Health impacts of lead in the context of used lead acid batteries

Webinar on the Sustainable and Environmentally Sound Management of used lead acid batteries in Latin America and the Caribbean

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- Sources and routes of human exposure
- Health effects according to the level of exposure
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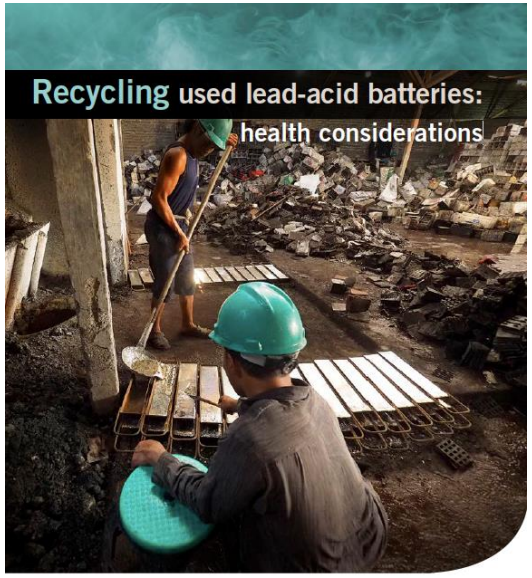
Lead-acid batteries

- Global demand of refined lead – 10.8 million tonnes in 2016
- Half from lead recycling
- ≃ 85% total global consumption – motorized vehicles, solar cells, wind turbines, back up power supplies
- Recycling – source of environmental and human exposures – informal and artisanal market



Additional chemical hazards in lead acid batteries recycling

- Plastic – hard rubber (ebonite) – when burned result in toxic gases, including sulphur dioxide, chlorine, dioxins and dibenzofurans
- Sulfuric acide electrolyte solution
- Lead with asrsenic, antimony, barium and cadmium

Lead causes significant burden of disease

Estimates from Institute for Health Metrics and Evaluation (IHME), 2017 data

- 1.1 million deaths from long-term effects
- 24.4 million disability adjusted life years (DALYs) lost
- 63.2% of the global burden of idiopathic developmental intellectual disability
- 10.3% of hypertensive disease

- *https://vizhub.healthdata.org/gbd-compare/*

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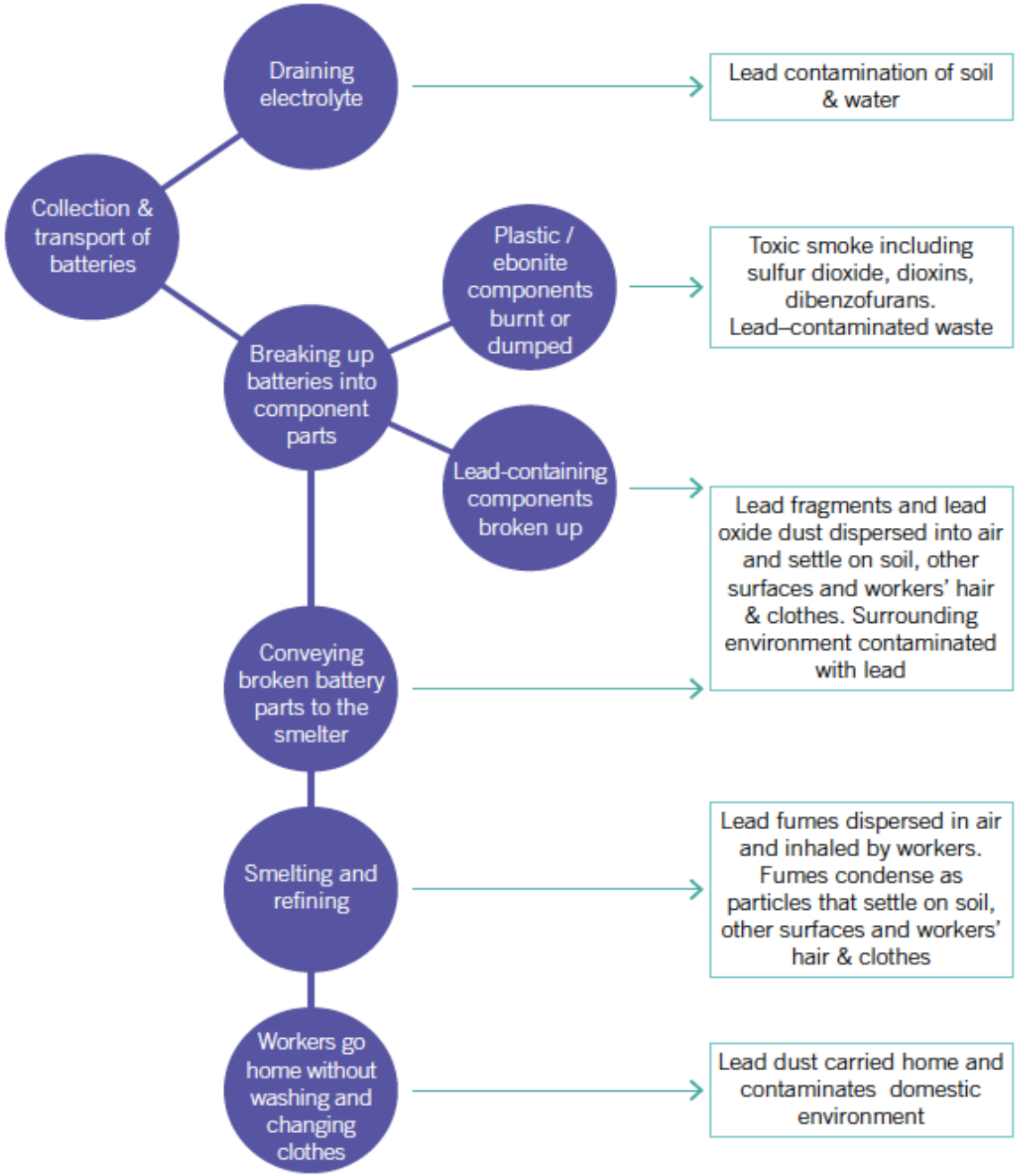
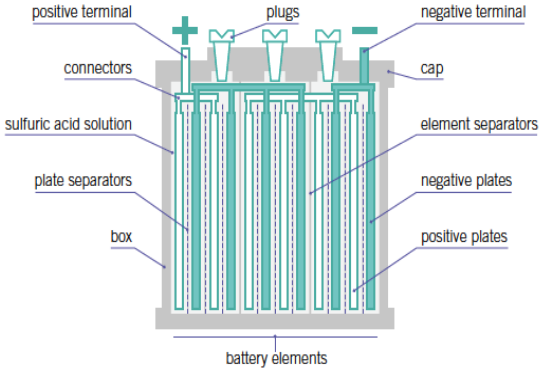
Figure 2. **Schematic illustrating points at which lead is released during battery recyclin**





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Main routes of human exposures and absorption: inhalation and ingestion of fumes and dust; dermal contact

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Table 1. **Association of subclinical and clinical effects with blood lead concentrations**

Blood lead concentration	Health effect	Reference
<5 µg/dL	**Children:** • Decreased IQ, cognitive performance and academic achievement • increased incidence of problem behaviours and diagnosis of attention deficit hyperactivity disorder • Reduced fetal growth (based on maternal blood lead concentration) **All ages:** • Impaired renal function, • Reduced synthesis of delta-aminolevulinic acid dehydratase (ALAD), contributing to anaemia	NTP, 2012
<10 µg/dL	**Children:** • Delayed puberty **Adults:** • Hypertension • Increased cardiovascular-related mortality *(based on limited evidence)* • Spontaneous abortion (based on maternal blood lead concentration) *(based on limited evidence)* • Preterm birth (based on maternal blood lead concentration) *(based on limited evidence)*	
>20 µg/dL	**Children:** • Anaemia	Schwartz et al., 1990
>30 µg/dL	**Children:** • Reduced nerve conduction velocity	

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Table 1. Association of subclinical and clinical effects with blood lead concentrations

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>40 µg/dL	**Children:** • Decreased haemoglobin synthesis **Adults:** • Peripheral neuropathy • Neurobehavioural effects • Abdominal colic	ATSDR, 2007
>50 µg/dL	**Adults:** • Decreased haemoglobin synthesis	
>50 µg/dL *(= lowest concentration in children with malaria)*	**Children:** • Severe neurological features	Greig et al., 2014
>60 µg/dL	**Children:** • Abdominal colic	NAS, 1972 quoted in ATSDR, 2007
>60 µg/dL *(= lowest concentration; mean 178 µg/dL)*	**Children:** • Features of acute poisoning but no encephalopathy	
>90 µg/dL *(= lowest concentration, mean 330 µg/dL)*	**Children:** • Encephalopathy	
>105 µg/dL *(= lowest concentration in children without malaria)*	**Children:** • Severe neurological features	Greig et al., 2014
≥150 µg/dL	**Children:** • Death	NAS, 1972 quoted in ATSDR, 2007
>216 µg/dL *(= lowest concentration, range 216-460 µg/dL)*		Thurtle et al., 2014

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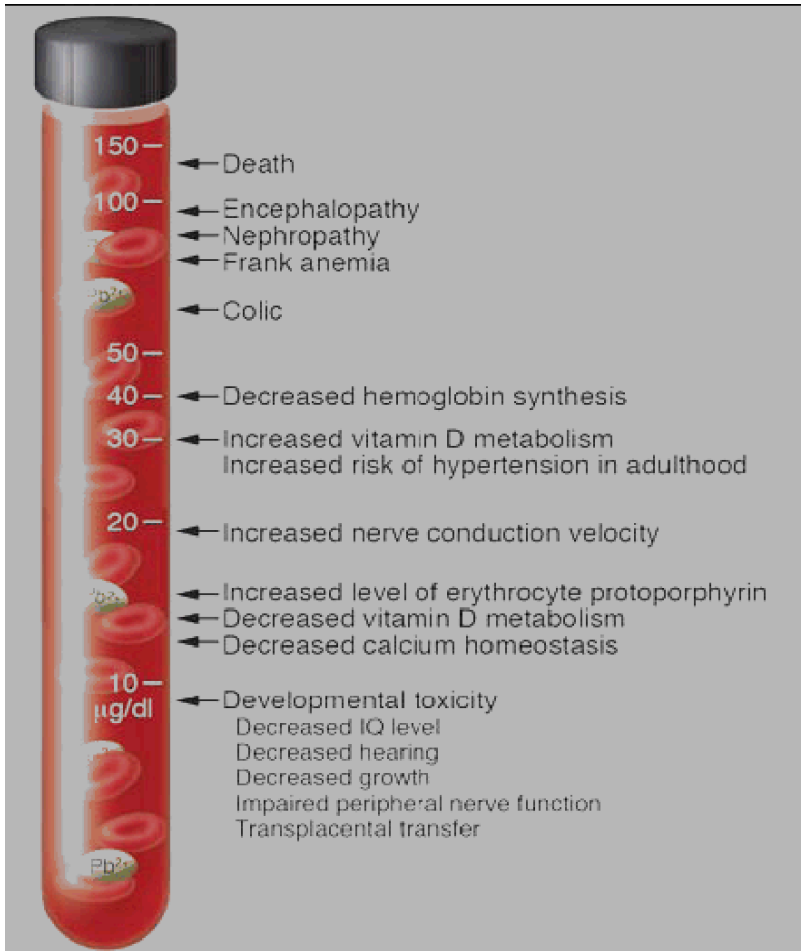
FAO/WHO Expert Committee on Food Additives (2010): withdrew previously tolerable intake

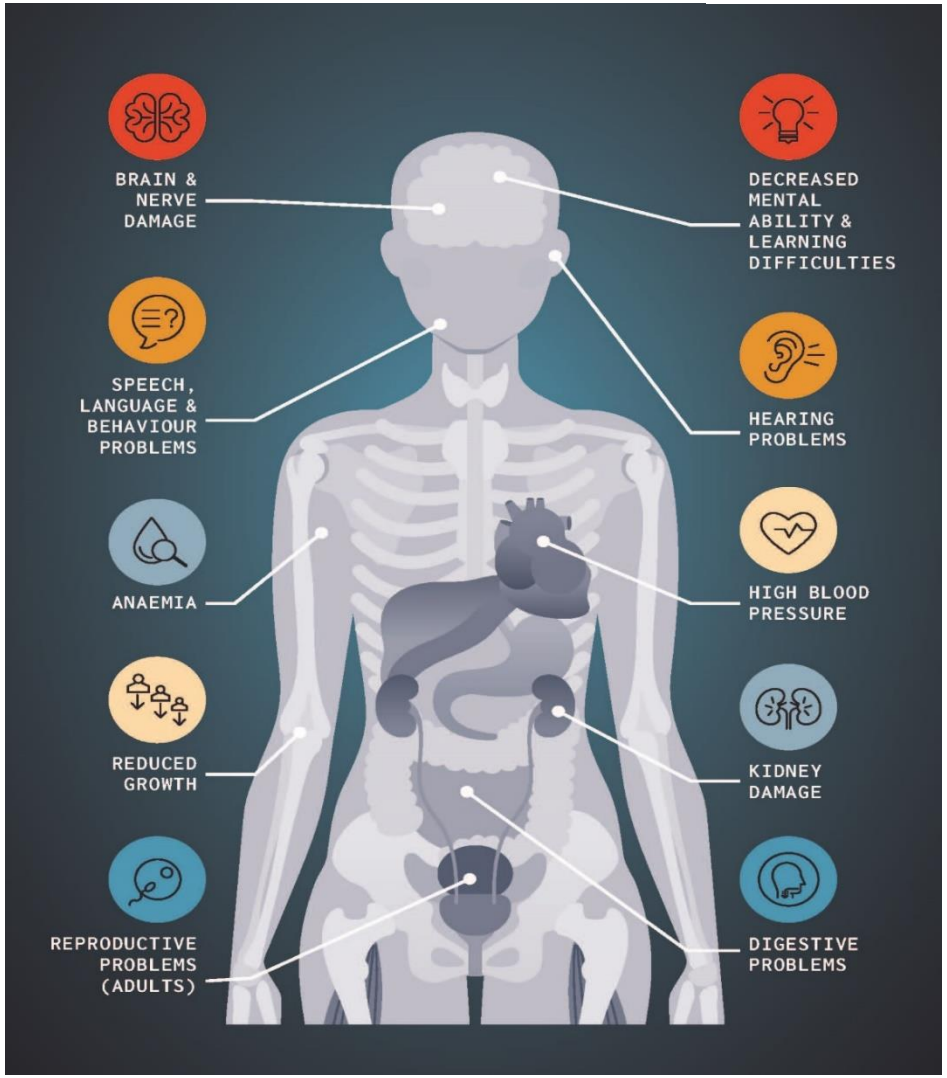
> **"no threshold level below which lead causes no injury to the developing human brain"**

CDC (2013): "*no safe blood lead level (BLL) in children has been identified*."

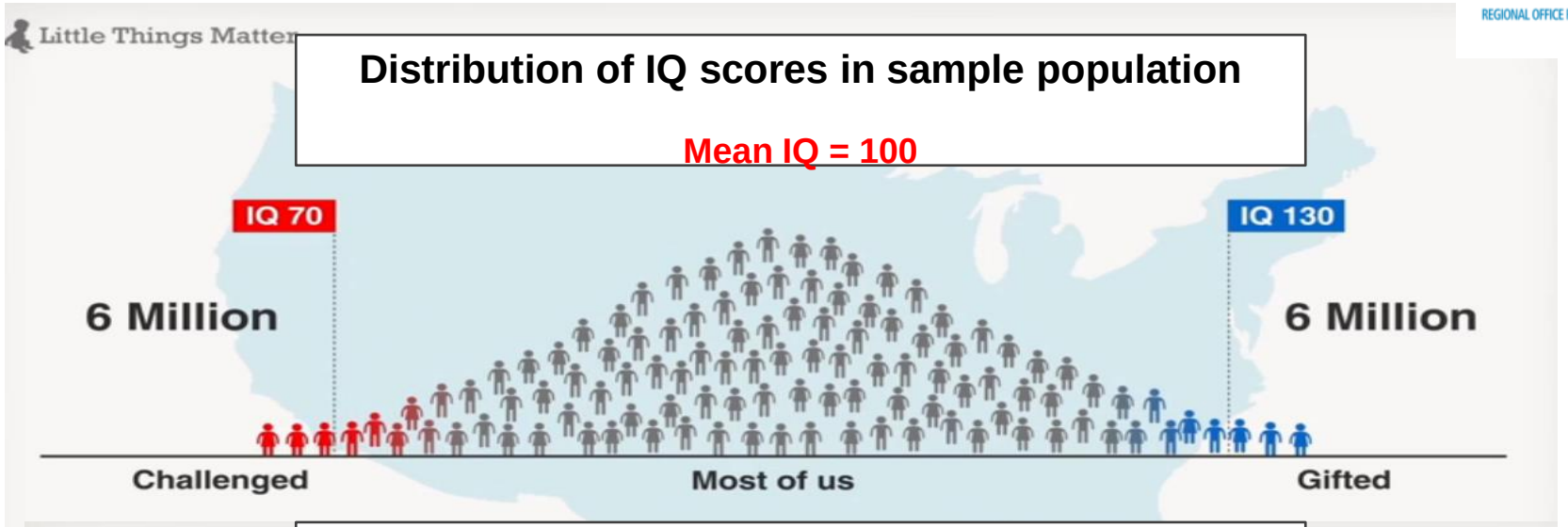


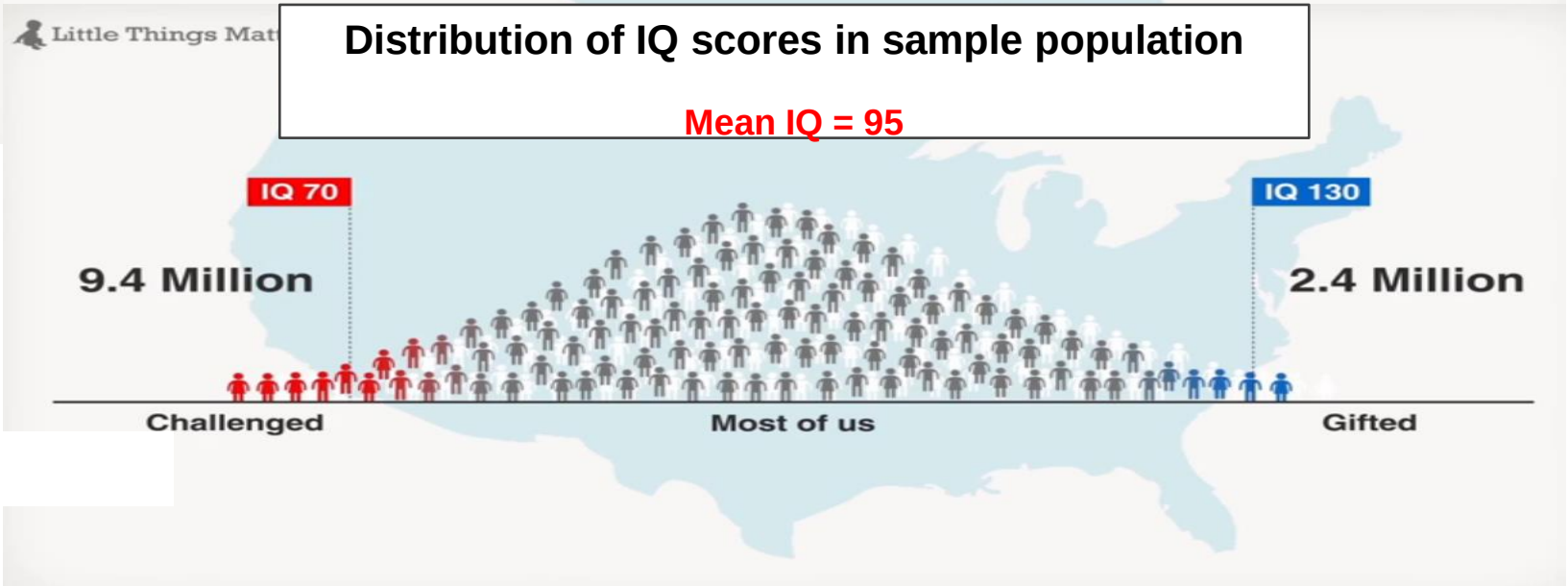
Lead is a multi-system toxicant

- No known level of exposure without harmful effects
- Mimics calcium and iron in the body so has effects in multiple body systems
- Accumulates in bone
- Long-term effects include reduced IQ, antisocial behaviour, cardiovascular & renal disease



Small IQ reduction has significant societal impact





Children are especially vulnerable

- Greater exposure:
  - spend more time on the ground and in contact with contaminated soil and dust
  - hand-to-mouth activity, mouthing
  - absorb 4–5 times more lead from the gut than adults
- Early childhood is critical period for neurological and organ development
- Damage may be permanent
  - reduced potential for intellectual development
  - increased likelihood of behavioural disorders

Figure 2 – A large quantity of lead paint chips can be seen in this radiograph of the abdomen and pelvis of a 2-year-old boy with lead poisoning.

Pregnant women under vulnerable conditions for lead exposures

- Pregnancy mobilizes lead stored in bone, releasing it back into blood where it can be circulated to maternal tissues and the fetus
- Lead exposure may cause reduced fetal growth
- Lead exposure in pregnancy increases risk of complications e.g. hypertension

Treatment

- Chelation therapy – EDTA (ethylenediaminetetraacetic acid)
- Chelators bind to metals, including ones that are essential (calcium, copper and zinc), and thus requires replacement
- Chelation is not recommended if metals exposures continue

Lead persists in the environment

- Lead concentration in water and soil is highest near point sources
- Lead particles can undergo long-range atmospheric transport and be deposited on soil, water and crops
- Mobility and bioavailability are determined by pH and presence of organic and inorganic matter to which lead can bind

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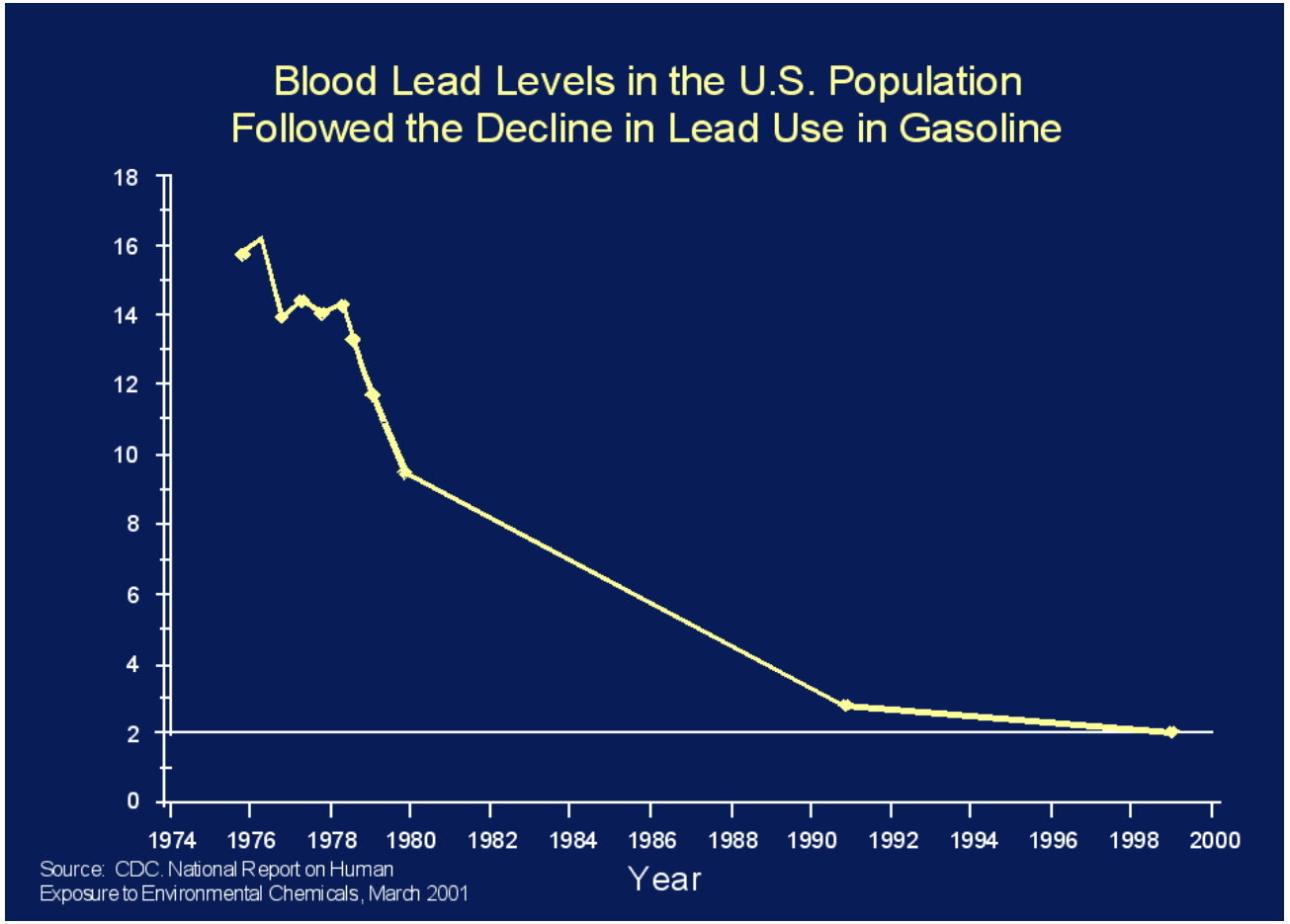
- May be bioaccumulated in food chains, toxic to soil microorganisms & invertebrates e.g. nematodes, insects
- In animals, damages multiple organ systems and causes growth deformities

Health impact of public policy



Conclusions

- Lead has wide-ranging effects on health – these have personal, societal and economic impacts
- Lead is a persistent hazard – it remains in the environment, in the home and in the human body
- Lead-acid battery recycling is an important source of exposure to lead
- Prevention is better (and cheaper) than cure!
- Public policies can have positive impacts in public health.

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Thanks for your attention

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