

Assessing Mercury Exposures

The most effective way to evaluate a potential mercury vapor exposure and the potential for health effects is to assess the levels of mercury vapor present in air.

The potential for health effects (See “**Mercury and You**”) during or after mercury vapor exposure depends upon:

- the environmental level of exposure (e.g., indoor air mercury level),
- the duration of exposure (e.g., short or long term), and
- the sensitivity of the exposed individual (e.g., very young).

In cases where there is evidence of mercury vapor exposure, medical professionals may sometimes measure levels of mercury in urine or blood to assess an individual’s level of exposure and the potential for health effects. Relationships between mercury exposure and levels of mercury in blood and urine are critically dependent upon the timing of urine or blood sampling with respect to exposure. Also, levels of mercury in blood or urine due to mercury vapor exposure are often difficult to distinguish from levels of mercury already existing in blood or urine due to other common mercury exposures (e.g., dietary seafood, dental amalgams). If urine or blood mercury levels are obtained, it is important to correctly interpret the measurements and to understand their limitations.

This section provides **general background information** useful for understanding:

- what happens to mercury when you breathe it (as mercury vapor) or swallow it (as elemental or methylmercury)
- what urine or blood mercury levels indicate about mercury exposure
- what urine or blood mercury levels indicate about the potential for health effects

This section also provides **additional supporting information** summarizing:

- what happens to inhaled mercury vapor in the body
- what mercury levels in hair indicate about mercury exposure
- key differences between urine, blood and hair as biomarkers of mercury exposure
- urine mercury levels that have been associated with health effects in scientific studies

IMPORTANT NOTES:

Information provided here is for general understanding only.

Using levels of mercury in urine or blood to assess mercury exposure or the potential for health effects should only be done by a knowledgeable health or medical professional.

In New York State, urine and blood samples for mercury analysis must be collected and analyzed in accordance with NYS Public Health Law.

The results of analysis of urine and blood samples for mercury that meet or exceed reportable levels must be reported to the New York State Heavy Metals Registry in accordance with NYS Sanitary Code (Chapter 1 Part 22).

(www.health.state.ny.us/environmental/workplace/part22.htm)

Mercury Exposure and Urine, Blood or Hair Mercury Levels

What happens to mercury when it is breathed in or swallowed?

When mercury vapor (Hg^0) is inhaled, or methylmercury is ingested, most of it passes into blood and is carried throughout the body, primarily to the kidneys, liver, and brain. In a pregnant woman, it also goes to the fetal liver and fetal brain.

Inhaled mercury vapor tends to leave the blood and be eliminated in the urine. Ingested methylmercury tends to remain in the blood for a longer period and be eliminated mainly in the feces, although some is deposited in hair.

What do urine mercury levels indicate about mercury exposure?

Small amounts of mercury are often present in urine, frequently due to mercury in dental amalgam.

Typical levels of mercury in urine range up to about 3 micrograms mercury/Liter of urine (mcg/L) and about 2 micrograms/gram creatinine (mcg/g). Creatinine is a metabolite normally found in urine that indicates how dilute or concentrated a urine sample is. It is used to normalize mercury urine levels to adjust for collection of a spot urine sample rather than a 24-hour urine sample.

The amount of mercury in urine depends upon the form of mercury, the level and duration of mercury exposure, and the elapsed time between exposure and urine sample collection.

Elemental and inorganic mercury are eliminated from the body in the urine. Elevated mercury levels in urine may indicate long-term, high level mercury exposure (for example, in a workplace).

Increases in the amount of mercury in urine are unlikely to be detected following short-term, low level mercury exposure (for example, from a thermometer break).

This is because mercury in the kidney tends to be retained and released slowly (and erratically) into urine over time. Also, a small increase in the mercury level in urine is unlikely to exceed the range of typical values.

What do blood mercury levels indicate about mercury exposure?

Small amounts of mercury are often present in blood, primarily due to variable amounts of methylmercury in the diet.

Typical levels of total mercury in blood range up to about 5 micrograms/Liter (mcg /L).

The amount of mercury in blood depends upon the form of mercury, the level and duration of mercury exposure, and the elapsed time between exposure and sample collection.

Elevated mercury levels in blood usually indicate a diet high in seafood containing methylmercury.

Methylmercury from the diet persists in blood much longer than elemental or inorganic mercury. Very little methylmercury is eliminated in urine; most is eliminated in feces.

With little or no methylmercury exposure, persistently elevated blood mercury levels may indicate ongoing high level elemental or inorganic mercury exposure. Elevated blood mercury levels that decrease rapidly with time may indicate an exposure to high level elemental or inorganic mercury that has ended.

Elemental mercury that is inhaled or inorganic mercury that is swallowed or absorbed through the skin enters the blood and then the urine. Most elemental or inorganic mercury will be present in blood for only a few days after exposure stops. If exposure was long-term and at high levels, the amount of mercury in blood might exceed typical levels, but declines quickly after exposure stops. If exposure was for a short time and at a low level, the amount of mercury in blood is unlikely to exceed typical levels.

What do hair mercury levels indicate about possible mercury exposures?

Some methylmercury from fish consumption is deposited in hair from blood. Mercury levels in hair are sometimes used to evaluate past methylmercury exposure. Studies of large groups of people have observed that elevated levels of methylmercury in maternal hair may be associated with harmful effects on neurological development of babies. In those studies, the mercury level in the mother's hair was used to estimate her baby's exposure to mercury before birth. However, relationships between methylmercury levels in hair and health effects are not clearly established. Therefore, although the mercury level in hair is considered a useful biomarker for past exposure to methylmercury from eating contaminated fish, it is not routinely recommended for assessing the likelihood of health effects.

Exposures to other forms of mercury have not been clearly or consistently shown to be reflected in hair mercury levels.

Urine or Blood Mercury Levels and Potential Health Effects

What do urine mercury levels indicate about the potential for health effects?

Urine mercury levels are unlikely to be useful for assessing potential health effects from short-term, low level exposures to mercury vapor because such exposures are unlikely to result in mercury urine levels elevated above typical values.

High level mercury vapor exposures or long-term, low level exposures may result in elevated urine mercury levels which can indicate potential for health effects.

Subtle effects on visual memory, attention, manual coordination, mood, increased levels of fatigue and confusion have occasionally been associated with sustained urine mercury levels above 10 mcg/g creatinine. Increasingly higher urine mercury levels are associated with increasingly frequent and severe nervous system changes in personality, cognition and coordination. Urine mercury levels above 20 to 35 mcg/g

creatinine have been associated with increased hand tremor and early signs suggesting potential kidney disease.

What do blood mercury levels indicate about the potential for health effects?

Elevated blood mercury levels are usually due to consumption of seafood contaminated with methylmercury, but may also result from recent or ongoing exposure to high levels of elemental or inorganic mercury.

Elevated blood mercury levels are of greatest concern in pregnant women because of the sensitivity of the developing fetal brain to mercury exposure.

Scientists do not know precisely what level of mercury in blood may be associated with harmful effects. Associations between mercury levels of about 60 mcg/L in umbilical cord blood at birth and subsequent subtle effects on brain development of the baby, suggest that maternal mercury blood levels of 30 to 40 mcg /L or higher may pose some risk of harm to the fetus.

“Summary of Biomarkers of Mercury Exposure” provides information useful for interpreting whether mercury levels in blood, urine or hair may be elevated.

“Levels of Mercury in Urine and Potential Health Effects” provides a detailed summary of urine mercury levels and health effects associated with various types and levels of mercury vapor exposures.

Summary of Biomarkers of Mercury Exposure

	Biomarker	Form of Mercury Exposure		Comments
		Hg ⁰	MeHg	
Common Background Source		Dental amalgams	Fish diet	
Useful Biomarkers		Urine, blood	Blood, hair	
Half-life ¹	Urine	30-90 days	NA	
	Blood	Phase 1: 1–3 days Phase 2: several weeks	Phase 1: 1-3 days Phase 2: 30-90 days	
U.S. General Population Background Level (95 th percentile)	Urine ³	6–11 yrs: 0.89 mcg/L 1.1 mcg/gC 12–19 yrs: 1.0 mcg/L 0.85 mcg/gC ≥ 20 yrs: 1.8 mcg/L 1.8 mcg/gC		Represents primarily Hg ⁰ and inorganic Hg
	Blood ³	1–5 yrs: 1.2 mcg/L 6–11 yrs: 1.6 mcg/L 12–19 yrs: 1.9 mcg/L ≥ 20 yrs: 4.9 mcg/L		
U.S. Women Population Background Level (95 th percentile 16-49 yrs)	Hair ⁴	1.7 ppm		Primarily MeHg
NYS Reportable Level ²	Urine	20 mcg/L	NA	Represents primarily Hg ⁰ and inorganic Hg
	Blood	5 mcg/L		All forms of Hg

Form of mercury: Hg⁰ (elemental), MeHg (methylmercury)

NA: Not applicable

Units: mcg/L (micrograms per liter), mcg/gC (micrograms per gram creatinine), ppm (parts per million, equivalent to micrograms per gram)

¹ half-life is the amount of time it takes for the amount of mercury to decrease by 50%; mercury in blood initially decreases with short half-life (phase 1) followed by a longer half-life (phase 2); information on half-life's is summarized in Fourth National Report on Human Exposure to Environmental Chemicals Centers for Disease Control and Prevention (CDC) (2010) and Kershaw et al., (1980).

² must be reported to the NYS Heavy Metals Registry.

³ (CDC) 2017.

⁴McDowell MA, et al., (2004).

Levels of Mercury in Urine and Potential Health Effects

Mercury (total) in Urine	Comments
Typical Levels of Total Mercury in Urine	
2.8 mcg/L 2.6 mcg/gC	95th percentile, U.S. adults, □20 years old, 2007–2008 (n=1861) [CDC, 2011]
1.82 mcg/L 1.18 mcg/gC	95th percentile, U.S. young adults, 12–19 years old, 2007–2008(n=375) [CDC, 2011]
1.82 mcg/L 1.71 mcg/gC	95th percentile, U.S. children, 6–11 years old, 2007–2008 (n=398) [CDC, 2011]
<1 – 7 mcg/gC	Commonly (~99% of US population) associated with dental amalgams (n=520) [Barregard et al., 1995].
1 – 2 mcg/gC	Mean level in children (6–10 yrs old) without dental amalgams (n=521) [Bellinger et al., 2006; DeRouen et al., 2006]
1 – 3 mcg/gC	Mean level in children (6–10 yrs old) with dental amalgams (n=520) [Bellinger et al., 2006; DeRouen et al., 2006]; no neurological effects observed.
Highest Levels Associated with Dental Amalgams: Estimated Highest 1% of US Population.	
7 – 50 mcg/gC	Highest values are from case reports of nicotine gum chewers. [Barregard, 1995, 2005].
Health Effects of Chronic Occupational Exposure (many years) to Mercury Vapor	
≥ 200 mcg/L	High incidence (80%) of <i>erithism</i> (fatigue, emotional lability, insomnia, shyness) (n=77 exposed workers) [Urban et al., 1996]
100+ mcg/L	Subtle cognitive deficits: attention, memory, reasoning, manual dexterity [reviewed by Echeverria et al., 2005]
30 – 100 mcg/L	Inconsistent effects: fatigue, mood, tremor, memory, confusion [reviewed by ACGIH (2001) and Echeverria et al. (1995, 2005)]
25 – 35 mcg/gC	Low effect levels for early biochemical markers of kidney toxicity (chloralkali workers) (n=89 exposed, 75 control) [Langworth et al., 1992].
20 mcg/gC	Low effect level for increased hand tremor (chloralkali workers). Highly dependent on duration of exposure (15 year mean, n=26) [Fawer et al., 1983].
5.3 mcg/gC (1.6 – 26 mcg/gC)	Mean (range) in dental professionals where urine mercury concentration was correlated with an early biomarker of kidney toxicity (p=0.001) (n=44) [Langworth et al., 1997].
Dentists: 3.32 mcg/L (0 – 18 mcg/L) Dental Assistants: 1.98 mcg/L (0 – 15 mcg/L)	Mean (range) in dental professionals where urine mercury concentration was related to deficits in attention, visual memory, manual coordination, complex coordination in male dentists (n=194) and female dental assistants (n=233) (p<0.05); [Echeverria et al., 2005].

mcg/L – micrograms mercury per liter of blood
mcg/gC – micrograms mercury per gram of creatinine

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