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Dealing with Legacy Chemicals at Schools

PCBs, Lead, Flame Retardants

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Washington State Department of Health

Outline of Talk

- PCBs, Lead, flame retardants

- What are they?
- Where might they be found in schools?
- Why are they a health concern?
- What can schools do about them?

Polychlorinated biphenyls (PCBs)

- Manufactured from 1929-1979 in U.S.
- During this period, 1.6 billion pounds manufactured in the U.S.

Photo Credit: Senator Markey Report, 2016

PCBs sources in schools

PCBs in caulk around windows and masonry joints

PCBs used in magnetic T-12 ballasts for fluorescent lights

Photo Credits: EPA website on PCBs

Human Health Effects of PCBs

PCBs can cause cancer, immune toxicity, neurological and behavioral problems, and reproductive effects.

Learning and Behavior

fetal/infant exposures to PCBs…

Animals (rodents and monkeys)

- hyperactivity, slower adaption to new challenge, learning and memory impairments

Children (PCB exposure during fetal period)

- Abnormal infant reflexes, reduced IQ, learning and memory impairments

Immune Effects

Animals

- Reduced antibody response (monkeys)

Humans:

- Elevated ear and lower respiratory infections
- Reduced vaccination response

Reproductive effects

Animals (rodents, monkeys)

- Lower birth weight, fewer live births, lower conception rates

Humans

- Longer time-to-pregnancy
- Reduced growth at birth and into puberty

Interaction with Hormone systems

Strongest evidence - Disruption of thyroid hormone levels

More recent evidence–

- Binding to estrogen receptor
- PCBs induce enzymes that alter estrogen metabolism

Cancer

- Clear evidence that commercial PCB mixtures cause cancer in animals (liver, thyroid).
- Studies in workers (commercial mixtures)
  - Liver, bile-duct cancers
  - Melanoma

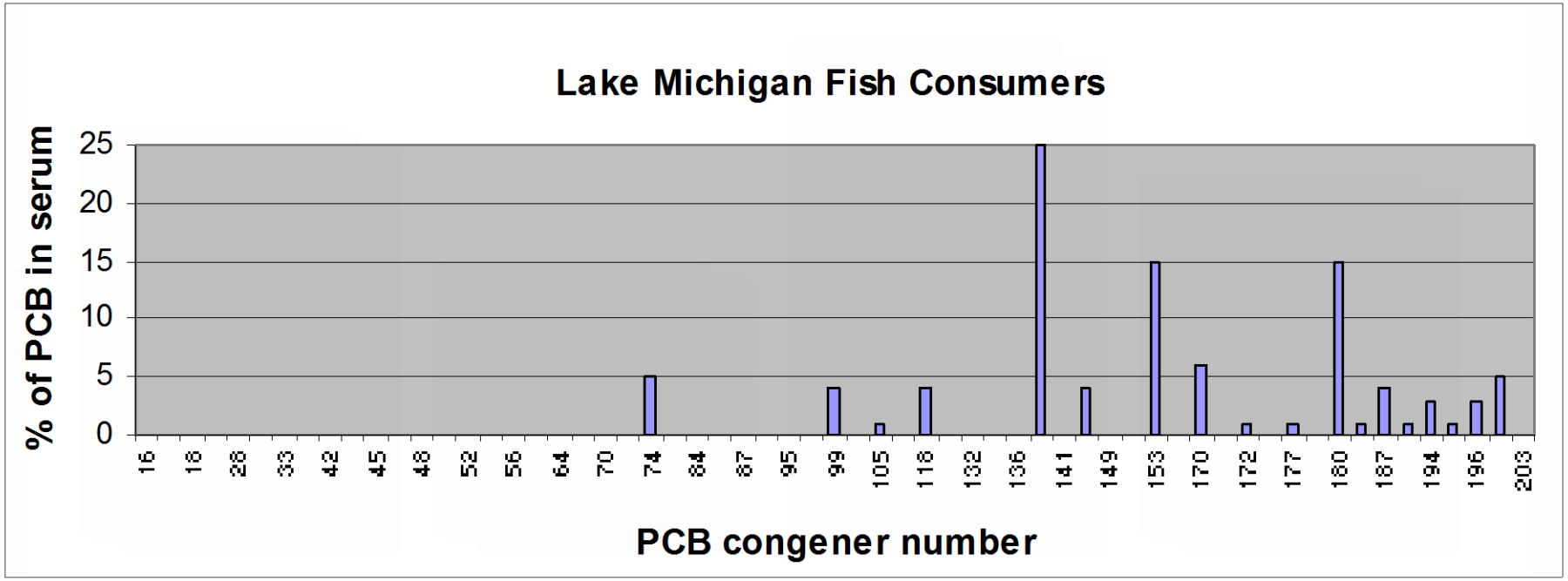
Human exposure to PCBs

- PCB detected in serum of 100% of U.S. population sampled, 2003-04 by CDC.
  - ~80% drop in blood serum of US Population since 1980

Top sources of PCBs:

- Diet (especially certain fish)
- Building materials, house dust, indoor air
- Ambient air, water, soil

Fish Consumers



Humphrey et al., 2000

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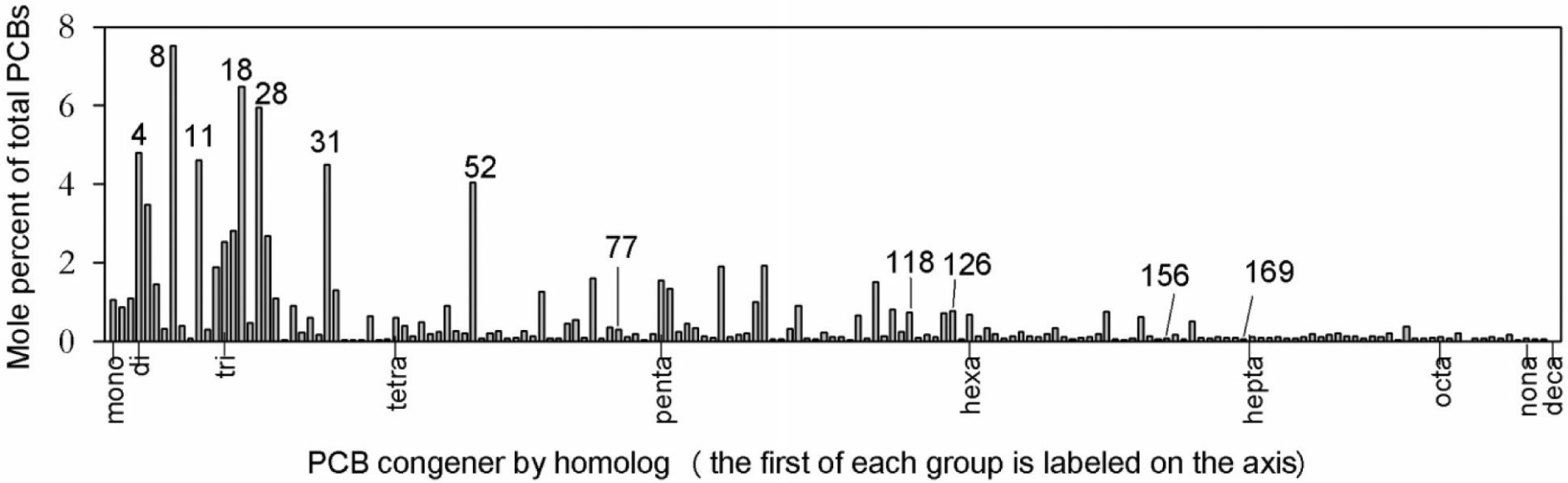
PCBs in urban air (Chicago)



Hu et al. 2008 Environ Sci Technol 42(21):7873

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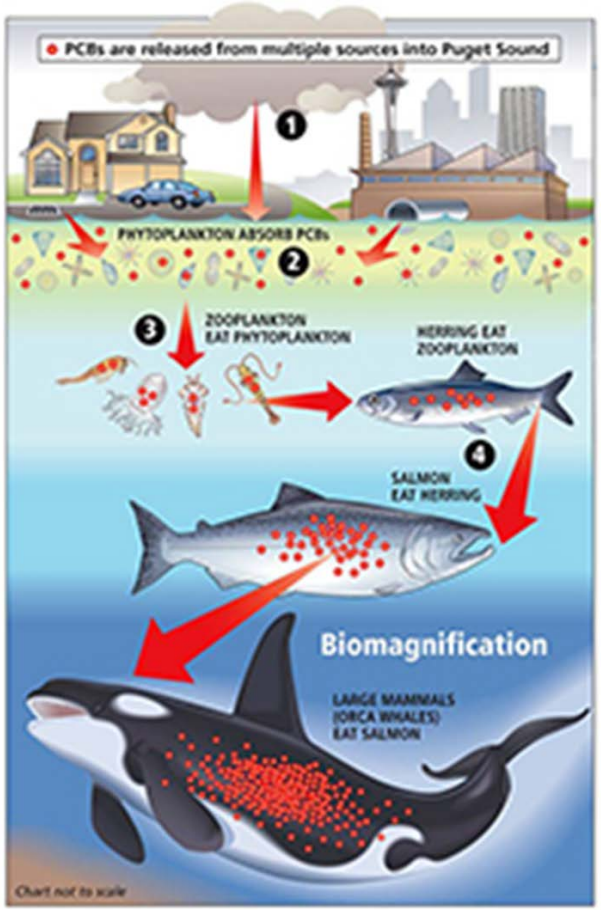
Human Exposures Vary

- Background exposure
- Populations with higher body burdens:
  - Fish consumers
  - Consumers of marine mammals
  - Living/working in contaminated buildings
  - Older age
  - Occupational exposure

Control indoor sources to…

- Prevent inhalation of airborne PCBs by staff and students
- Prevent skin contact with sources (e.g. caulk)
- Prevent ingestion of dusts



- Prevent release of PCBs to environment

Find and replace old PCB light ballasts and fixtures

Reduce risk

- Ballasts at high risk for failing (dripping, catching fire)
- Ballasts likely to be emitting small amounts of PCBs
- Fixtures may be contaminated with PCBs

Other reasons

- New lighting is much more energy efficient
- T12 fluorescent lighting does not meet new efficiency standards

How to find and remove ballasts

- Visual inspection to see if light ballasts contain PCB.
- Hire contractor to remove PCB ballasts and any contaminated parts of fixture.

A typical pre-1979 PCB-containing fluorescent light ballast (FLB)

A typical Non-PCB containing fluorescent light ballast. The ballast has a "No PCBs" marking on the top of the ballast and the text "electronic ballast". Only magnetic fluorescent light ballasts contained PCBs.

Photo credit: EPA website

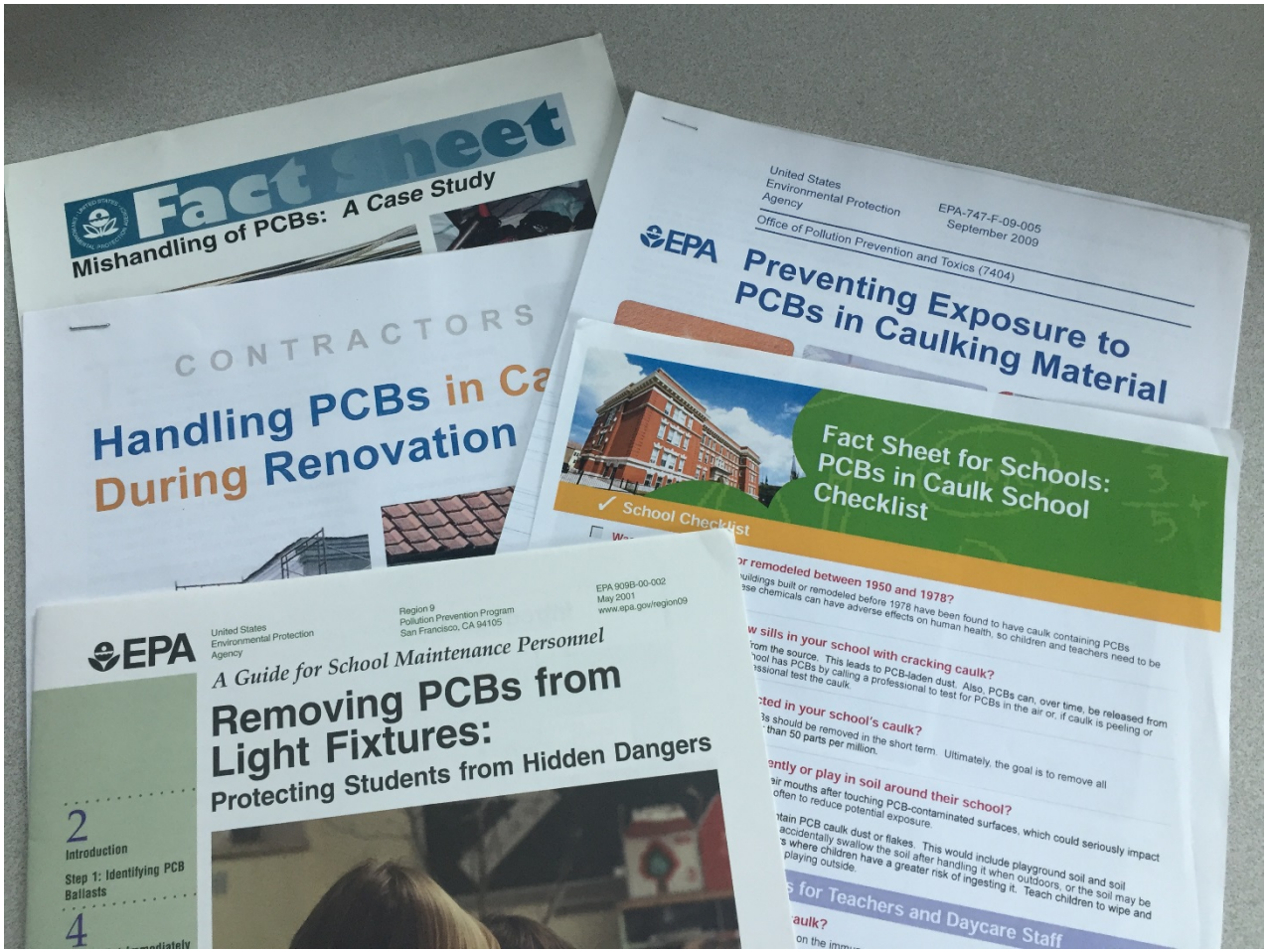
What You Can Do about Caulk

- Test and remove PCB contaminated caulk.
- Until it can be safely removed, limit exposure to caulk containing PCBs (EPA advice):
  - Apply sealant to minimize escape
  - maintain a proper ventilation in building
  - Keep children from touching caulk or surfaces near it
  - Wash children's toys often, and wash their hands with soap and water before eating
  - Use wet cloths to clean surfaces and clean frequently to reduce dust

Do NOT remove PCBs without help

- Detailed laws governing handling, disposal of hazardous waste.
- Important safety rules about how to protect workers, school population during removal and clean-up – Must be followed!
- Errors in removal and clean-up can expose people and drastically increase costs for school.
- **WA Resources**: EPA Region 10, Dept of Ecology.

https://www.epa.gov/pcbs



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Lead

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What is Lead?

- Natural metal
- Historic uses in Washington State
  - Additive in paint, gasoline
  - lead water pipes and lead solders in plumbing
  - Industrial emissions from mining, smelters *(489,000 acres in WA impacted by smelters)*
  - Ingredient in popular orchard insecticide (*188,000 acres impacted by lead-arsenate in WA)*

Lead also in Products: Examples

- Ceramic dishes – red and yellow glazes
- Pewter, leaded glass crystal
- Some traditional, folk, ethnic remedies/cosmetics
- Lead-acid batteries
- Ammunition and fishing weights

Lead in vinyl

Toys and jewelry

Fishing weights

Lead Exposures and Pathways

HOME
Paint
Lead pipes
Lead solder
Consumer products
Hobbies
Imported cosmetics
Traditional remedies

OUTDOOR
Soil
Job take-home
Leaded gas residue
Industrial emissions
Ammunitions
Aircraft

DUST

SOIL

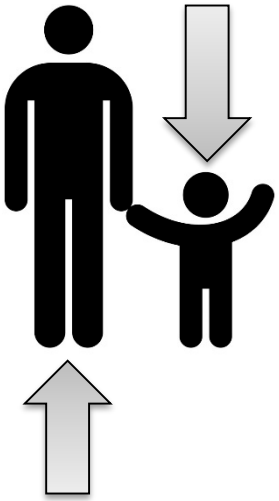
WATER

FOOD

Ingestion

Inhalation

40-70% absorption*



5-20% absorption

* Rates for ingested lead only, ATSDR

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Key sources of lead for children

- Indoor paint and paint dust
- Hobbies, consumer products
- Drinking water (from pipes and solder)
- Contaminated soil (from exterior paint, industrial emissions, lead-arsenate pesticide use)

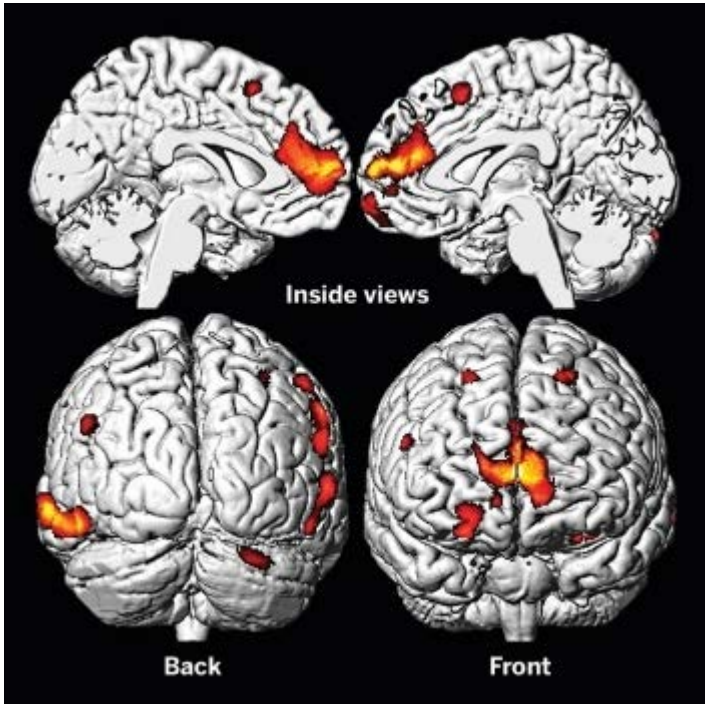
Health Effects of Lead

- Highly toxic, No known safe threshold
- Irreversible adverse effects on child's nervous system, growth and development, cognitive development, and behavior
- CDC action level = child's blood lead ≥ 5 µg/dL.

Children < 6 y/o are Most Vulnerable

- Developing brain and nervous systems is more sensitive to lead.
- Young children have higher exposure:
  - absorb more of the lead they are exposed to
  - hand-to-mouth behavior and close contact with floor increases intake of lead in dust or soil
  - Ingest more water per pound than adults so intake of lead from water is higher (especially infants ingesting formula mixed with lead-contaminated water)

Impacts to children's learning and behavior



Loss of gray matter in adults with childhood lead poisoning

Cecil et al (2008) PLOS Medicine DOI:10.1371

- Developing brain is very sensitive to chemicals early in life
- There is sufficient evidence that early childhood blood lead level <5 µg/dL is associated with decreased academic achievement, decreased IQ, attention-related behavior problems, anti-social and criminal behavior later in life.
  - *National Toxicology Program Monograph on Health Effects of Low-level Lead, 2012*

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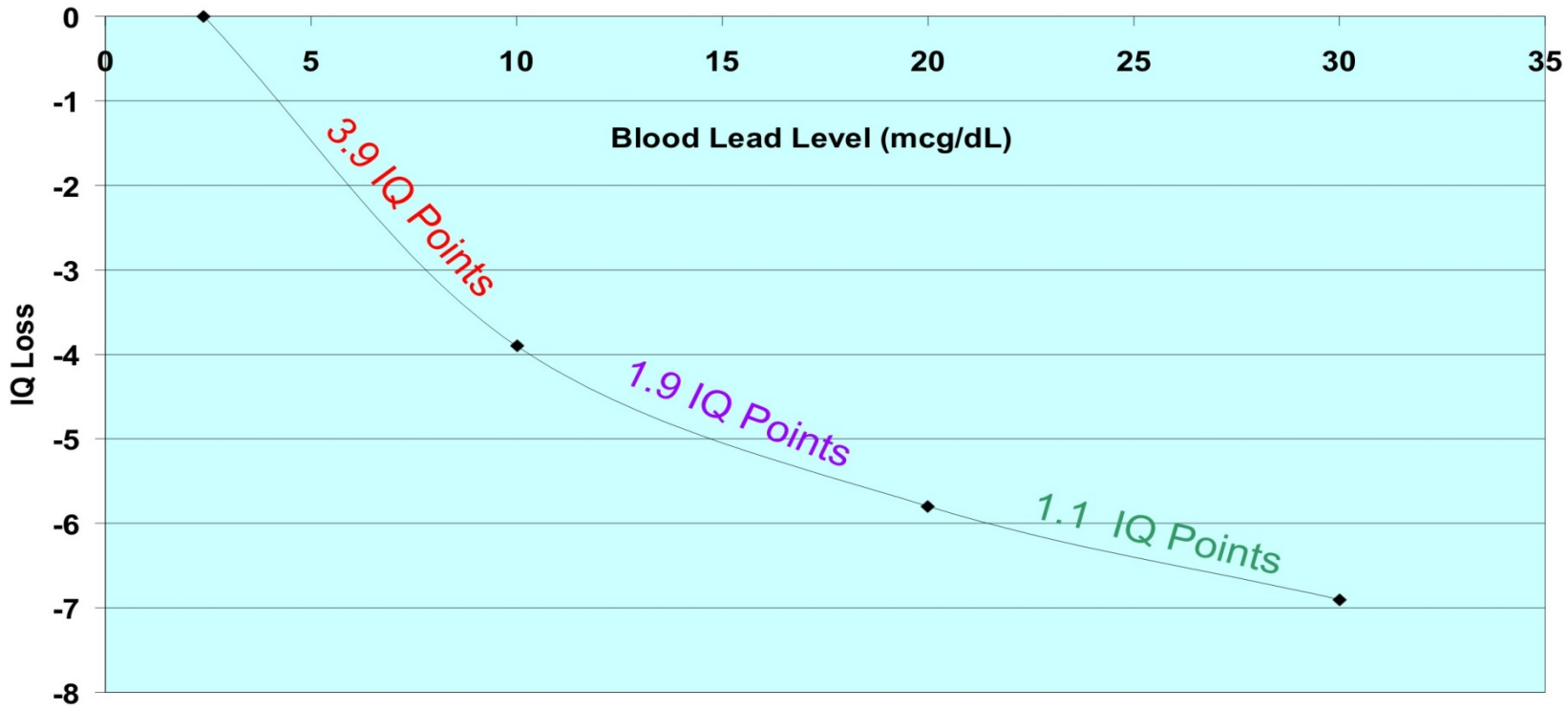
IQ Loss versus BLL

Lanphear et al, 2005, Environ Health Perspect 113(7): 894-9



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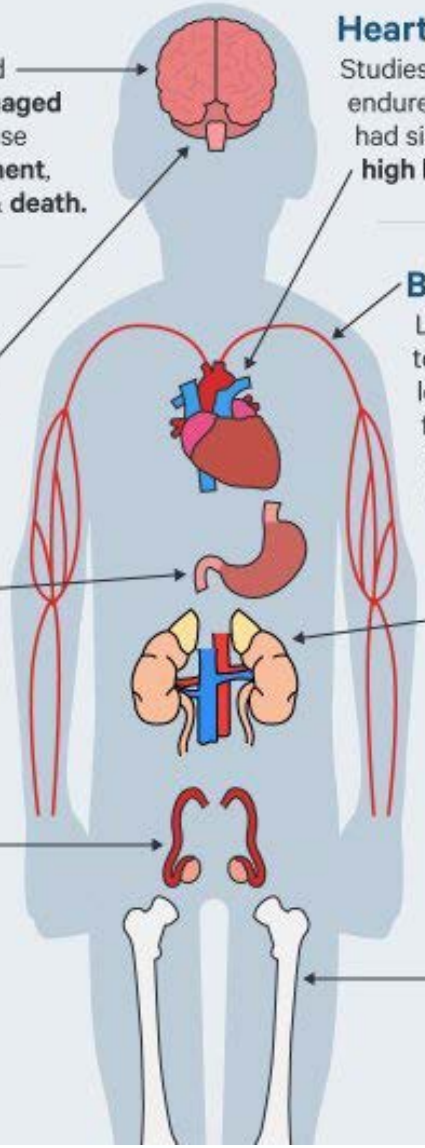
Lead isn't good for adults either…

- Sufficient evidence that low blood lead in adults are associated with…
  - Reproductive effects
  - Renal effects
  - Cardiovascular effects
  - Essential tremor

– National Toxicology Program Monograph on Health Effects of Low-level Lead, 2012

How **lead** affects childrens' health



Brain

Any exposure is linked to lowered **IQ**, **ADHD**, **hearing loss**, and **damaged nerves**. Acute exposures can cause convulsions, **loss of body movement**, **coma**, **stupor**, **hyperirritability**, & **death.**

Hormones

Lead disrupts levels of vitamin D, which can **impair cell growth**, maturation, and tooth and bone development.

Stomach

Severe lead exposure can create intense **abdominal pain** and **cramping**.

Reproductive System

A moderate exposure can not only **lower sperm count**, but also **damage them**. Chronic exposures can diminish the concentration, total count, and motility of sperm, though it's unclear how long these effects last after the exposure ends.

Heart

Studies suggest that adults who endured lead poisoning as children had significantly higher risks of **high blood pressure** 50 years later.

Blood

Lead inhibits the body's ability to make hemoglobin, which can lead to anemia. This reduces oxygen flow to organs, causing **fatigue**, **lightheadedness**, **rapid heartbeat**, **dizziness**, & **shortness of breath.**

Kidneys

Chronic exposures can cause chronic inflammation, which can lead to **kidney failure**, **bloody urine**, **fever**, **nausea**, **vomiting**, **drowsiness**, **coma**, **weight gain**, **confusion**, **rash**, and **urinary changes**.

Bones

Lead may impair development and the health of bones, which can **slow growth in children**.

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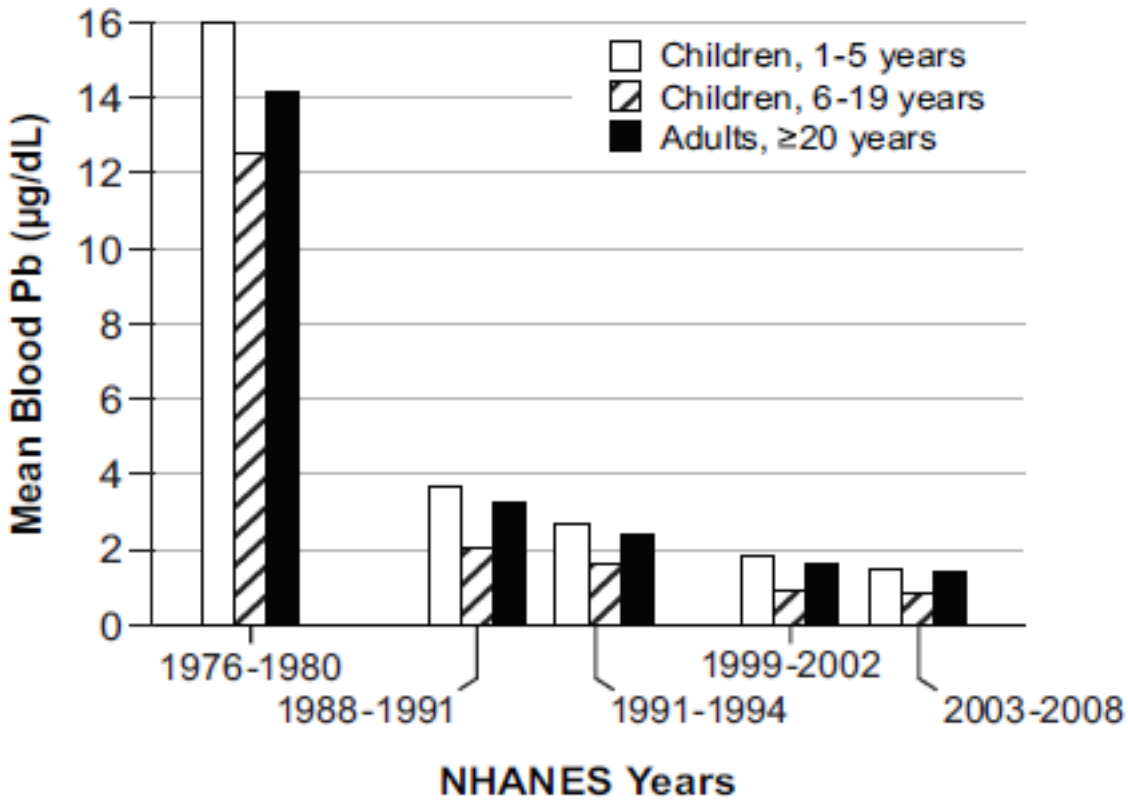
↓Blood lead levels in US population over time



Years and ages are grouped based on available published data:

- 1976-1980 (Mahaffey *et al.* 1982)
- 1988-1991 (Brody *et al.* 1994)
- 1991-1994, 1999-2002 (CDC 2005a)
- 2003-2008 (CDC (2005a, 2011b))

Source: NTP Monograph on Low level effects of lead, 2012

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What schools can do

1. Assess potential for lead in water

   Lead service lines? Lead in water fixtures?

2. Take action to ↓ lead exposure, as necessary

Testing for lead in drinking water is complex, don't test without first learning about EPA's three T's and DOH guidance.

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What schools can do

If school building was constructed before 1978…

- ❑Lead in indoor paint? Dust?
- ❑Lead in exterior paint or soil near building?
- ❑Lead on playground structures?

- **Hire a certified lead inspector or risk assessor**
- **Hire a Lead-Safe certified contractor**

- EPA Renovation, Repair, and Painting Rule may apply if children <6 y/o are present.

Until lead paint source can be safely removed…

- Keep young children away from chewable painted surfaces (window sills)
- Maintain paint (no cracking, chipping, peeling)
- frequent cleaning to remove dust (wet mop, HEPA filter on vacuum)
- Wash hands!
- More recommendations on website: www.doh.wa.gov

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flame retardants

- Polyurethane foam
- Textiles
- Electronics
- Building materials
- Car interiors
- Many plastics

Health concerns for flame retardants

- Cancer
- developmental toxicity (endocrine disruption)
  - Physical and cognitive development
  - Behavioral effects
- Reproductive toxicity
- Liver toxicity

California Investigation in 40 preschools/daycares

(Bradman et al., 2014)

- PBDE and tris-phosphate flame retardants in 100% of dust sampled. Air levels were low.
- Facilities with foam products had significantly higher concentrations of flame retardant chemicals than the centers without such equipment.
- Suspected sources: nap mats, upholstered furniture

2015-16 survey of flame retardants

- Looked for evidence of exposure in the general population and children
  - Biomonitoring
  - Environmental sampling

- Collected available information specific to children's exposures and toxicity to children.

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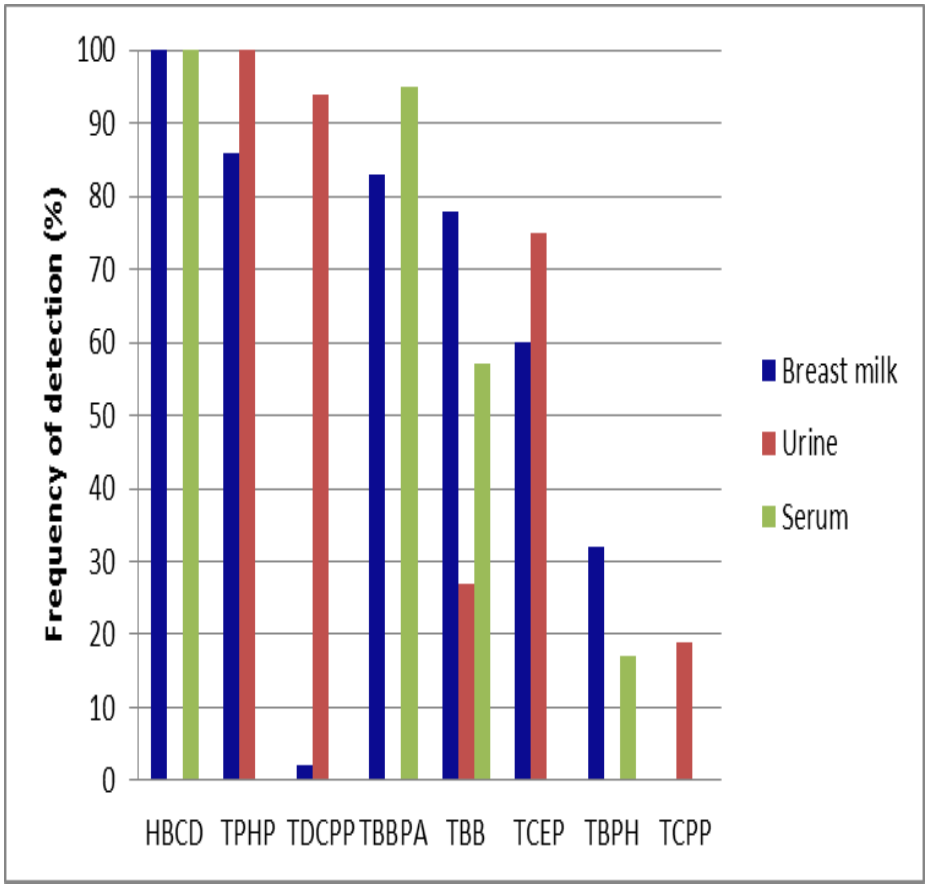
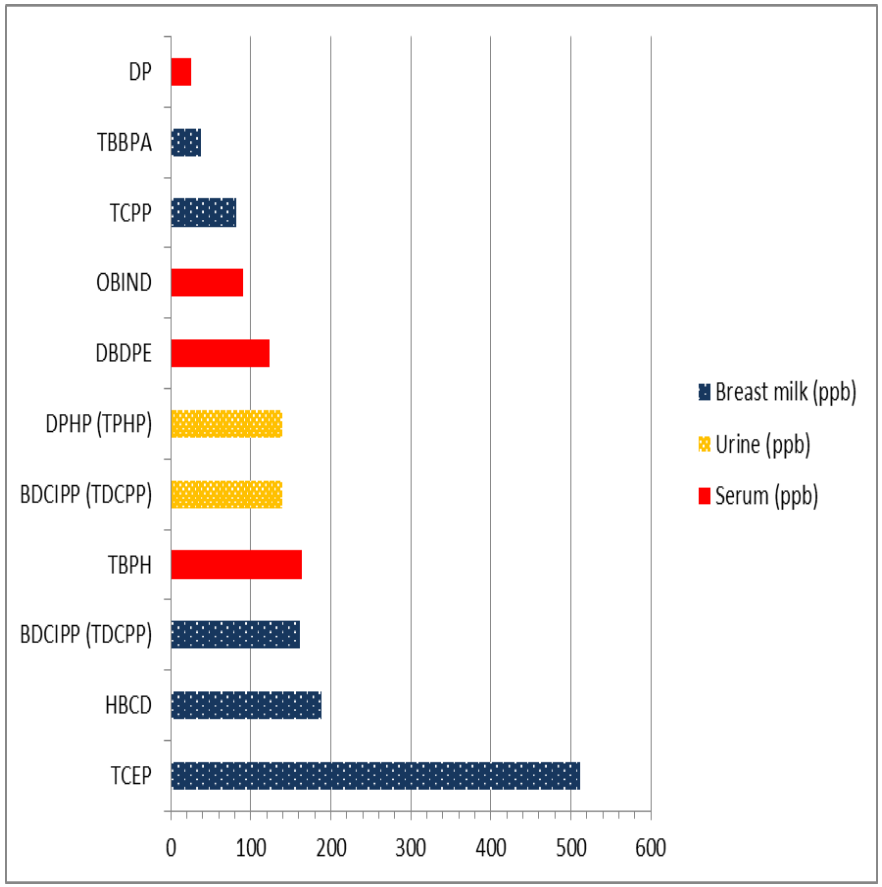
Top FRs found in biomonitoring

- Most frequently found
- Found at highest levels

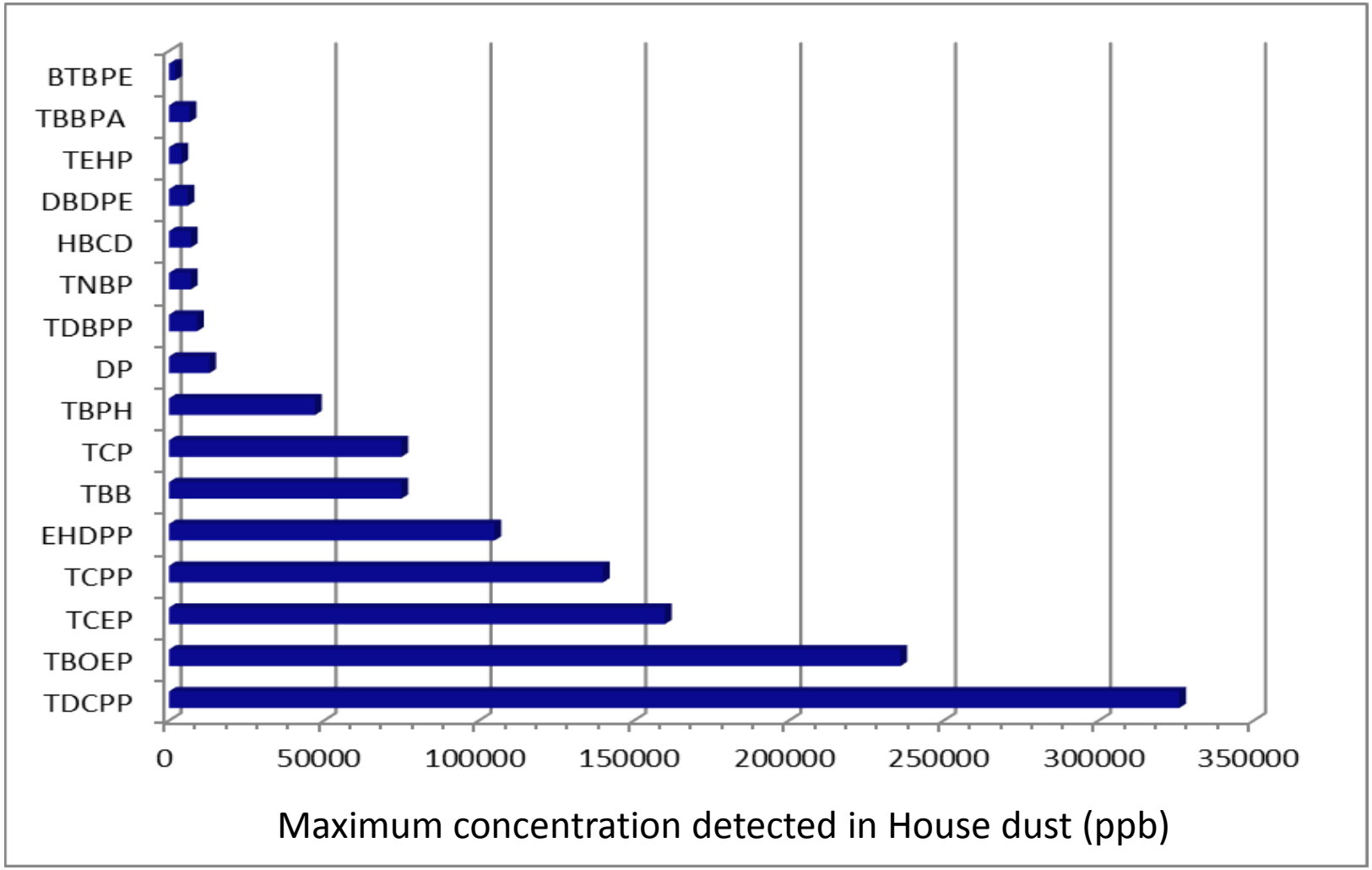




Max. concentration detected

2016 Ban: HBCD, TDCPP, TCEP, TBBPA

TOP FRs found in U.S. house dust



Initial findings

- A number of flame retardants in current use in consumer products are creating unavoidable and unwanted exposures to people.
- Majority of the flame retardants found in people and house dust are additive type flame retardants.
- Many detected have potential for persistence, bioaccumulation, and toxicity -developmental and reproductive toxicity and cancer.

Taking Action

Washington State Laws:

- 2008 RCW 70.76 - *restricted PBDEs in WA products*
- 2016 RCW 70.240.025 – *restricted 5 more flame retardants in residential furniture and children's products*

Develop recommendations for future policy action – 2017

- DOH reviewing other flame retardants of potential concern to children.
- Expanding disclosure about presence in children products through Children's Safe Product Act (RCW 70.240)

What schools can Do

- New upholstered furniture can meet flammability standards without flame retardant chemicals
  - Check new California furniture labels (TB117-2013)
  - Green Science Policy Center has a buyers guide www.GreenSciencePolicy.org

- Frequently clean to remove indoor dust
- Maintain ventilation in school buildings
- Wash hands before eating

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