

Toolkit for Establishing Laws to Control the Use of Lead in Paint

# Module Bi & Bii

## Health and Environmental Hazards of Lead

Central and Eastern Europe and Central Asia Regional Workshop on the Establishment of Legal Limits on Lead in Paint, 19-20 May 2016, Chisinau, Republic of Moldova



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# Outline

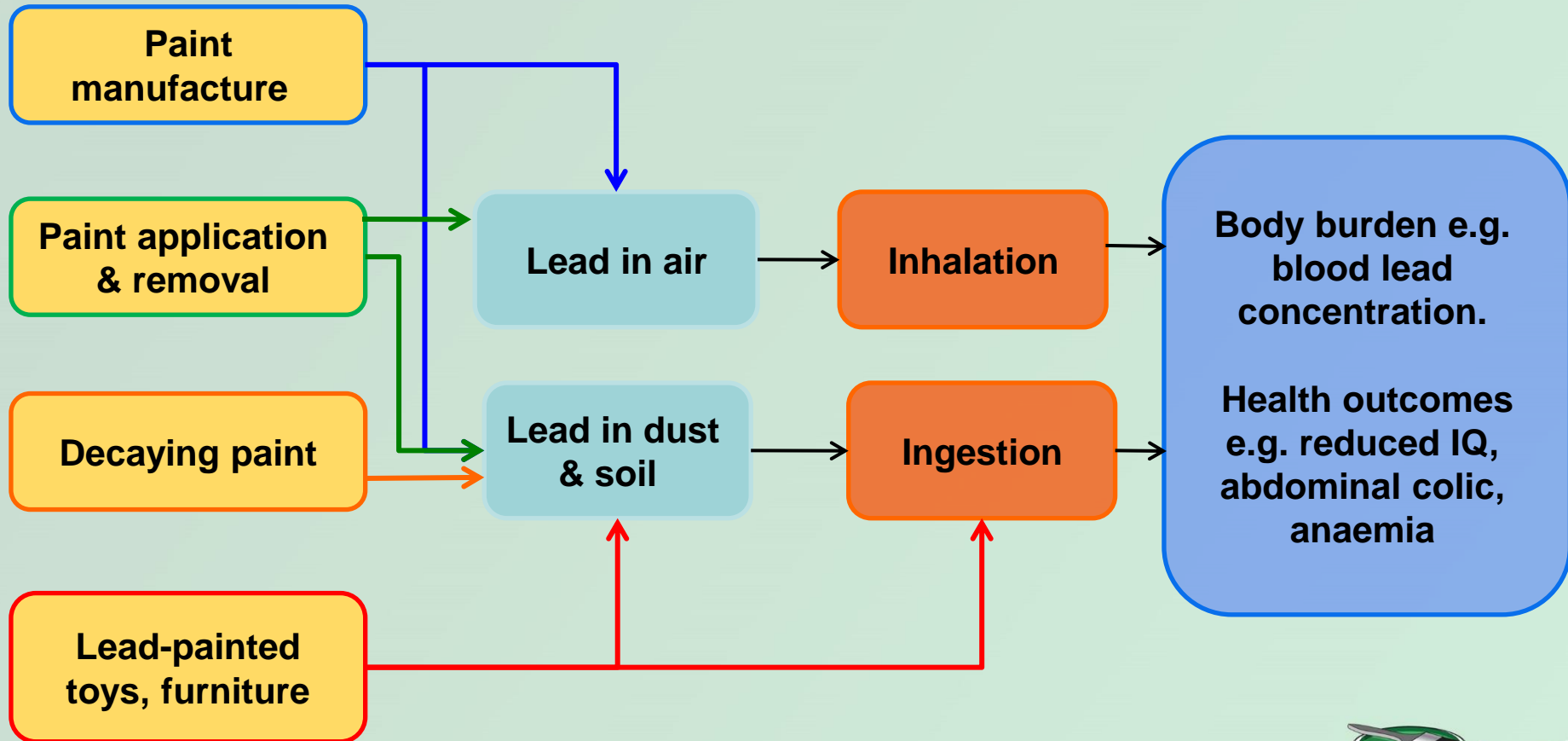
- Sources of lead release
- Sources and routes of exposure to lead from paint
- Health effects in humans
- Who is at risk?
- Societal impact of lead
- Environmental impacts of lead
- Summary



# Sources of lead release

- Natural (volcanic, weathering of rocks)
- Anthropogenic sources:
  - mobilization of lead in raw materials such as fossil fuels and other extracted and treated ores and metals
  - releases during the manufacture, use and disposal of products using lead (e.g. paint, batteries, toys)
  - direct releases from waste to soil and aquatic environments
  - prior to the removal of lead from gasoline in most countries, leaded gasoline was a significant source of lead
- Lead emitted to the atmosphere is mainly in particle form

# Multiple pathways of exposure to lead from paint



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# Ingestion is an important route of exposure for children

- Children may ingest contaminated dust and paint chips
- Children with pica are at particularly high risk – severe poisoning may occur
- Picture is a radiograph of a child with lead poisoning from eating lead paint, showing paint chips (white spots) 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 1)



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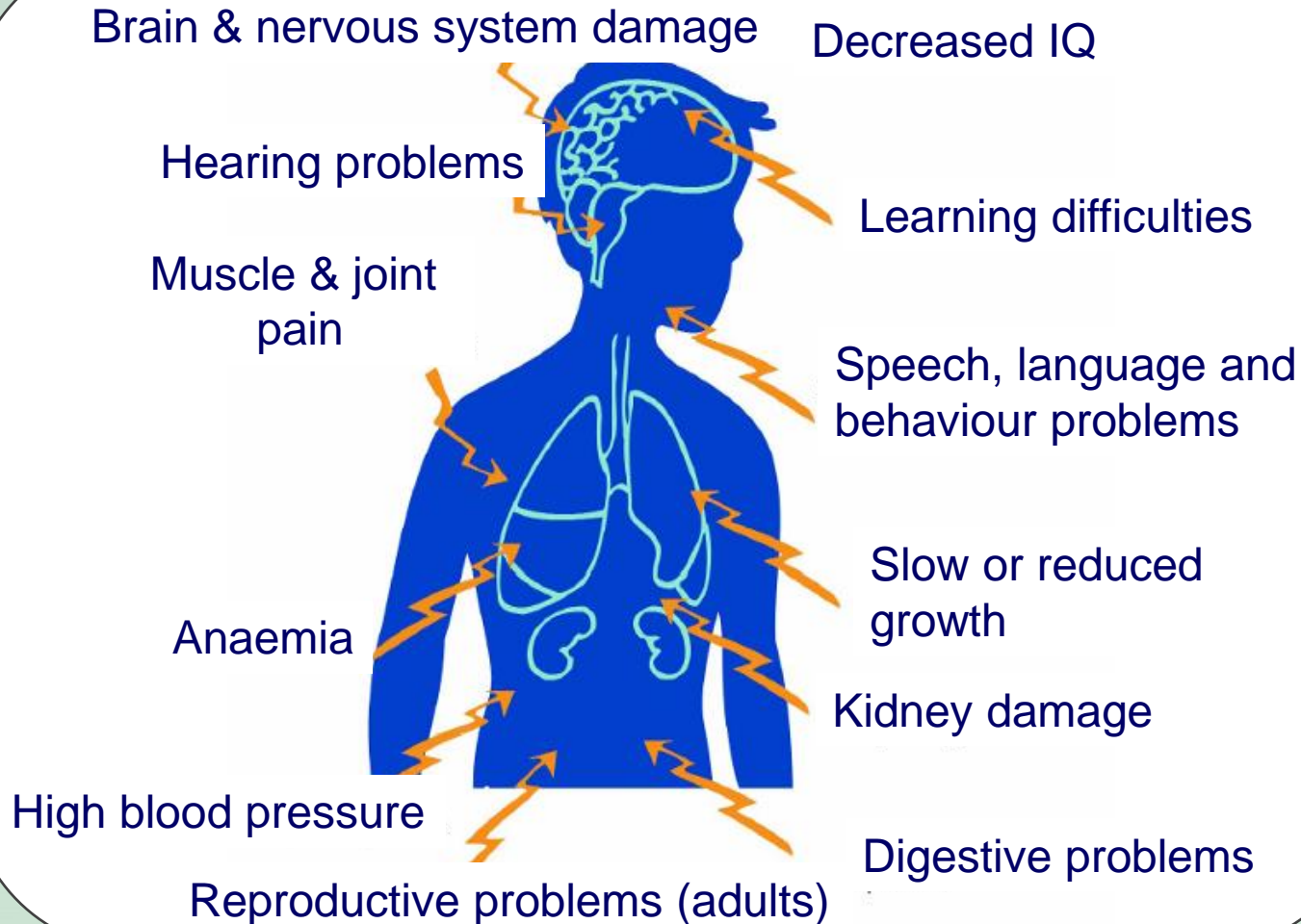
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# Lead accumulates in the body

- Bound to red blood cells and distributes to soft tissues, e.g. brain and kidneys, and to bone
- Stored in bone for many years (half-life = 10 – 25 years)
- Lead in bone provides a pool from which lead can move back into blood and to target organs
- Lead can remobilize from bone during pregnancy, lactation and the menopause



# Lead is a multi-system toxicant



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# No known threshold for toxic effects – US 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 behavior problem behaviors	Tibia and dentin Pb are associated with attention-deficit and cognition.
		<i>Limited</i>	Delayed puberty, decreased IQ, and decreased hearing	Children does not show growth.
	<10 µg/dL	<i>Sufficient</i>	Delayed puberty, IQ, and decreased hearing	
		<i>Limited</i>	Increased hypersensitivity to allergens and increased IgE	
		<i>Inadequate</i>	Any age – asthma, eczema, cardiovascular disease	
Adults	<5 µg/dL	<i>Sufficient</i>	Increased fetal loss, reduced fetal growth	In the general population, bone Pb and 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

<5 µg/dL  
Decreased academic achievement & IQ, & increased problem behaviours  
Effects on kidney, reduced fetal growth

**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.

(Reference 2)



# Who is at risk? Children

- Children have greater exposure:
  - play on the ground, hand-to-mouth activity, mouthing objects
  - absorb 4-5 times more lead from the gut than adults
  - nutritional deficiency, e.g. iron or calcium, increases bioavailability of lead
- Exposure may already occur *in utero*



# Who is at risk? Children

- Fetal 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, releasing it back into blood where it can be circulated to maternal tissues and the fetus
- 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

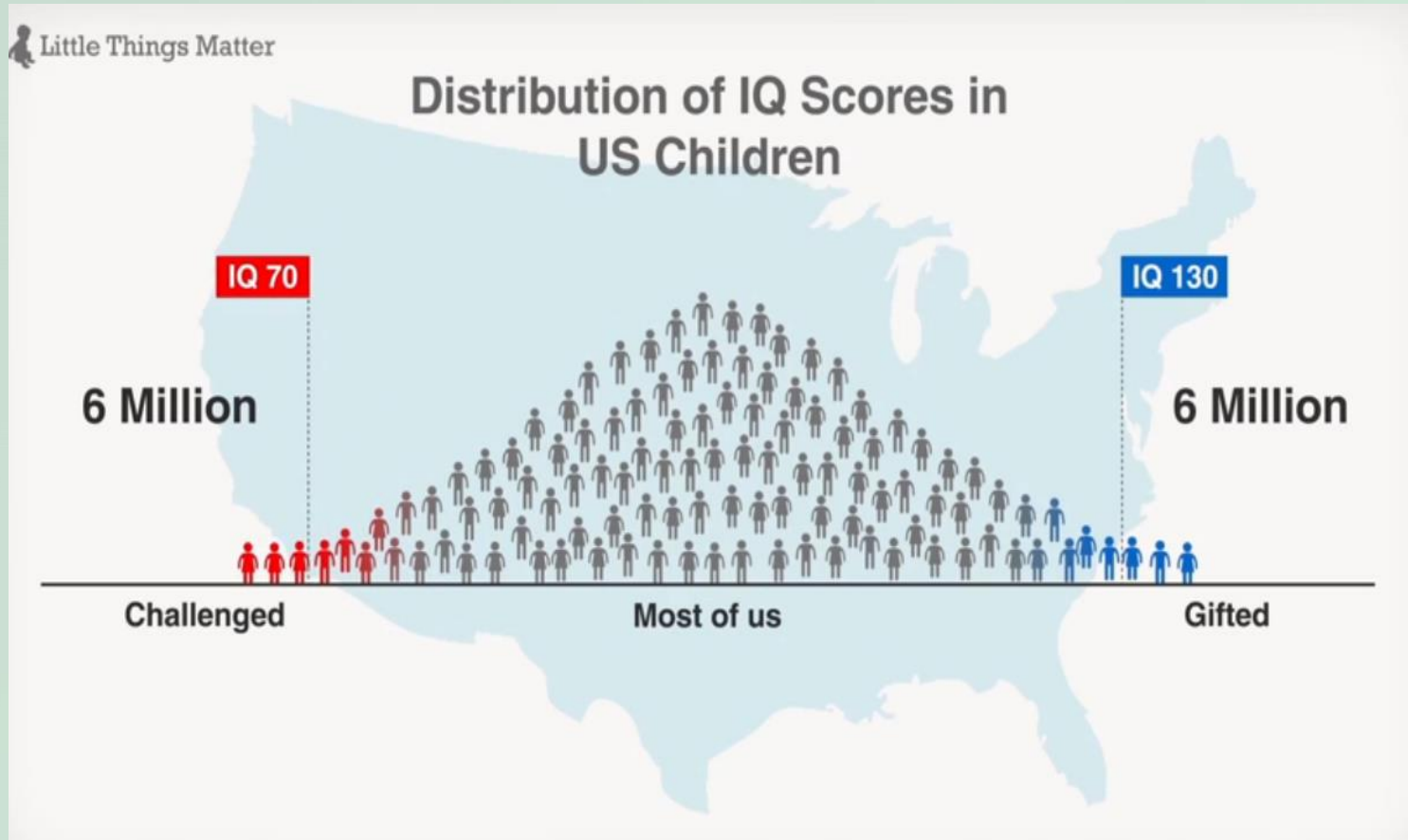


# Lead causes significant burden of disease

- 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

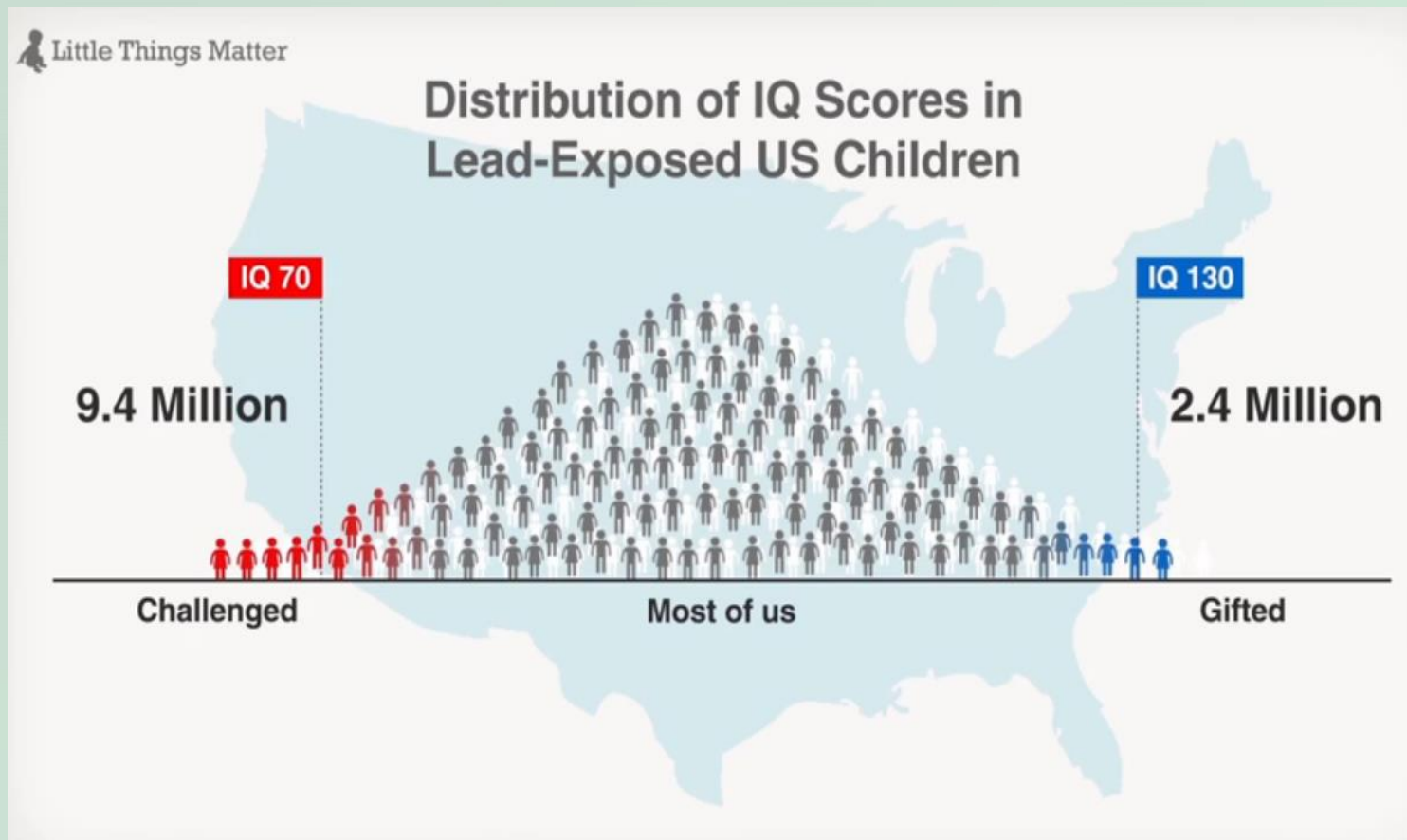
(Reference 3)

# Small IQ reduction has significant societal impact (mean IQ 100)



(Reference 4)

# Small IQ reduction has significant societal impact (mean IQ 95)



(Reference 4)

# Environmental impacts of lead



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# Impacts on the ecosystem

- Terrestrial exposure to lead is greatest near point sources (e.g. smelters)
- Plants absorb lead from the soil and retain most of the lead in their roots
- Aquatic exposure to lead is strongly dependent on environmental conditions (pH, salinity, etc)
- Lead bioaccumulates in organisms, in particular those that feed primarily on particulate matter
- Secondary poisoning may occur e.g. in predators feeding on contaminated animals





# Impacts on organisms

- Effects on micro-organisms from soil with lead concentrations as low as 10 mg/kg (10 ppm)
- Ingestion of lead-contaminated bacteria and fungi by nematodes can cause impaired reproduction
- In higher animals lead is shown to damage multiple organ systems (blood, central nervous system, kidneys, reproductive & immune systems)
- Fish can develop spinal deformity and blackening of the skin in the caudal region (black tail)
- Birds may be poisoned by eating lead shot and sinkers



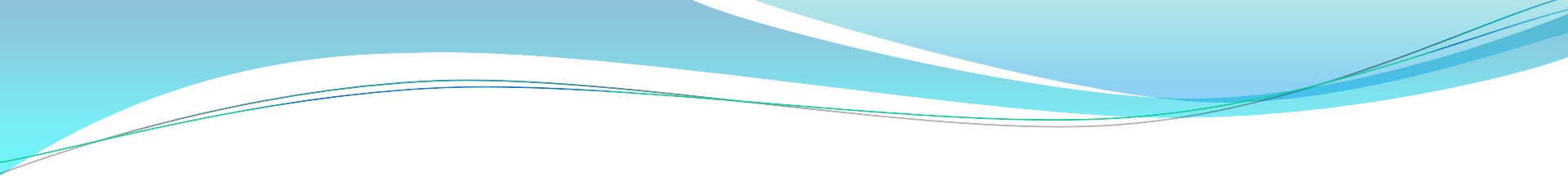
# Summary

- Lead exposure causes toxic effects in multiple body systems; some effects are permanent
- There is no known level of lead exposure that is considered safe
- Lead exposure has both a personal and a societal impact
- Lead has negative environmental impacts



# Additional information

- More information and references are in the **Toolkit for Establishing Laws to Control the Use of Lead in Paint**  
<http://web.unep.org/chemicalsandwaste/noleadinpaint/toolkit>
- Module Bi Health hazards of lead
- Module Bii Environmental impact of lead



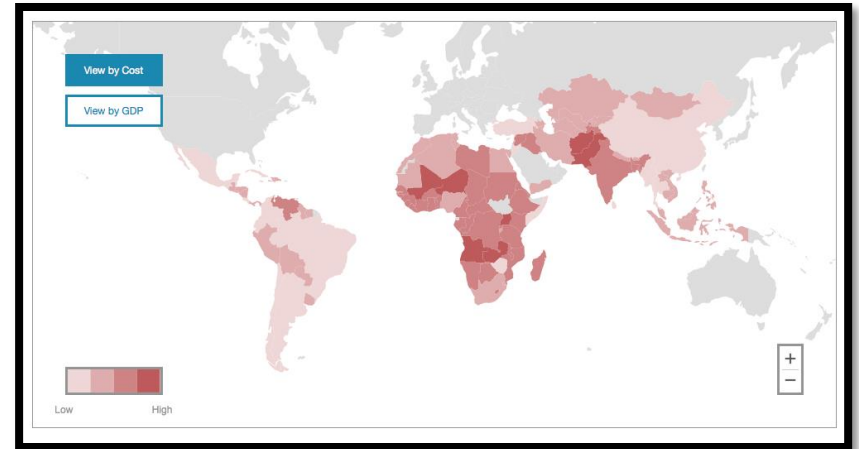
# **Reducing the Economic and Health Impacts of Childhood Lead Poisoning: *US Actions to Eliminate Lead in Paint***

Central and Eastern Europe and Central Asia  
Regional Workshop on the Establishment of Legal  
Limits on Lead in Paint  
May 19, 2016

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# Global Economic Impact Data Visualization: Economic Cost of Childhood Lead Exposure

- Annual economic costs of lead exposure in low and middle-income countries is \$977 billion



- \$ 135 billion in Africa
- \$ 142 billion in Latin America
- \$ 700 billion in Asia
- For comparison: US \$ 50.9 and EU \$ 55 billion
- NYU School of Medicine – on-line tool shows data by country

# Select Country Results

Country	Annual Cost (I\$)	% GDP
Armenia	413 million	2.23
Azerbaijan	2.49 billion	2.68
Georgia	427 million	1.73
Kazakhstan	8.18 billion	3.75
Kyrgyzstan	463 million	3.75
Tajikistan	463 Million	3.47

- Calculation: The cost is estimated using Lost Economic Productivity per IQ Loss due to blood lead levels
- Full report by New York University researchers available online and by request.
- For comparison:  
US cost \$50 B, 0.33 GDP  
EU cost \$ 55 B, 0.30 GDP

# Levels of Lead Detected in Paint and Blood in Select Countries

(US: paint limit 90 ppm; 2.5% children above 5 ug/dl)

Country	Average Level in Paint (ppm)	% Children with BLL > 5 ug/dl	References (Paint/Blood)
Argentina	17,000	--	UNEP 2013
Cameroon	23,100	50	CREPD 2011/UNEP Workshop, Dec 2015
China	15,100	38.5	Clark, 2009 (sampled in 2006)/WHO 2004
Ethiopia	18,500	--	UNEP 2013
India	32,700	36.3	Johnson, 2009/WHO 2004
Kazakhstan	16,000	--	Clark, 2014 (sampled in 2011)
Russia	11,000	51.8	Clark, 2015 (sampled in 2011)/WHO 2004
Uruguay	9.8	--	UNEP 2013

# Action to Reduce Economic and Health Impacts of Lead Exposure

- Lead in paint is a major source of childhood lead exposure
- Alternatives to lead additives in paint are available and affordable
- Government action needed to establish and enforce effective laws or regulations to limit lead in paint
- Lead Paint Alliance goal is for all countries to do this by 2020
- Guidance and tools are available through the Lead Paint Alliance



# Thank You

- NYU Research: Trasande and Attina, Environmental Health Perspectives, volume 121, number 9, Sept 2013;  
<http://ehp.niehs.nih.gov/1206424/>
- Next week: NYU Research Web Tool link available
- Technical Contact information

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