

**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>&lt;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.

**Table 1.2: NTP conclusions on health effects of low-level Pb by major health effect areas**

Health Area	Population or Exposure Window	NTP Conclusion	Principal Health Effects	Blood Pb Evidence	Bone Pb Evidence	
Neurological	Prenatal	Limited	Decrease in measures of cognitive function	Yes, <5 µg/dL	No data	
		Limited	Decreased IQ, increased incidence of attention-related and problem behaviors, decreased hearing	Yes, <10 µg/dL	No data	
	Children	Sufficient	Decreased academic achievement, IQ, and specific cognitive measures; increased incidence of attention-related and problem behaviors	Yes, <5 µg/dL	Tibia and dentin Pb are associated with attention, behavior, and cognition.	
		Sufficient	Decreased hearing	Yes, <10 µg/dL	No data	
	Adults	Sufficient	Increased incidence of essential tremor	Yes, <10 µg/dL	No data	
		Limited	Psychiatric effects, decreased hearing, decreased cognitive function, increased incidence of ALS	Yes, <10 µg/dL	The association between bone Pb and cognitive decline is more consistent than blood.	
Limited		Increased incidence of essential tremor	Yes, <5 µg/dL			
Immune	Children	Limited	Increased hypersensitivity/allergy by skin prick test to common allergens and IgE* (not a health outcome)	Yes, <10 µg/dL	No data	
		Inadequate	Asthma, eczema	Unclear	No data	
	Adults	Inadequate	–	Unclear	No data	
Cardiovascular	Children	Inadequate	–	Unclear	No data	
	Adults	Sufficient	Increased blood pressure and increased risk of hypertension	Yes, <10 µg/dL	The association between bone Pb and cardiovascular effects is more consistent than blood.	
		Limited	Increased cardiovascular-related mortality and ECG abnormalities	Yes, <10 µg/dL		
Renal	Children <12 years old	Inadequate	–	Unclear	No data	
	Children ≥12 years old	Limited	Decreased glomerular filtration rate	Yes, <5 µg/dL	No data	
	Adults	Sufficient	Decreased glomerular filtration rate	Yes, <5 µg/dL	Yes, one study	
Reproductive and Developmental	Prenatal	Limited	Reduced postnatal growth	Yes, <10 µg/dL	No data	
	Children	Sufficient	Delayed puberty, reduced postnatal growth	Yes, <10 µg/dL	One study does not support effects of bone Pb on growth.	
		Limited	Delayed puberty	Yes, <5 µg/dL		
	Adults	Women	Sufficient	Reduced fetal growth	Yes, <5 µg/dL	Maternal tibia Pb is associated
			Limited	Increase in spontaneous abortion and preterm birth	Yes, <10 µg/dL	No data
		Men	Sufficient	Adverse changes in sperm parameters and increased time to pregnancy	Yes, ≥15-20 µg/dL	No data
	Limited		Decreased fertility	Yes, ≥10 µg/dL	No data	
	Limited		Increased spontaneous abortion	Yes, >31 µg/dL	No data	
	Adults	Inadequate	Stillbirth, endocrine effects, birth defects	Unclear	No data	

**Abbreviations:** ALS, amyotrophic lateral sclerosis; ECG, electrocardiography; 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.