

Module B1

Health Hazards of Lead



LEAD PAINT ALLIANCE

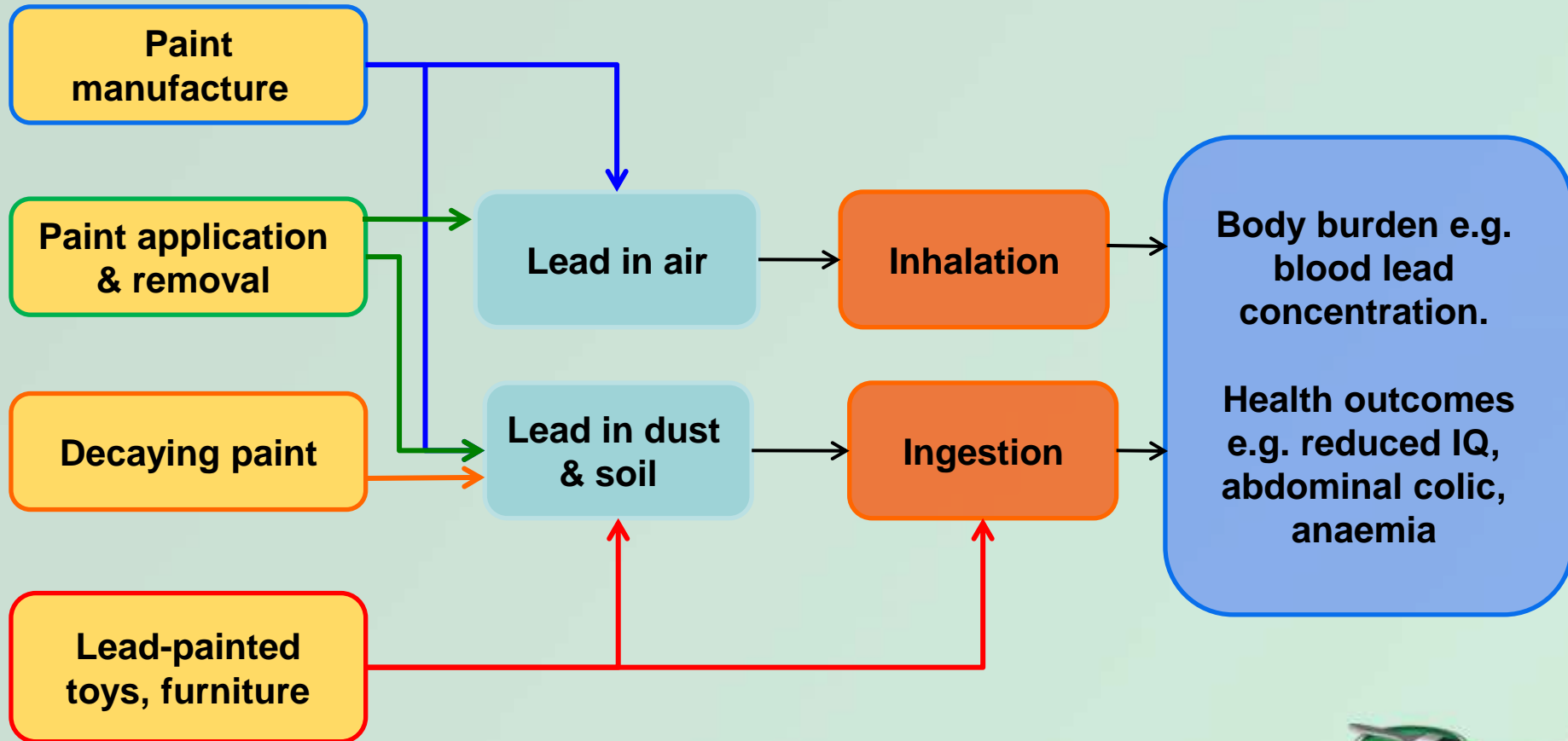
Outline

- Sources and routes of exposure
- Health effects
- Who is at risk?
- Societal impact of lead
- Economic and health impacts of control measures
- Summary
- References
- Point of Contact



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Pathways of exposure to lead from paint



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2 main routes of exposure to lead

- **Inhalation** of fine particles and fumes e.g. from sanding or burning lead paint
- **Ingestion** of dust and paint chips
 - Children with pica are at particularly high risk
 - Picture is a radiograph of a child with lead poisoning from eating lead paint, showing paint chips dispersed throughout the gut



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.

Reference B.i.1



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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 is probably not physiologically active but provides a store from which lead can move back into blood and to target organs
 - Lead can remobilize from bone during pregnancy, lactation and the menopause



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Lead is a multi-system toxicant

Brain & nervous system damage

Decreased IQ

Hearing problems

Learning difficulties

Muscle & joint
pain

Speech, language and
behaviour problems

Anaemia

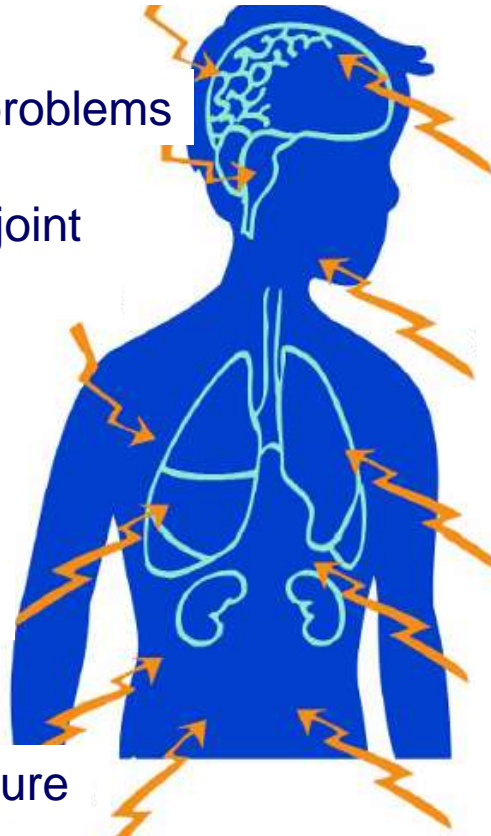
Slow or reduced
growth

Kidney damage

High blood pressure

Digestive problems

Reproductive problems (adults)



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Features of lead poisoning may be non-specific

- Low-level exposure – features of poisoning 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



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Lead poisoning can be life-threatening

- High dose acute/sub-acute exposure can cause lead encephalopathy with irritability, ataxia, coma, convulsions, death
 - e.g. >400 children have died in NW Nigeria from environmental exposure to lead
- Severe lead poisoning is possible from repeated ingestion of lead paint chips (pica)



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Who is at risk? Children

- Children are especially vulnerable
- Children have greater exposure:
 - Hand-to-mouth activity, mouthing objects
 - Consume more food and drink, and breathe more air per kg body weight than adults
 - Absorb 4-5 times more lead from the gut than adults
 - Nutritional deficiency, e.g. iron, increases bioavailability of lead
- Exposure may already occur *in utero*



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Who is at risk? Children

- Foetal period and early childhood are critical periods for neurological and other organ development
- Damage to the neurological system may be permanent
 - Reduces a child's potential for intellectual development
 - Increases the likelihood of behavioural disorders
- Children have more years of future life for expression of long-term effects

Who is at risk? Pregnant women

- Pregnancy mobilizes lead stored in bone so further exposure from the environment raises the blood lead concentration even higher
- Increased risk of hypertension during pregnancy – may be greater risk of pre-eclampsia
- Exposure of pregnant women can result in exposure of the fetus – may cause reduced fetal growth

Who is at risk? Other adults

- Most adult exposures are occupational e.g. manufacturing lead paint, stripping paint using unsafe methods, recycling lead-containing materials
- Non-occupational exposure can occur in the home from house paint that has flaked or chalked as it has aged or been disturbed during home renovations, or from the use of lead paints and metal in hobbies and crafts



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No known threshold for toxic effects – National Toxicology Program assessment of evidence

Table 1.1: NTP conclusions on health effects of low-level Pb by life stage

Life Stage	Blood Pb Level	NTP Conclusion	Principal Health Effects	Bone Pb Evidence
Children	<5 µg/dL	<i>Sufficient</i>	Decreased academic achievement, IQ, and specific cognitive measures; increased incidence of attention-related behaviors and problem behaviors	Tibia and dentin Pb are associated with attention-related behaviors, problem behaviors, and cognition.
		<i>Limited</i>	Delayed puberty and decreased kidney function in children ≥12 years of age	The one available study of bone Pb in children does not support an association with postnatal growth.
	<10 µg/dL	<i>Sufficient</i>	Delayed puberty, reduced postnatal growth, decreased IQ, and decreased hearing	No data
		<i>Limited</i>	Increased hypersensitivity/allergy by skin prick test to allergens and increased IgE* (not a health outcome)	No data
		<i>Inadequate</i>	<i>Any age</i> – asthma, eczema, nonallergy immune function, cardiovascular effects; <i><12 years of age</i> – renal function	No data
Adults	<5 µg/dL	<i>Sufficient</i>	Decreased glomerular filtration rate; maternal blood Pb associated with reduced fetal growth	The one available study of bone Pb in the general population supports an association between bone Pb and decreased kidney function. Maternal bone Pb is associated with reduced fetal growth.
		<i>Limited</i>	Increased incidence of essential tremor	No data
	<10 µg/dL	<i>Sufficient</i>	Increased blood pressure, increased risk of hypertension, and increased incidence of essential tremor	The association between bone Pb and cardiovascular effects is more consistent than for blood Pb.
		<i>Limited</i>	Psychological effects, decreased cognitive function, decreased hearing, increased incidence of ALS, and increased cardiovascular-related mortality; maternal blood Pb associated with increased incidence of spontaneous abortion and preterm birth	The association between bone Pb and cognitive decline is more consistent than for blood Pb.
		<i>Inadequate</i>	Immune function, stillbirth, endocrine effects, birth defects, fertility or time to pregnancy**, sperm parameters**	No data

Abbreviations: ALS, amyotrophic lateral sclerosis; IgE, immunoglobulin E; IQ, intelligence quotient

*Increased serum IgE is associated with hypersensitivity; however, as described in [Section 1.4.3](#), increased IgE does not equate to disease.

**The NTP concludes that there is *inadequate* evidence that blood Pb levels <10 µg/dL are associated with fertility, time to pregnancy, and sperm parameters; however, given the basis of the original nomination, the NTP evaluated the evidence that higher blood Pb levels (i.e., >10 µg/dL) are associated with reproductive and developmental effects, and those conclusions are discussed in [Section 1.4.6](#) and presented in [Table 1.2](#).

Lead causes significant burden of disease

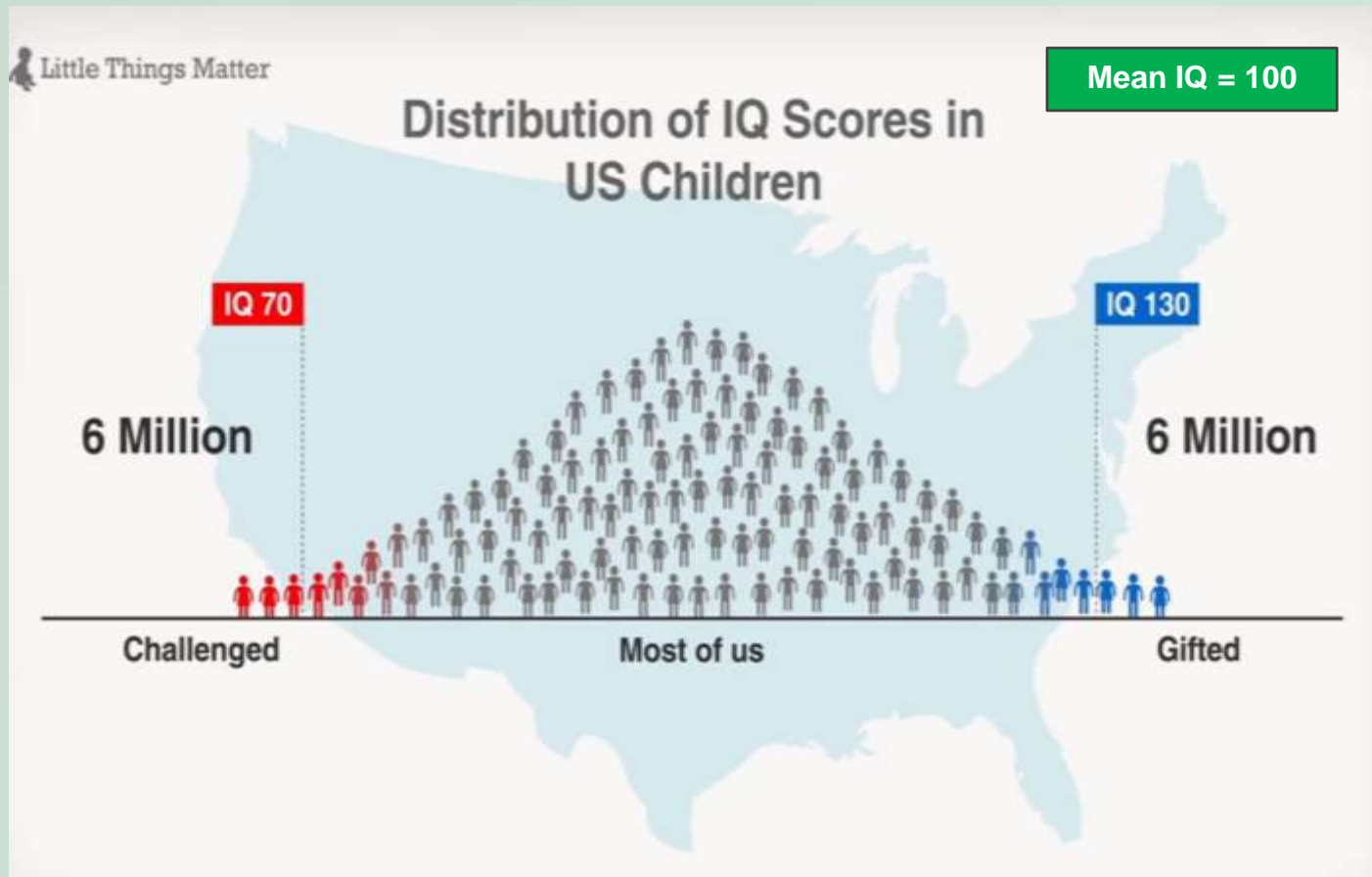
- 0.6% of global burden disease
- 143,000 deaths per year
- 8.977 million disability adjusted life years (DALYs)
 - 7.2 million DALYs – mild mental retardation
 - 1.8 million DALYs – cardiovascular disease
- Childhood lead exposure contributes ~ 600,000 new cases of children with intellectual disabilities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

Reference B.i.3



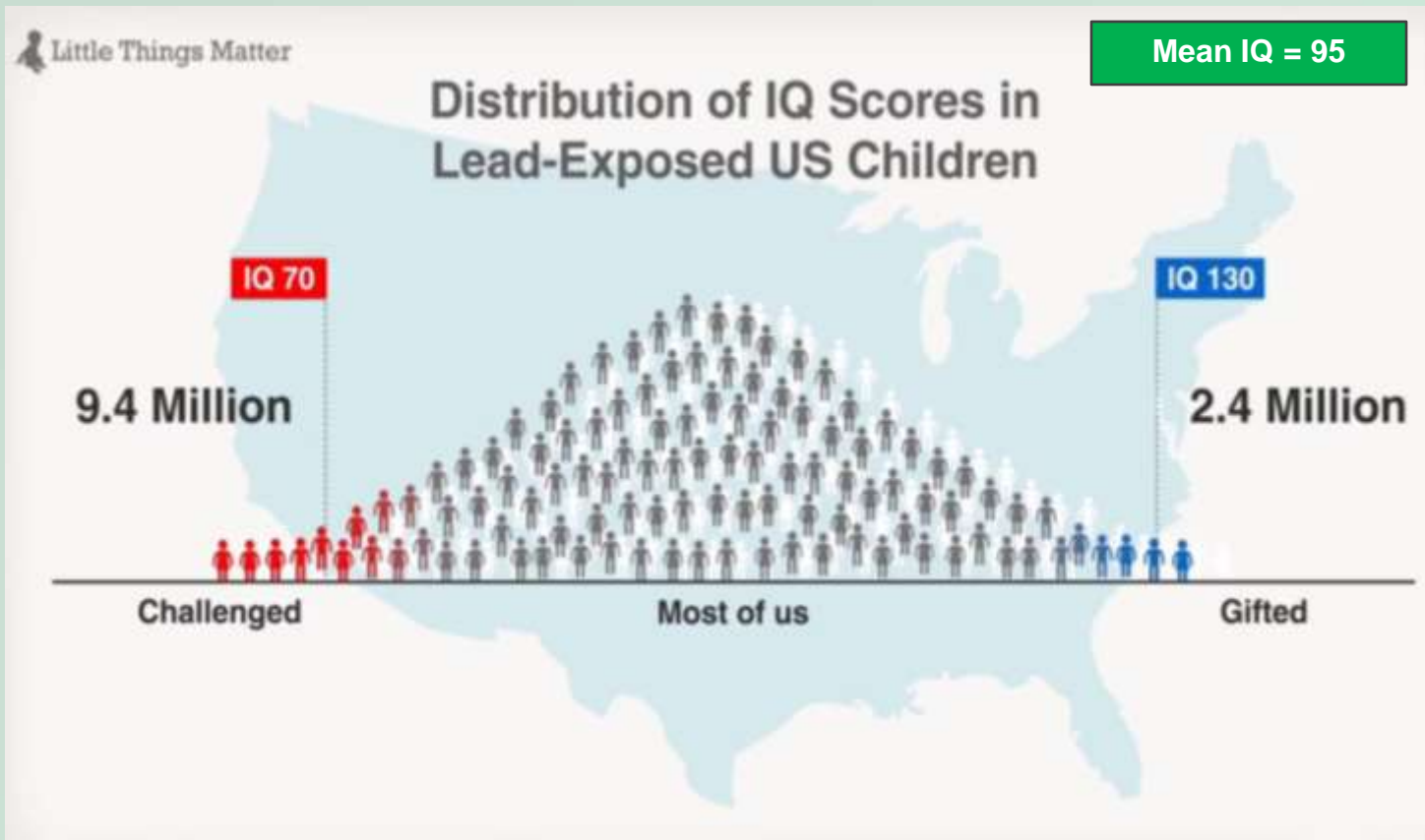
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Small IQ reduction has significant societal impact (1)



Reference B.i.4

Small IQ reduction has significant societal impact (2)



Reference B.i.4



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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

Reference B.i.5



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Economic benefits of action can be substantial

- In USA estimated cost of lead paint hazard control is US\$ 1-11 billion
- Lead hazard control has benefits e.g. reduced health care costs, reduced need for special education, reduced crime, increased earnings and tax revenue
- Total saving estimated as US\$ 192 – 270 billion
- Each US\$ 1 invested in lead paint hazard control yields return of US\$ 17 – 221

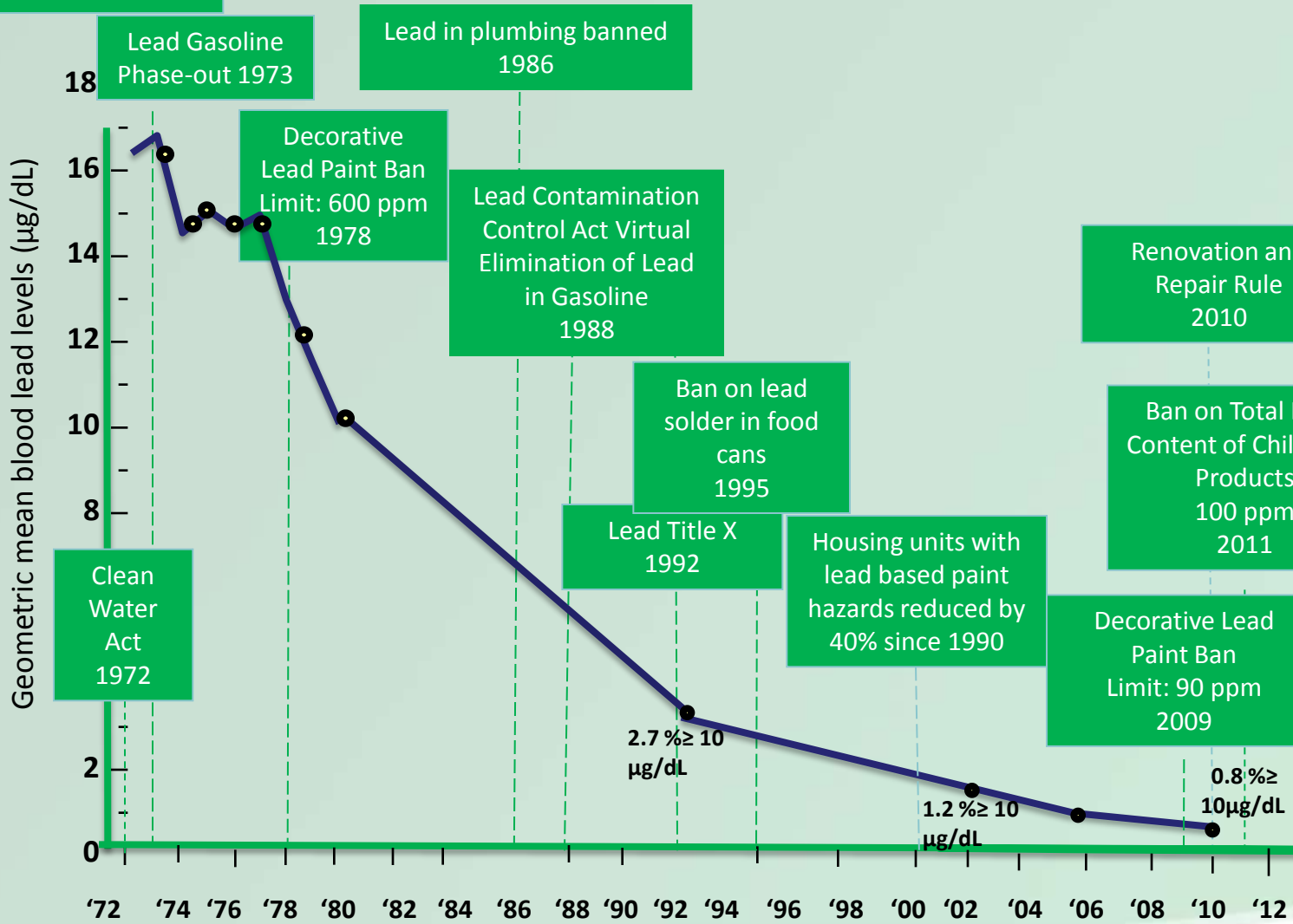
Reference B.i.6



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Lead-based Paint
Poisoning
Prevention Act
1971

Lead poisoning prevention policies have reduced population blood lead levels (USA)



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Summary

- Lead exposure causes toxic effects in multiple body systems; some effects are permanent
- Lead exposure has both a personal and a societal impact
- Lead poisoning is preventable: implementation of lead control measures has significantly reduced population-level blood lead concentrations
- Removing lead paint as a source of exposure will have significant health and economic benefits



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References

Originally presented at the Global Alliance to Eliminate Lead Paint Workshop on Establishing Legal Limits on Lead in Paint, 22 – 23 September 2014, New Delhi, India. Updated and expanded for inclusion in the Lead Paint Alliance “Toolkit” for Governments. April 2015

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B.i.2. National Toxicology Programme (2012) NTP evaluation of effects of low-level lead
<http://ntp.niehs.nih.gov/pubhealth/hat/noms/lead/index.html>

B.i.3. Prüss-Ustün A et al (2011) Knowns and unknowns on burden of disease due to chemicals: a systematic review. Environmental Health 10:9. <http://www.ehjournal.net/content/10/1/9>

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http://ehp.niehs.nih.gov/1206424/?utm_source=rss&utm_medium=rss&utm_campaign=1206424
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General references

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<http://www.who.int/ceh/publications/childhoodpoisoning/en/>

B.i.9. Lead poisoning and health, Fact sheet No 379, (in Arabic, Chinese, English, French, Russian and Spanish)

<http://www.who.int/mediacentre/factsheets/fs379/en/>



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