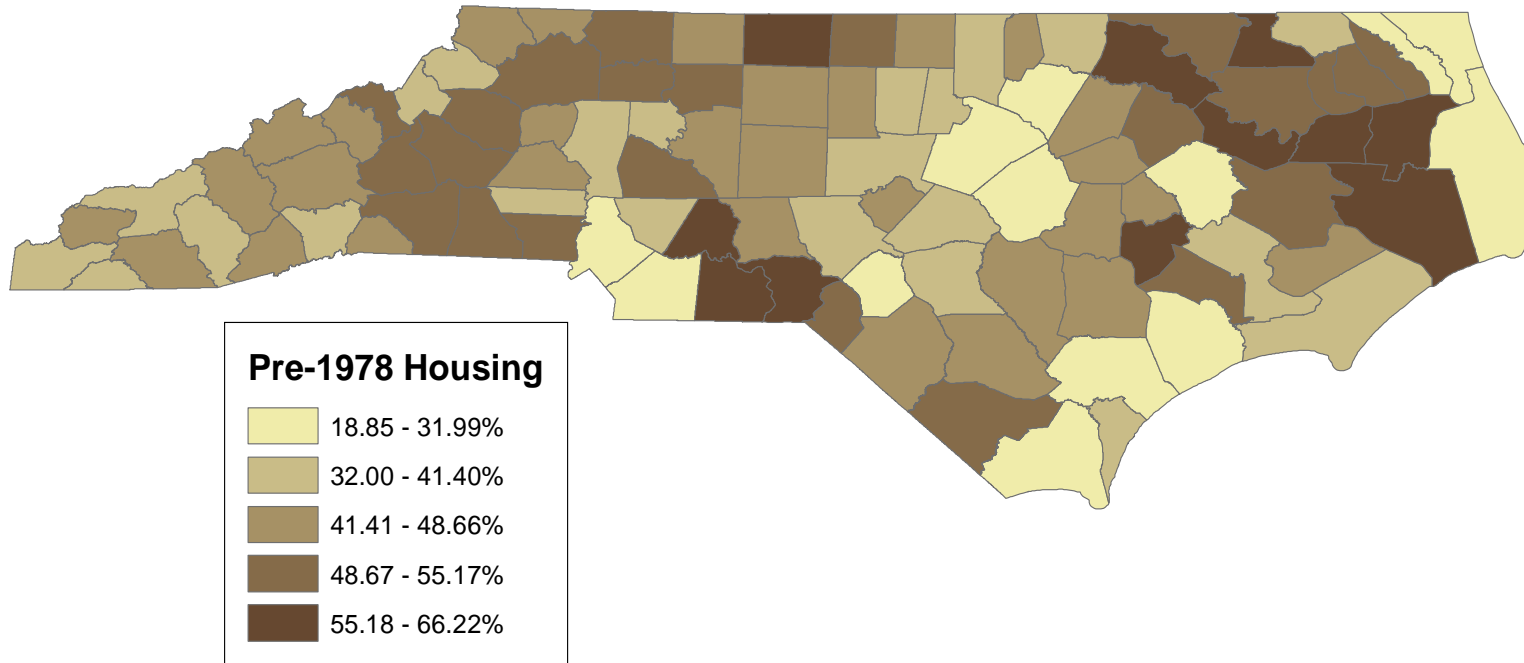


Image source: Megan Rodgers, UNC CEHS

Data Source: US Census Bureau

PERCENT OF PRE-1950 HOUSING IN NC

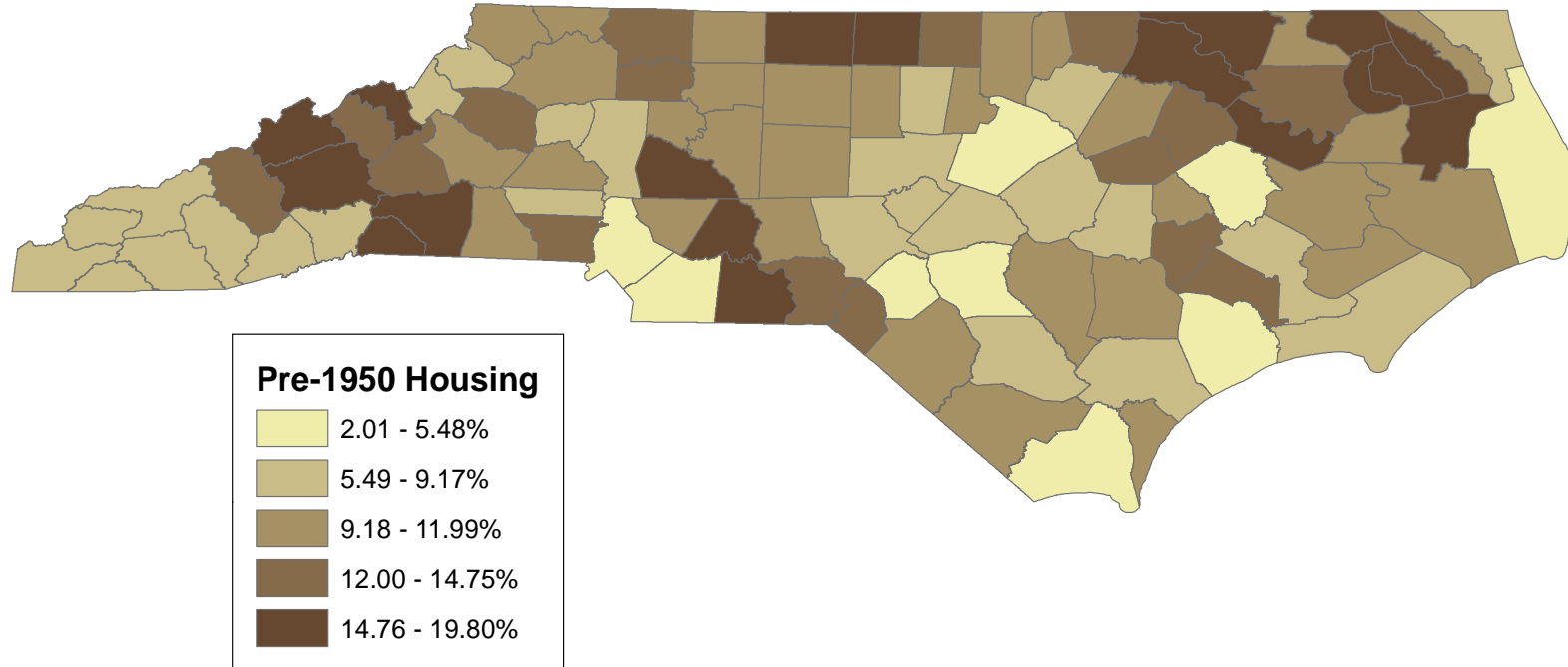


Image source: Megan Rodgers, UNC CEHS

Data Source: US Census Bureau

PERCENT OF POPULATION THAT IS FOREIGN BORN IN NC

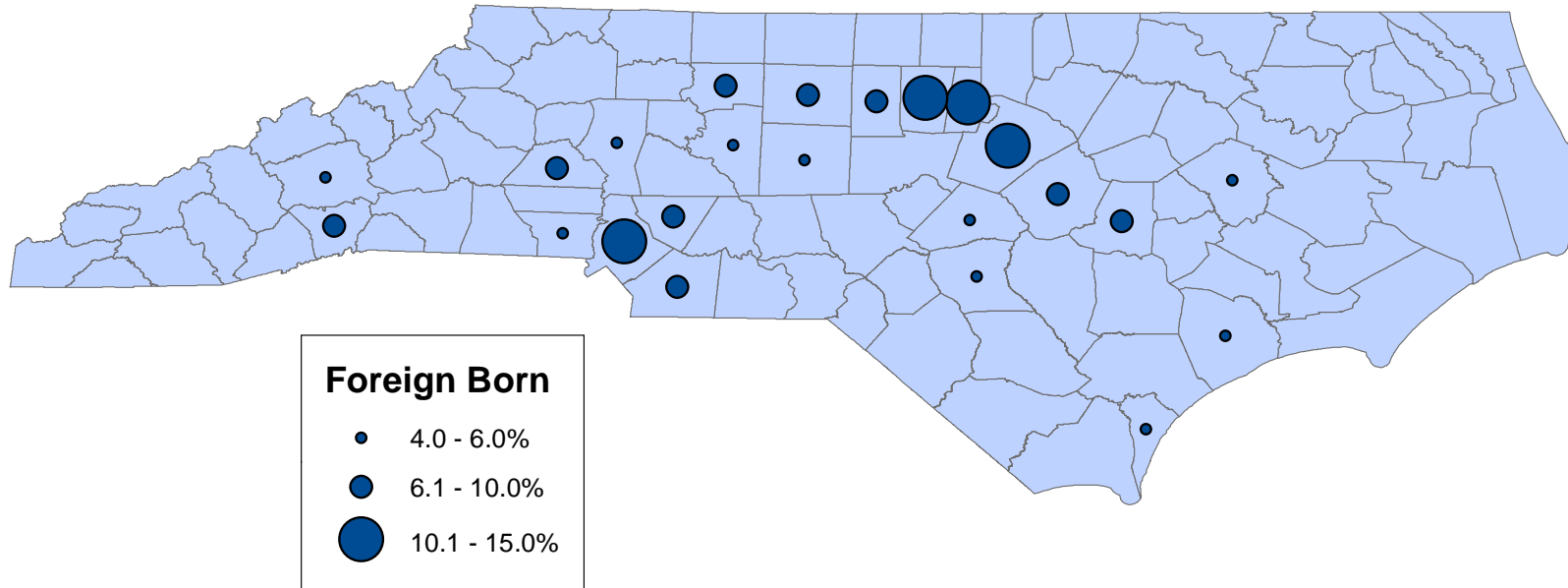
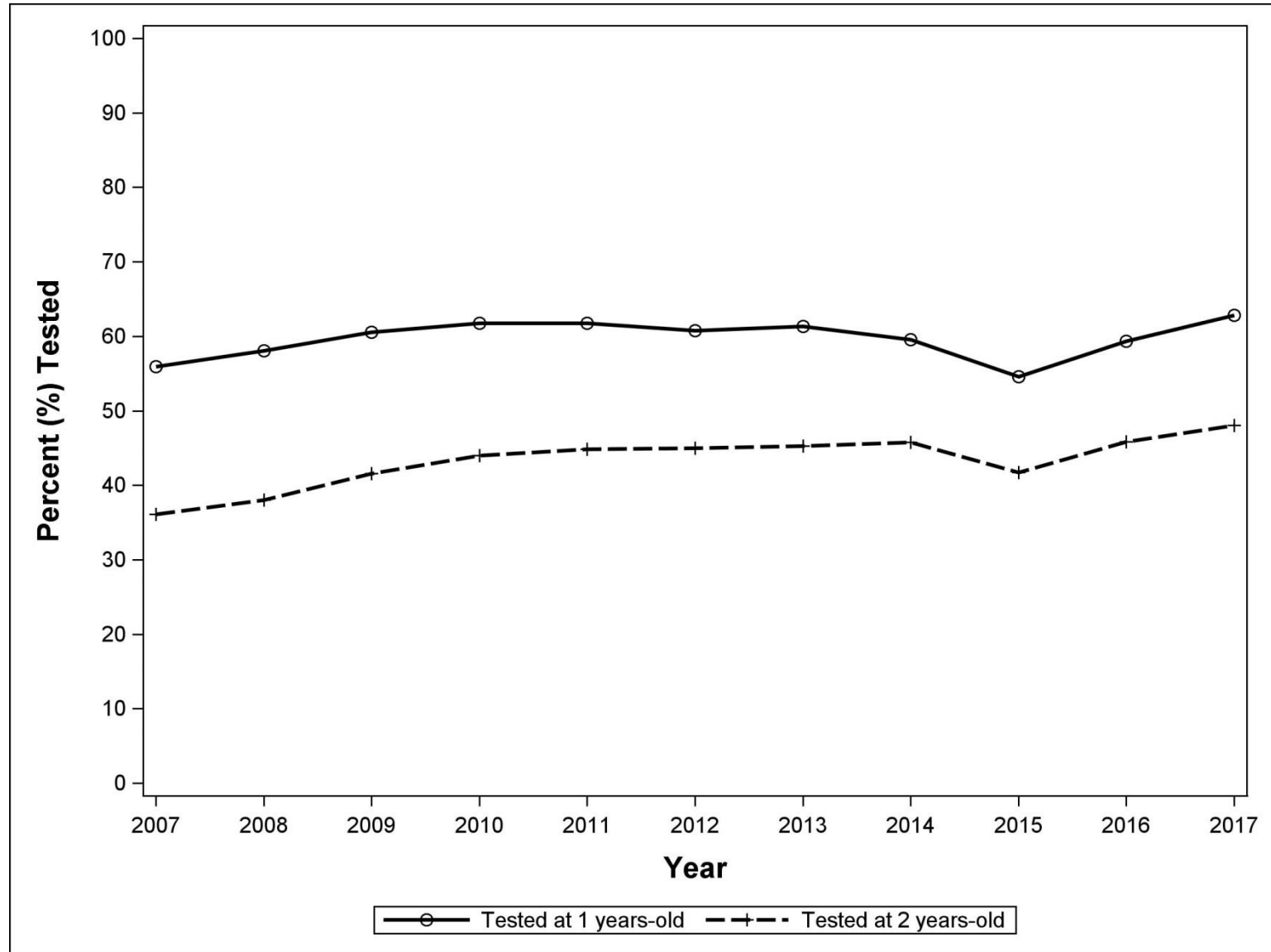


Image source: Megan Rodgers, UNC CEHS
Data Source: US Census Bureau

Percent of NC Children Tested at 1 and 2 Years Old



COMMON SOURCES OF LEAD EXPOSURE

- **Lead-based paint**
- Contaminated soil, dust, air and water
- Lead-related occupations and hobbies
- Brass keys and metal key chains
- Vinyl miniblinds
- Homemade and imported pottery
- Imported foods, candies, cosmetics, herbal remedies, ceremonial powders, and spices
- Antique toys and furniture



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OCCUPATIONS WITH LEAD HAZARDS

- Artists (materials used may contain lead)
- Auto repairers (car parts may contain lead)
- Battery manufacturers (batteries contain lead)
- Bridge reconstruction workers (old paint may contain lead)
- Construction workers (materials used may include lead)
- Firing range instructors and gunsmiths (ammunition contains lead)
- Glass manufacturers (lead may be used in glass production)
- Lead manufacturers
- Lead miners
- Lead refiners
- Lead smelters
- Manufacturers of bullets, ceramics, and electrical components (all contain lead)
- Painters (old paint and commercial paint may contain lead)
- Plastic manufacturers (materials made may contain lead)
- Plumbers and pipe fitters (pipes may contain lead)
- Police officers (ammunition contains lead)
- Radiator repairers (radiators may contain lead)
- Recyclers of metal, electronics, and batteries (may contain lead)
- Rubber product manufacturers (process contains lead)
- Shipbuilders (materials used may include lead)
- Solid waste incinerator operators (waste may contain lead)
- Steel welder (galvanized steel is coated in part with lead)



Photo Credit: Jess Rinsky, PhD

PROTECTING YOUR CHILDREN FROM LEAD

- Give regular snacks and nutritious foods
- Wash hands before eating
- Clean house using wet mop and wipes
- Leave shoes at the door
- Block access to lead paint hazards
- Keep objects not meant for young children away from teething babies
- Have children tested at 1 and 2 year old well visit

[For more information, go to: http://www.cdc.gov/nceh/lead/](http://www.cdc.gov/nceh/lead/)



QUESTIONS?

Contact information: Kim Gaetz, 919-707-5953
kim.gaetz@dhhs.nc.gov

Resources available in English and Spanish at
<http://nchealthyhomes.com/lead-poisoning/>



HTTPS://EHS.NCPUBLICHEALTH.COM/HHCCCEHB/CEHU/LEAD/DATA.HTM

The image is a screenshot of a web page from the North Carolina Department of Health and Human Services (DHHS). The page is titled "Children's Environmental Health" and "Childhood Lead Poisoning Prevention Program: Data". It features a blue navigation sidebar on the left with links to various health topics. The main content area is white and contains a breadcrumb trail, a title, a "Publications" section with two links, and a "Surveillance Data" section with a list of 13 PDF links for lead surveillance data from 2002 to 2014, plus a comparison report from 2007-2009.

Public Health

DHHS > Public Health > Env. Health Section > CEHU > Lead Poisoning Prevention Program > Data

Children's Environmental Health

Childhood Lead Poisoning Prevention Program: Data

Publications

- [Lead in Spices, Herbal Remedies, and Ceremonial Powders Sampled from Home Investigations for Children with Elevated Blood Lead Levels -- North Carolina, 2011-2018](#)
- [Running the Numbers: Trends in Lead Poisoning Prevention Data for Children Aged < 6 Years in North Carolina](#)

Surveillance Data

- [2014 Lead Surveillance Data](#) (PDF, 150 KB)
- [2013 Lead Surveillance Data](#) (PDF, 156 KB)
- [2012 Lead Surveillance Data](#) (PDF, 15 KB)
- [2011 Lead Surveillance Data](#) (PDF, 66 KB)
- [2010 Lead Surveillance Data](#) (PDF, 58 KB)
- [2009, 2008, and 2007 Comparison of Medicaid Match Data](#) (PDF, 18 KB)
- [2009 Lead Surveillance Data](#) (PDF, 25 KB)
- [2008 Lead Surveillance Data](#) (PDF, 27 KB)
- [2007 Lead Surveillance Data](#) (PDF, 32 KB)
- [2006 Lead Surveillance Data](#) (PDF, 31 KB)
- [2005 Lead Surveillance Data](#) (PDF, 79 KB)
- [2004 Lead Surveillance Data](#) (PDF, 20 KB)
- [2003 Lead Surveillance Data](#) (PDF, 20 KB)
- [2002 Lead Surveillance Data](#) (PDF, 21 KB)

Environmental Health

Emergency Preparedness and Response

Food Protection and Facilities Branch

Children's Environmental Health

Centralized Intern Training & Authorization

On-Site Water Protection Branch

Topics A-Z

Contacts

SURVEILLANCE DATA BY NC COUNTY

- <https://ehs.ncpublichealth.com/hhccehb/cehu/>

LET'S LOOK AT SOME REAL CASES...

CASE 1: NORTH CAROLINA, 2017

- 13 month-old child with developmental delay
- A confirmed blood lead level was 22 $\mu\text{g}/\text{dL}$ (lead poisoning)
- The child's home was built after 1978 and no lead paint hazards were found
- Family of SE Asian/Indian origin

BALGUTI KESARIA

- An Ayurvedic medicine, *Balguti kesaria*, that the parents had been giving the child was found to contain 220mg/kg lead
- NC reported to the FDA → August 2017
Safety Alert



<https://www.fda.gov/drugs/drugsafety/ucm570237.htm>

Safety Alerts for Human Medical Products

2018 Safety Alerts for Human Medical Products

2017 Safety Alerts for Human Medical Products

Balguti Kesaria Ayurvedic Medicine: FDA Warning - High Levels Of Lead

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[Posted 08/04/2017]

AUDIENCE: Consumer, Health Care Professional

ISSUE: The U.S. Food and Drug Administration is warning parents and caregivers not to use “Balguti Kesaria (or Kesaria Balguti) Ayurvedic Medicine” due to the risk of lead poisoning.

FDA has not reviewed this product for safety or effectiveness. Exposure to lead can cause serious damage to the central nervous system, the kidneys and the immune system. In children, chronic exposure to lead—even at low levels—is associated with impaired cognitive function, including reduced IQ, behavioral difficulties, and other problems.

BACKGROUND: This product is sold online and manufactured by multiple companies, including Kesari Ayurvedic Pharmacy in India. Individuals have also mailed or brought the product into the United States. “Balguti Kesaria Ayurvedic Medicine” is used with infants and children for a variety of conditions including rickets, cough and cold, worms and dentition (teething).

FDA initially learned of this risk from the North Carolina Division of Public Health after the product was tested and found to contain high levels of lead. FDA was also notified by the Michigan Department of Health and Human Services of high levels of lead in two children who were given this product. Michigan’s testing also found high levels of lead in the product. To date, FDA has received one adverse event report of high levels of lead and developmental delays in a child who was given this product.

RECOMMENDATION: Anyone who is using this product or giving it to a child should stop immediately and consult a health care professional.

INORGANIC LEAD:

The Lowest Observed Effects in Children



The chart shows the effects of lead contamination at various levels. The levels in this diagram do not necessarily indicate the lowest levels at which lead exerts an effect. These are the levels at which studies have adequately demonstrated an effect.

Source: ATSDR, 1990.

HOW MUCH LEAD IS TOO MUCH?

- **1960s:** $\geq 60 \mu\text{g/dL}$
- **1971** $\geq 40 \mu\text{g/dL}$
- **1975** $\geq 30 \mu\text{g/dL}$
- **1985** $\geq 25 \mu\text{g/dL}$
- **1991** $\geq 10 \mu\text{g/dL}$
- **2012** $\geq 5 \mu\text{g/dL}$

ASSUMPTIONS OF EARLIER RESEARCH

- 1. No symptoms = No lead poisoning**
- 2. Symptomatic children (without encephalopathy) would recover completely**

LEAD TOXICITY – CENTRAL NERVOUS SYSTEM

- **Chemically similar to cations so interferes with many metabolic pathways that use calcium (and perhaps zinc)**
- **Impairs neurotransmitter function**
- **The hippocampus (important for learning and memory) is one of the most affected areas of the brain**

American Journal of Diseases of Children

VOLUME 66

NOVEMBER 1943

NUMBER 5

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LATE EFFECTS OF LEAD POISONING ON MENTAL DEVELOPMENT

RANDOLPH K. BYERS, M.D.

AND

ELIZABETH E. LORD, PH.D.

BOSTON

FOREWORD

The sudden tragic death of Dr. Lord on Jan. 10, 1943 occurred before the completion of the final draft of this paper. It was she who first felt that the minor deviations found on psychologic examination of these children with lead poisoning might be of important significance for the future. It was she who maintained the file of cases, studying them from the psychologic point of view, without encouragement from any one for the first several years.

That lead poisoning occurring in early life usually has a disastrous effect on mental development has not been generally recognized, though the subject of lead poisoning in children has been discussed by many observers. The manifestations of acute involvement of the nervous system have been adequately described, and the gross destructive lesions in the brain consequent to acute lead encephalopathy accompanied by cerebral edema and high intracranial pressure have been recognized. On the other hand, McKhann,² for instance, stated: "The neurologic manifestations of lead poisoning usually subside without serious consequences if the ingestion of lead is stopped and the removal of lead from the circulation and its deposition in inert form in the bones can be hastened, as described, by the use of a diet high in calcium together with the administration of cod liver oil or viosterol to accelerate the laying down of new bone."

COGNITIVE EFFECTS AT LOW LEAD LEVELS

- Problems at Low Lead Levels
 - Canfield et al. 2003 BLLs from children (n=172) at 6, 12, 18, 24, 36, 48, 60 months
 - Stanford-Binet at age 3 and 5 years
 - Each BLL increase of 10 $\mu\text{g}/\text{dL}$ associated with 4.6 decrease in IQ.
 - Relationship was non-linear Decrease in IQ in those with BLL of 1-10 $\mu\text{g}/\text{dL}$ was 7.4
- Canfield RL, Henderson CR, Jr, Cory-Slechta DA, et al. Intellectual impairment in children with blood lead concentrations below 10 microg per deciliter. N Engl J Med. 2003

COGNITIVE EFFECTS AT LOW LEVELS

- Lanphear et al. 2005: Pooled data from 7 international studies of children from infancy to age 5-10 years (n=1333)
- IQ was the main outcome
- Non-linear relationship with “low-level” lead poisoning
 - BLL 2.4 –10 $\mu\text{g}/\text{dL}$: 3.9 point decrease in IQ
 - BLL 10-20 $\mu\text{g}/\text{dL}$: 1.9 point decrease in IQ
 - BLL 20-30 $\mu\text{g}/\text{dL}$: 1.1 point decrease in IQ

CASE 2: NORTH CAROLINA

- **2 year old boy with a capillary BLL of 18**
- **Venous BLLs 12 → 13 → 12 → 12 → 7**
- **Symptoms: constipation, developmental delay, behavioral problems**
- **Risk assessment: child bites his nails, licks furniture and chews toys**
- **Father works in a plant that produces lead; BLL dropped to 7 after father changed jobs**
- **Affected sibling**

CASE 3: NORTH CAROLINA, 2018

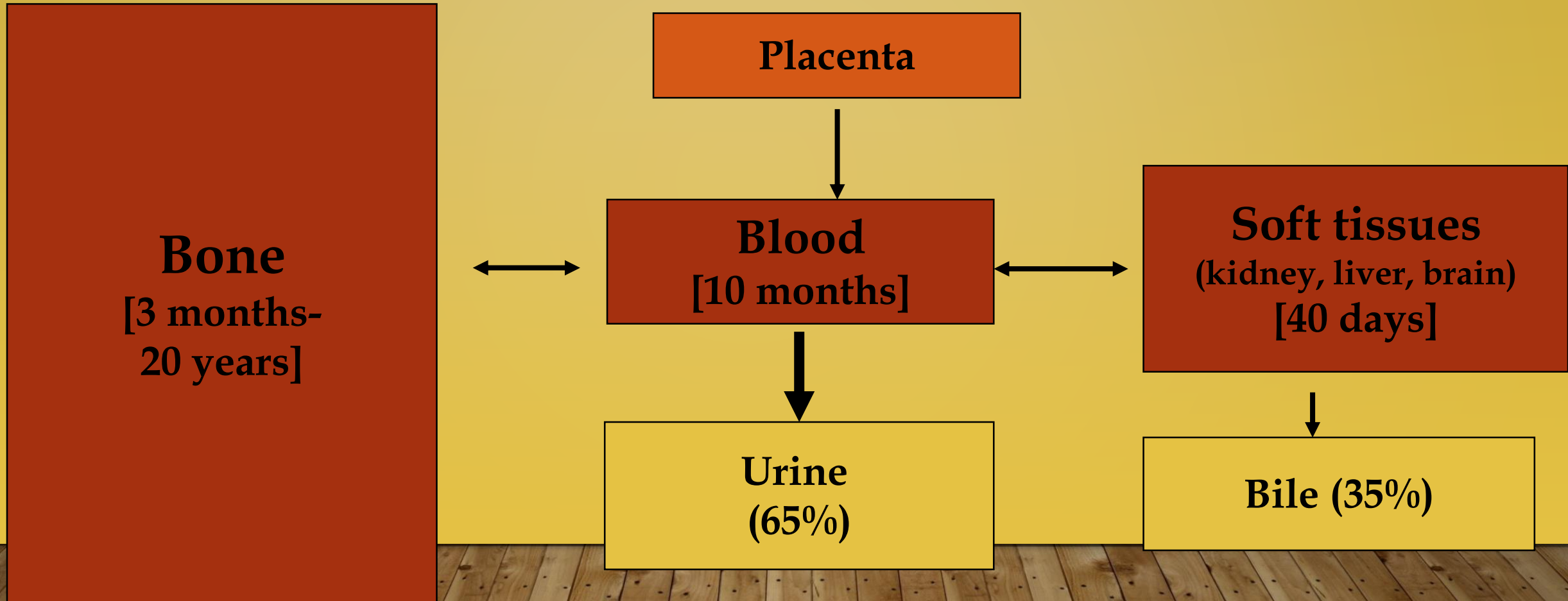
- 12 month-old girl taken for routine screening
- No symptoms of concern, but history of constipation
- Confirmed **BLL of 65.9 $\mu\text{g}/\text{dL}$**
- Referred for hospital admission
- Abdominal xray: no foreign body
- Labs: mildly **decreased hemoglobin=anemia**
- Admitted for chelation with DMSA (succimer)

CASE 3: SOURCE OF EXPOSURE

- History of spending increasing amounts of time in a shooting range owned by a family member
- Older sibling also confirmed to have lead poisoning
- Case patient BLLs: January = 66 → chelation
 June = 47
 August = 42

Slow decrease in BLL... why?

MOST ABSORBED LEAD IS STORED IN BONE



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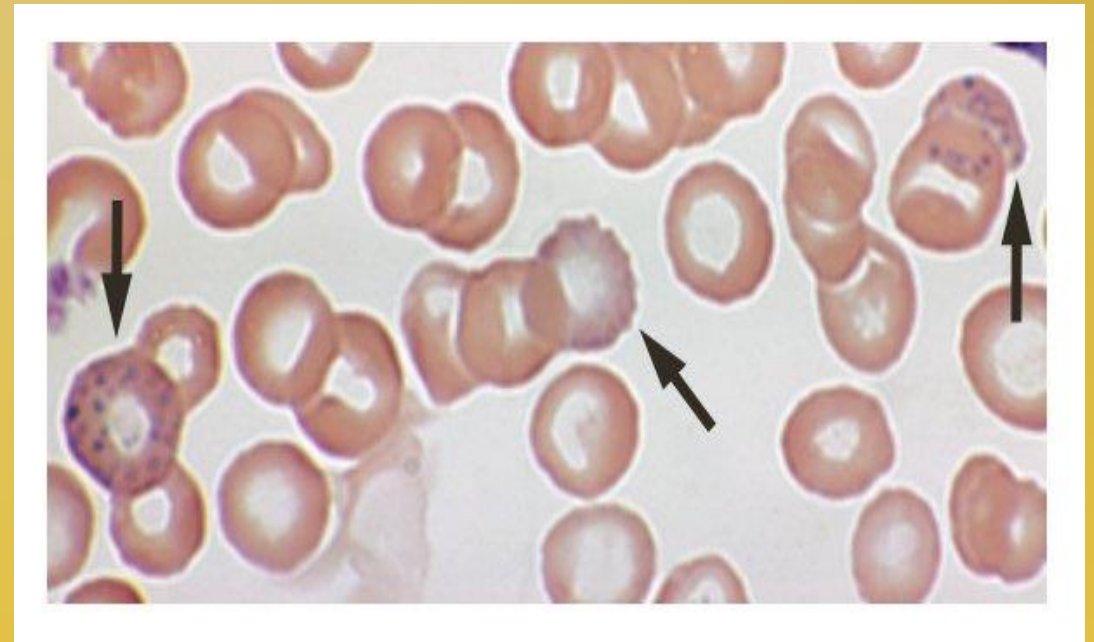


The chart shows the effects of lead contamination at various levels. The levels in this diagram do not necessarily indicate the lowest levels at which lead exerts an effect. These are the levels at which studies have adequately demonstrated an effect.

Source: ATSDR, 1990.

HOW LEAD CAUSES ANEMIA (LOW HEMOGLOBIN)

- **Inhibits enzymes required for red blood cell (rbc) formation**
- **Decreases erythropoietin production in the kidney**
- **Decreases the life span of a rbc by making the cell membrane more fragile**
- **Pale, small rbcs (microcytosis, hypochromia)**



CASE 4: NEW HAMPSHIRE, 2000

- **2 y.o. girl presented to a community hospital ED with c/o low grade fever and vomiting x 1 day**
- **Lab findings:**
 - microcytic anemia – hemoglobin **7.6g/dL** (normal >11.4)
 - **Basophilic stippling of red blood cells noted**
 - **Throat swab rapid strep test – Positive**
- **Discharged home with rx for an antibiotic for strep throat and medication for nausea/vomiting**

CASE 4: NEW HAMPSHIRE, 2000

- **19 days later, admitted to same hospital for worsening vomiting**
- **Transferred the next day to a tertiary care hospital**
- **Later that day hypotension, difficulty breathing developed and she became unresponsive**
- **Intubated and ventilated**
- **CT scan showed diffuse cerebral edema (swelling of the brain)**

CASE 4: NEW HAMPSHIRE, 2000

- **A BLL drawn 1 day earlier = 391 $\mu\text{g}/\text{dL}$**
- **Chelation therapy started with british antilewisite (BAL) and calcium ethylenediaminetetraacetic acid (CaN_2EDTA)**
- **BLL decreased to 72 $\mu\text{g}/\text{dL}$**
- **Surgical treatment of increased intracranial pressure**
- **Coma persisted. Patient removed from life support 2 days after transfer**

DEMOGRAPHIC INFORMATION

- **Family Sudanese and had been living in Egypt 18 months**
- **Arrived in NH as refugees 3 weeks before illness**
- **Living in an apartment built prior to 1920**
- **The patient had been seen eating paint and plaster from holes in a wall**

ENVIRONMENTAL INVESTIGATION

- **BLLs in the mother and 3 siblings (ages 5-15): 4-12 $\mu\text{g}/\text{dL}$**
- **Lead isotope composition from the porch paint (35% lead) and window well dust ($6732\mu\text{g}/\text{ft}^2$) most closely matched the patient's blood lead composition**

INORGANIC LEAD:

The Lowest Observed Effects in Children



The chart shows the effects of lead contamination at various levels. The levels in this diagram do not necessarily indicate the lowest levels at which lead exerts an effect. These are the levels at which studies have adequately demonstrated an effect.

ACUTE LEAD ENCEPHALOPATHY

- Typical BLL >70-100 $\mu\text{g/dL}$
- Nerve palsies (cranial nerves) and seizures
- Bizarre behavior
- Ataxia (imbalance)
- Loss of developmental skills
- Cerebral edema/increased intracranial pressure (persistent vomiting, headache)
- Coma

SUMMARY: HEALTH EFFECTS

- **Children can develop health effects *without* apparent symptoms**
- **The diagnosis of lead poisoning is made by the blood lead level**
- **Symptoms can be vague and non-specific(e.g. fatigue, irritability)**
- **Children are more susceptible to lead poisoning than adults**
- **Lead affects every system in the body**
- **The blood lead level (BLL) may not reflect the total body lead burden**

THE BEST MEDICINE = PREVENTION

CHALLENGES IN PRIMARY PREVENTION OF LEAD POISONING

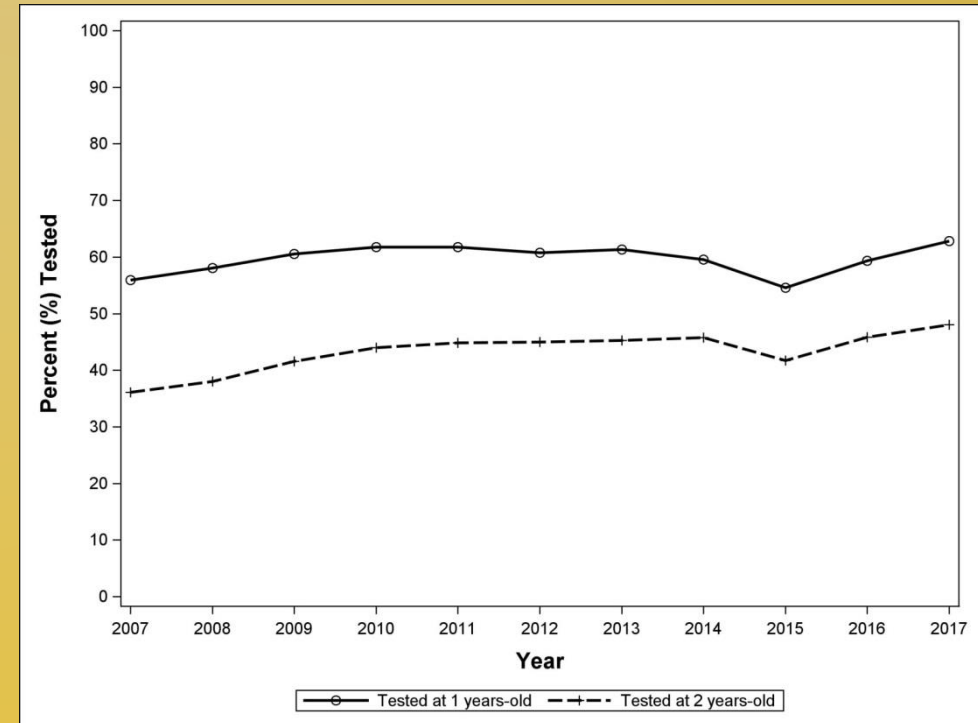
- NC CLPPP has no funding for removal/repair of lead hazards once detected
- Low income families may not be able to repair the lead hazard, so more children can be exposed
- Patchwork of funds and organizations who can assist.
- Need a statewide program for low-income homeowners or landlords



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CHALLENGES IN SECONDARY PREVENTION

- Low rates of testing
- Fewer children tested at age 2 (age of highest risk for lead poisoning)



CHALLENGES IN BLOOD LEAD MEASUREMENT

WASH THAT FINGER!

SOAP AND WATER! NOT WIPES

CHALLENGES IN DATA COLLECTION

- Use of point-of-care blood lead analyzers – manual data entry
- Missing data for blood lead results e.g. child's primary address, DOB
- General statute: Child's address, DOB, name, race, ethnicity, Medicaid # (if any) required by law