Health, economic and environmental impacts of lead
Outline

• Background
• Sources and routes of exposure
• Health effects
• Societal and economic impacts
• Environmental impacts
Background

• 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 dust & soil
- Lead in air
  - Inhalation
- 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

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 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 Africa approx. $134.7 billion (4.03% 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


Lead persists in the environment

• Lead can be released during paint manufacture, application, removal & disposal

• Old lead paint fragments into flakes & dust that contaminate the environment

• Lead can remain in the environment indefinitely

• Lead paint creates legacy of potential exposure for years into the future
Lead has impacts on ecosystems

- Lead particles can undergo long-range atmospheric transport and be deposited on soil and water.
- Lead concentration in water and soil is highest near point sources.
- Mobility and bioavailability are determined by pH and presence of organic and inorganic matter to which lead can bind.
- Lead in water bodies settles into sediment where it is relatively unavailable.
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

• Bioaccumulates but does not biomagnify
Conclusions

• Lead is a persistent hazard – it remains in the environment, in the home and in the human body

• Lead has wide-ranging effects on health – these have personal, societal and economic impacts

• Lead paint is an important source of exposure to lead

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