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## BACKGROUND

Cadmium is a naturally occurring element present as a highly mobile environmental contaminant in various forms in air pollution, consumer products (including tobacco), food, and water. It deposits in soil and ocean sediments. Both recent and long-standing studies have shown that exposure to cadmium can lead to cancers, bone problems, and neurodevelopmental disorders. The greatest source of cadmium exposure for non-smokers is non-organically grown food. For smokers, it is cigarettes. [Barański et al, 2014]

## HOW DO WE COME INTO CONTACT WITH CADMIUM?

Cadmium is both naturally occurring and a product of industry and agriculture. Industrial cadmium is released into the air and into our lungs, and cadmium enters soil either from the underlying geologic material, or is deposited from industrial plants or agricultural facilities. Plants take up cadmium easily [Malm et al, 2000]; therefore, a major source of cadmium exposure is food grown with synthetic fertilizers or soil with highly soluble cadmium. Cadmium solubility increases with lower pH, low organic matter content, and low clay content. The source of cadmium is also important—cadmium from manure, parent soil (i.e. from the underlying geologic material), or deposited from the air is less soluble than cadmium from synthetic fertilizers. [Malm et al, 2000] In other words, cadmium from synthetic fertilizers is more easily absorbed into plants from the soil than other sources of cadmium. Cadmium from the air also deposits into the ocean and is taken up easily by certain seafood, particularly shellfish. [Rahbar et al, 2014] Use of tobacco products, either smoking or chewing, is a major source.

Industrial sources of cadmium are many, and include: zinc production, anti-corrosion products, PVC stabilizers, batteries, solar panels, iron and steel scrap recycling, phosphate fertilizer production, and coal processing. Cadmium is also found in paint pigments, coatings, electroplating, alloys, televisions, lasers, and semi-conductors. Chronic occupational exposures are a significant source to workers in these industries. Highly bio-available cadmium from consumer products can be found in inexpensive children's jewelry [Weidenhamer et al, 2011] and toys [CEHN et al, 2011]; children are exposed by dermal routes and mouthing behaviors.

### Cadmium toxicity

Research has shown that cadmium affects the developing brain in children. Here are some other parts of the body it can effect.

#### RELATED HEALTH ISSUES

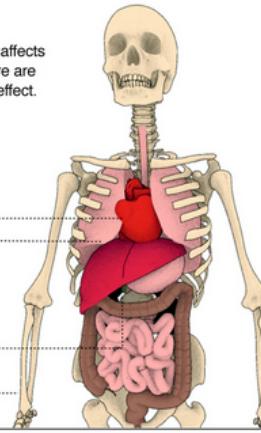
A recent study has linked it to breast cancer.

Cardiovascular disease

Obstructive pulmonary disease

The kidneys lose function, which can also cause gout, a form of arthritis.

Bones lose density and fracture.



SOURCES: Dr. Aimin Chen; Casaretti & Doull's Toxicology, (Curtis D. Klaassen); Environmental Health Perspectives, Dec. 2009

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### HOW DOES CADMIUM AFFECT PEOPLE?

Cadmium is a highly toxic metal with a very long half-life of 20-30 years in humans and accumulates in soft tissues, kidneys, and the liver. Specific mechanisms of cadmium toxicity are not well understood, however evidence suggests that cadmium affects DNA repair, and cell signaling and control. These effects lead to kidney damage, cancer, mutations, damage to hormone regulating mechanisms, reproductive disorders, and problems with cellular differentiation. [Rani et al, 2014] Some evidence also points to harmful long-term and heritable effects of cadmium. [Ray et al, 2014] In humans, cadmium takes a special ionic form, which resembles ionic calcium. This enables cadmium to disrupt biologic pathways involving calcium, leading to bone and muscle issues. [Choong et al, 2014] Additionally, there are a variety of occupational exposure problems, including inhalation of cadmium dust and fumes, with increased risks of cancer for occupational exposure. [CDC, 2012] Long term exposure to cadmium is typically measured through urine (unlike other metals), because of cadmium buildup in the kidneys, though short term exposure is typically measured through blood.

### WHAT ARE CURRENT ISSUES IN THE PACIFIC NORTHWEST?

An air pollution study publicized by USA Today in conjunction with academic researchers at the University of Massachusetts [USA Today, 2009] suggested that certain Portland-area public schools were nestled in some of the worst air pollution found in the country. Congress directed EPA to conduct a small air quality assessment of its own (two schools per state). EPA's regional office in Seattle reported to the community in North Portland that in fact the air quality surrounding the schools in question was acceptable based on current federal standards—with the exception of air cadmium levels. (The EPA study used less restrictive standards for several pollutants.) Coal transport by rail in the Pacific Northwest supports the industrial burning of coal, which releases cadmium into the air. Additionally, cadmium is one of the chemicals released into the air during transfer of crude oil from trains to holding tanks. [Tesoro Savage, 2013]

### THE UNITED STATES AND EUROPEAN UNION GOVERNMENTAL ORGANIZATIONS AND THE WORLD HEALTH ORGANIZATION HAVE ISSUED POSITIONS ON CADMIUM AND HEALTH:

Since 2010, the United States Consumer Products Safety Commission has reported five recalls of products with too high levels of cadmium, and issued a warning to stop using those products. In all cases, the products were marketed towards children. [USCPSC, 2014] The European Commission Restriction of Hazardous Substances Directive (RoHS) restricts cadmium in products to 0.01% or 100 ppm by weight, and places limits on cadmium in batteries. In 2009, the European Food Safety Authority released a statement lowering the tolerable weekly intake for cadmium to 2.5 micrograms per kilogram of body weight, and stated that “current exposure to cadmium at the level of the population should be reduced.” [EFSA, 2009] The EPA names cadmium as a hazardous air pollutant and sets a food reference dose of 7 micrograms per kilogram of body weight per week. [ATSDR, 2008]

The World Health Organization referred to cadmium exposure as a “major public health concern.” [WHO, 2010] The International Agency for Research on Cancer stated that “Cadmium and cadmium compounds are carcinogenic to humans (Group 1).” [IARC, 2012] Group 1 classification is the strongest assertion of carcinogenicity.

### SPECIFIC DISEASES OR CONDITIONS ASSOCIATED WITH EXPOSURE TO BOTH LOW AND HIGH LEVELS OF CADMIUM

#### Cancer

- A recent review of literature from 1984-2013 concluded that “Cadmium, a widespread environmental carcinogen...presents evidence as a possible cause of bladder cancer.” [Feki-Tounsi et al, 2014]. Evidence also exists for breast cancer association [Dematteo et al, 2013] and pancreatic cancer
- association [Wei et al, 2012] [Garcia-Esquinas et al, 2014]

### Cytoskeletal issues

- A recent review found that “exposure to low concentrations of Cd is associated with effects on bone, including increased risk of osteoporosis and fractures, and that this observation has implications for the health risk assessment of Cd.” [Åkesson et al, 2014]
- Cadmium was implicated in Itai Itai disease due to industrially contaminated water in people exposed (especially women). They suffered osteomalacia and osteopenia, decreased bone mineral content and decreased bone density [Kobayashi, 1971; Kasuya M, 2000; Inaba T et al, 2005].

### Neurodevelopmental Effects

- In a retrospective study of over 2,000 children, the authors of the paper concluded that “these findings suggest that children who have higher urinary cadmium concentrations may have increased risk of both [acquiring] LD [learning disability] and [being more likely to receive] special education. Importantly, we observed these associations at exposure levels that were previously considered to be without adverse effects, and these levels are common among U.S. children.” [Ciesielski et al, 2012]
- In a prospective study of 270 children, the authors “noted in boys a 1.53 times higher risk for emotional problems with a twofold increase in cord blood cadmium.” [Sioen et al, 2013]
- In a prospective study of over 1,000 children, the authors concluded: “Early-life low-level cadmium exposure was associated with lower child intelligence scores in our study cohort.” [Kippler et al, 2012]

### Endocrine and Reproductive Effects

- Cadmium mimics estrogen [Johnson, MD, 2003] so is an endocrine disrupting chemical. It also affects male reproduction in animal studies, and has recently been implicated in human epidemiological studies as causing decreased birth weight. [Johnston et al, 2014] [Kippler et al, 2012]

### Possible Effects on Cellular Aging

- A recent study showed that cadmium exposure was related to leukocyte telomere length (a marker of cellular aging). The authors concluded: “These findings provide further evidence of physiological impacts of cadmium at environmental levels and might provide insight into biological pathways underlying cadmium toxicity and chronic disease risks.” [Zota et al, 2014]

## WHAT YOU CAN DO TO PROTECT YOUR FAMILY AND COMMUNITY

1. Don’t smoke or use tobacco, and minimize your exposure to secondhand smoke.
2. Eat organic food, especially leafy greens, bread, grains, and root vegetables. Limit your consumption of shellfish.
3. Avoid children’s jewelry and metal toys.
4. Safely dispose of old batteries and do not accumulate old batteries in your home. They contain highly toxic metals and acid.
5. Use a portable air purifier in your home.
6. Work for policy change with local and regional governments, and legislatures, particularly in the realms of consumer product safety and food safety. For example, connect with organizations that advocate for laws requiring product ingredient disclosure and implementing healthier chemical use restrictions.
7. If you are a painter, avoid cadmium-containing pigments, such as cad yellow and cad red.
8. If you work in a job where you are exposed to cadmium as in smelting, refining, recycling, or plastics industries, then use personal protective equipment, ask for engineering controls to prevent exposures, change out of work clothes before leaving work, wash work clothes separately from family wash, do not wear work shoes in your home (similar precautions as one would use for lead exposure).
9. If you have galvanized water pipes in your home, let the water run after it has been sitting in the pipes, before drinking or cooking.

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