

Health impacts of ULAB recycling

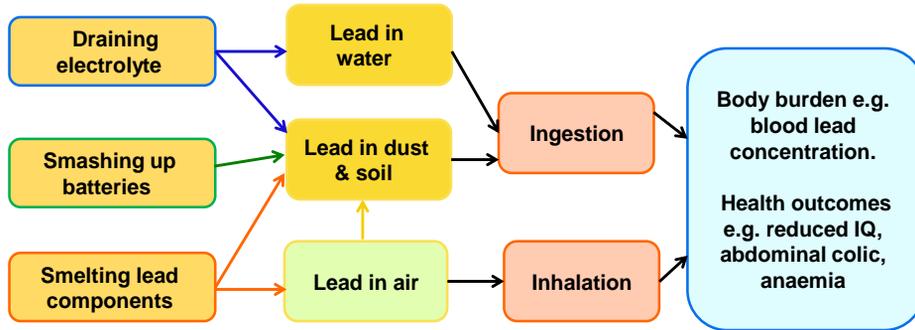


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Outline

- Sources, pathways and routes of exposure
- Health effects of lead
- Risk groups
- Societal and economic impacts
- Summary

Sources and pathways of exposure to lead from ULAB recycling



Lead released during recycling activities – breaking up batteries



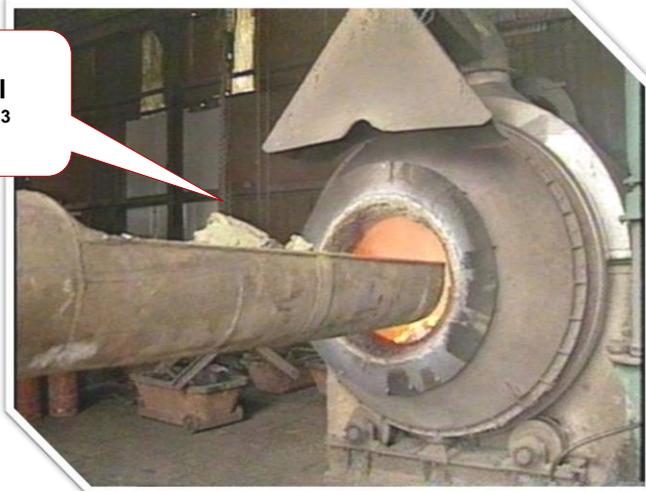
Airborne
lead level
198 $\mu\text{g}/\text{m}^3$

Picture courtesy Faridah Were, Kenya Industrial Research and Development Institute

Kenya, formal sector. Breaking up ULABs using axes, the debris is then sorted manually to remove non-lead materials. Release of lead oxide dust and lead particles

Lead released during recycling activities – charging the furnace

Airborne lead level
195 $\mu\text{g}/\text{m}^3$



Picture courtesy Faridah Were, Kenya Industrial Research and Development Institute

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Charging rotary furnace with lead pieces for smelting

Lead released during recycling activities – casting ingots



Airborne
lead level
161 µg/m³

Picture courtesy Faridah Were, Kenya Industrial Research and Development Institute

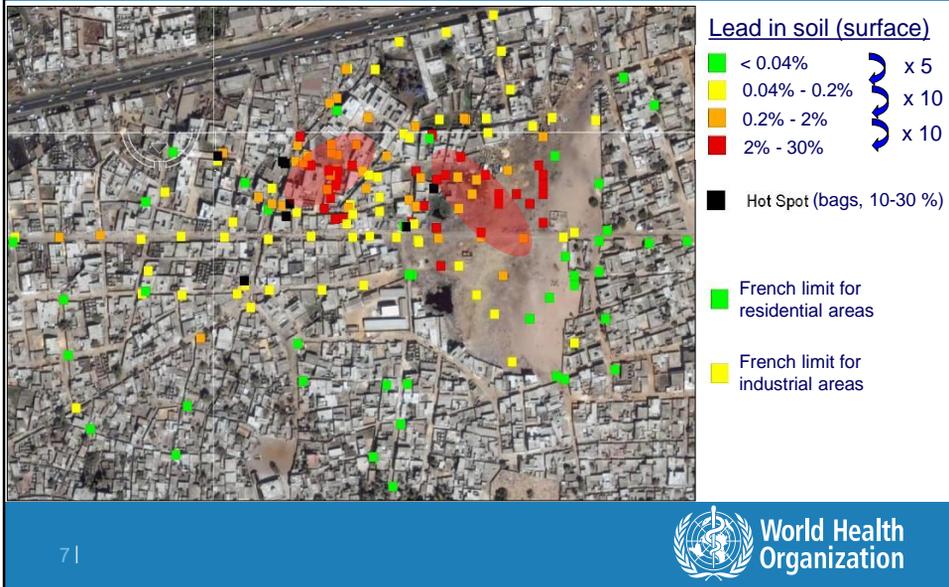
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Casting lead into ingots – fumes containing lead can be seen

Recycling can cause widespread environmental contamination



Picture is from Thiaroye sur Mer in Dakar, Senegal, where years of informal lead battery recycling plus efforts to sift lead particles from soil resulted in lead contamination throughout the community. Lead concentrations in soil were measured. All colours except green are excessive lead levels for a residential area.

2 main routes of exposure to lead

- Inhalation

- fumes and fine particles absorbed from lungs
- larger particles trapped in upper airway then swallowed



- Ingestion

- dust/soil - children at particular risk
- contaminated food and water



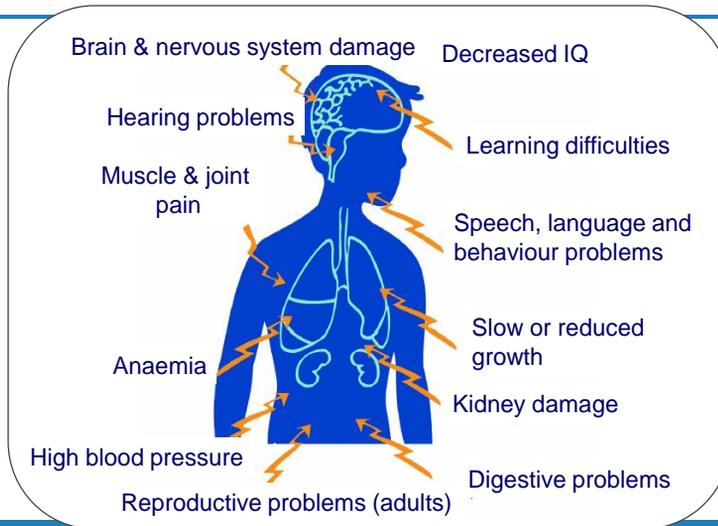
Lead emissions can result in deposition of lead particles on soil and food crops providing a pathway of exposure by ingestion.

Lead accumulates in the body

- Bound to red blood cells and distributes to soft tissues and bone
- Stored in bone for many years (half-life = 10 – 25 years)
 - in adults 90% of body burden may be in bone
- Equilibrium between lead in bone and lead in blood
- Lead in bone provides a store from which lead can move back into blood and to target organs
 - e.g. during pregnancy, lactation and the menopause



Lead is a multi-system toxicant



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Features of lead poisoning may be non-specific

- No safe level of exposure has been established
- Low-level exposure – features of may be subtle e.g. reduced IQ, impaired hearing, increased risk of hypertension
- Features of overt poisoning include: anorexia, colic, constipation, fatigue, mood changes, anaemia and developmental regression in young children
- Lead poisoning may be misdiagnosed e.g. as appendicitis, psychiatric illness



Lead poisoning can be life-threatening

- High dose acute/sub-acute exposure can cause lead encephalopathy with irritability, ataxia, coma, convulsions, death
 - e.g. 18 children died in Thiaroye sur Mer from environmental exposure to lead released by recycling of lead acid batteries
 - siblings had extremely high blood lead concentrations and some had developmental regression



Children are especially vulnerable

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



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Affects developing nervous system

Reduced cognition and behaviour scores

Impaired attention span, visual-motor & reasoning skills, reading ability

Changes in social behaviour (increased impulsivity & aggression)

Blood lead > 100 $\mu\text{g}/\text{L}$ associated with reduced IQ scores (5 points decrement in IQ for each 100 $\mu\text{g}/\text{l}$ increase above this value)

Some neurological damage may be irreversible

Pregnant women are vulnerable

- Pregnancy mobilizes lead stored in bone so further exposure from the environment raises the blood lead concentration even higher
- Increased risk of negative outcomes
 - spontaneous abortion
 - pre-term delivery
 - hypertension during pregnancy – may result in pre-eclampsia
 - reduced fetal growth

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Lead has long been known to adversely affect reproductive outcomes in females and has been used as an abortifacient (Bastrup-Madsen, 1950). Maternal lead exposure, even at low levels, may be associated with reduced fetal growth, lower birth weight, preterm birth and spontaneous abortion (NTP, 2012). Lead exposure is a risk factor for hypertension in pregnancy (gestational hypertension) and high levels of exposure may be a risk factor for pre-eclampsia, which can be life-threatening for both the mother and baby (CDC 2010; Troesken, 2006).

Lead causes significant burden of disease

- 0.6% of global burden disease
- 143,000 deaths per year
- 8.977 million disability adjusted life years (DALYs)
 - 7.2 million DALYs – mild mental retardation
 - 1.8 million DALYs – cardiovascular disease
- Childhood lead exposure contributes ~ 600,000 new cases of children with intellectual disabilities per year

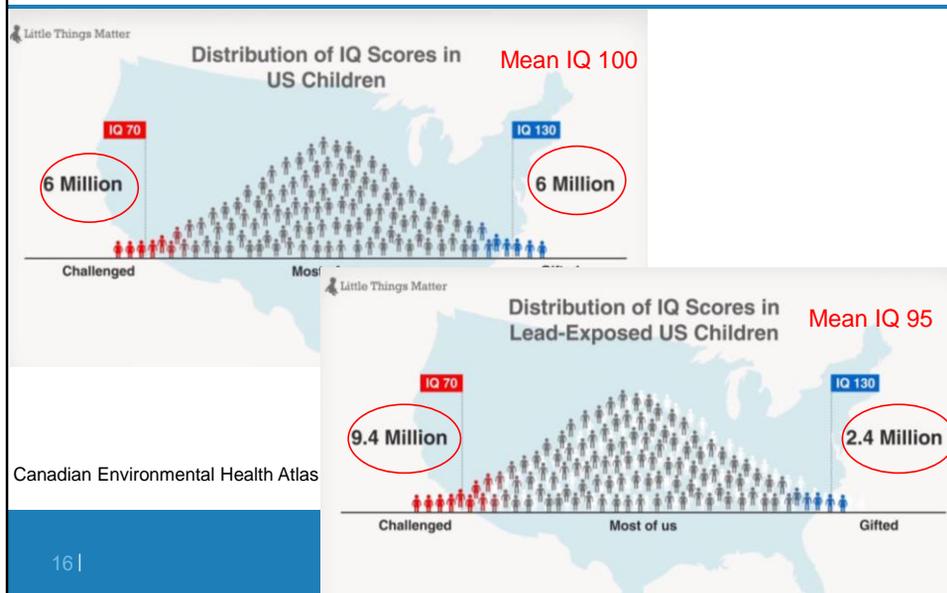
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DALYs = disability-adjusted life years

Small IQ reduction has significant social impact



Animation

A 5-point loss in IQ might not affect the ability of an individual to live a productive life. But if that loss is experienced by an entire population, the implications for that society could be profound.

Professor Bernard Weiss, a behavioural toxicologist at the University of Rochester, New York, USA, examined the societal impact of seemingly small losses of intelligence. Imagine an unaffected population numbering 260 million people (such as that of the USA) with an average IQ of 100 and a standard deviation of 15 (left-hand graph). In that population there would be 6 million people with IQs above 130 and 6 million below 70.

A decrease in average IQ of 5 points would shift the distribution to the left (right-hand graph). The number of people scoring above 130 would decline by 3.6 million while the number below 70 would increase by 3.4 million.

IQ: intelligence quotient

Picture adapted from

Gilbert, Weiss B. A rationale for lowering the blood lead action level from 10 to 2 ug/dL. *Neurotoxicology*. 2006 September; 27(5): 693–701
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2212280/pdf/nihms37310.pdf>

By Bruce Lanphear (reproduced with permission) and the Canadian Environmental

Health Atlas.

Economic costs of lead exposure are high

- Estimated economic losses due to reduced IQ from preventable lead exposure is approx 1.2% of global GDP
- Largest economic burden of lead exposure is borne by low and middle income countries
- Economic losses by region (in international dollars):
 - Africa: I\$ 134.7 billion
 - Asia: I\$ 699.9 billion
 - Latin America & Caribbean: I\$ 142.3 billion
 - USA I\$ 50.9 billion

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Attina TM, Trasande L (2013) Economic Costs of Childhood Lead Exposure in Low- and Middle-Income Countries. *Environ Health Perspect* 121(9): 1097-1102
http://ehp.niehs.nih.gov/1206424/?utm_source=rss&utm_medium=rss&utm_campaign=1206424

Summary

- Lead acid battery recycling can cause environmental contamination and lead exposure
- Lead exposure causes toxic effects in multiple body systems; some effects are permanent
- Lead exposure has both a personal and a societal impact
- Measures are needed to improve recycling methods and reduce lead exposure

