Health, economic and environmental impacts of lead
Outline

• Background
• Sources and routes of exposure
• Health effects
• Societal and economic impacts
• Environmental impacts
• Lead is a versatile and widely used toxic substance

• Human activities result in environmental contamination:
  ➢ mining & smelting; manufacturing, use, recycling and disposal of products made with lead

• Can be used in the manufacture of paint to give properties e.g. colour, rapid drying, corrosion resistance

• Lead paint is a source of human exposure to lead
Multiple pathways of exposure to lead from paint

- **Paint manufacture**
- **Paint application & removal**
- **Decaying paint**
- **Lead-painted toys, furniture**

**Lead in air**
- **Inhalation**

**Lead in dust & soil**
- **Ingestion**

**Body burden e.g. blood lead concentration.**
- **Health outcomes e.g. reduced IQ, abdominal colic, anaemia**
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
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
Pregnant women are vulnerable

• 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
Lead causes significant burden of disease

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

• 1.06 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/
Small IQ reduction has significant societal impact

Distribution of IQ scores in sample population

Mean IQ = 100

Distribution of IQ scores in sample population

Mean IQ = 95
Economic costs of lead exposure are high

• Estimated economic losses due to reduced IQ is ~1.2% of global GDP

• Largest economic burden is borne by low and middle income countries – approx. $977 billion

• Regional economic losses in Latin America and Caribbean approx. $142.3 billion (2.04% of regional GDP)

• Attina TM, Trasande L. Economic costs of childhood lead exposure in low- and middle-income countries. Environ Health Perspect. 2013 Sep;121(9):1097-102
Economic benefits of action are significant

• Banning lead paint now saves future costs
  ➢ Avoids future costs of lead exposure resulting from use of lead paint now e.g. cost of reduced IQ, cost of criminality
  ➢ Avoids future costs of hazard controls for legacy paint e.g. remediation
    o estimated costs of remediating lead-painted homes:
      France: US$ 194 – 499 million
      USA: US$ 1 – 11 billion


Guideline values related to lead exposure

• WHO/FAO tolerable dietary intake – no health protective value established

• WHO drinking water guideline value: 10 µg/L
  ➢ Provisional value, not health-based but based on technical feasibility – concentrations should be maintained as low as reasonably practical

• Paint limit (proposed in Model Law): 90 ppm of total lead
  ➢ Not health-based but based on technical feasibility – concentrations should be maintained as low as reasonably practical
Lead poisoning prevention policies reduce population blood lead levels

- Lead-based Paint Poisoning Prevention Act 1971
- Lead gasoline phase-out 1973
- Lead in plumbing banned 1986
- Lead and Copper Rule (drinking water) 1991
- Safe Drinking Water Act 1974
- Lead limit in residential & decorative paint & on children's products: 600 ppm 1978
- Lead Contamination Control Act (drinking fountains) 1988
- Virtual elimination of lead in gasoline 1988
- Ban on lead solder in food cans 1995
- Residential Lead-Based Paint Hazard Reduction Act 1992
- Housing units with lead based paint hazards reduced by 40% since 1990
- Renovation, Repair and Painting Rule (Lead Paint) 2008
- Total lead in children's products limited to 100 ppm 2011
- Lead limit in residential & decorative paint & on children's products reduced to 90 ppm 2009
Lead persists in the environment

- Multiple sources of lead contamination in the environment – including lead paint
- Lead can remain in the environment indefinitely
- 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
Lead persists in the environment

• Mobility and bioavailability are determined by pH and presence of organic and inorganic matter to which lead can bind

• Lead particles in water bodies eventually settle into sediment where the lead is relatively unavailable

• Lead compounds and fragments can be ingested and cause toxicity
Lead is toxic to organisms at all levels of complexity

- May be toxic to soil microorganisms & invertebrates e.g. nematodes, insects
- In higher animals, damages multiple organ systems and causes growth deformities
- Secondary poisoning may occur e.g. in predators feeding on contaminated animals
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 paint is an important source of exposure to lead

• Prevention - through banning lead paint - is better (and cheaper) than cure!