Cadmium

DISCLAIMER: the following is not meant to treat anyone with advice or tell you what you should do, such as relative to use of medication, exercise, or changing your diet. The information in this handout is merely offering what has been published in the research literature, as well as based on my professional experience. Talk to a doctor or other appropriate professionals as to what is best for your own specific needs.

It should also be appreciated that everyone has their own perspective on how to improve health. Nutritionists do it through food. Physicians do it through medicine. Psychologists do it through changing thoughts, feelings, and behaviors. Consequently, what is offered here is a reflection of my own bias and perspective.

Cadmium is known for its toxicity and being carcinogenic. It is in the top 10 chemicals of major public health concern according to WHO (along with arsenic, lead and mercury). There is an agency of the federal government, (Agency for Toxic Substances and Disease Registry, ATSDR) that ranks 275 toxic substances as to which poses the greatest threat to human health based on frequency, toxicity, and potential for exposure to people. Cadmium is #7 (as of 2022. Arsenic is #1, lead #2, mercury #3).

Cadmium harms the kidneys, liver, reproductive system, cardiovascular, thyroid, and bones. It also concentrates in the pancreas and salivary glands, joints, arteries, and the covering of bones and almost all body tissues. It has been associated with lung cancer, and possibly prostate, testicular and breast cancers. One estimate has been made that as many as a third of breast cancer cases in the U.S. may be associated with elevated cadmium levels (Aging, "Environmental cadmium and breast cancer risk" Carolyn Gallagher et al, Nov. 2010). It is said to contribute to more cancers than all the other heavy metals combined. It can contribute to uterine fibroids and other reproductive tract diseases if the level is high enough.

It can cause damage to the immune system, hormonal imbalances, fetal malformations, and lead to brain damage. It may also contribute to heart disease and diabetes. There is some research between cadmium levels and neurocognitive tests based on the NHANES 3 survey done between 1988-1994 on people 20-59 years old (Environmental Health, "Associations between cadmium exposure and neurocognitive test scores in a cross-sectional study of US adults" Timothy Ciesielski et al, 2/5/2013). Subtle impairments on such cognitive performance were found with cadmium exposure that had been thought to be safe.

Possible conditions associated with cadmium toxicity

- alopecia (hair loss)
- anemia
- atherosclerosis
- arteriosclerosis
- arthritis, osteo
- arthritis, rheumatoid
- bone repair, inhibited
- cancer
- cardiovascular disease
- cerebral hemorrhage
- cholesterol, elevated
- cirrhosis of the liver
- diabetes
- emphysema
- enlarged heart
- failure to thrive syndrome
- fertility, decreased
- hyperlipidemia (high levels of fat in blood)
- hyperactivity in children
- hypertension
- hypoglycemia
- inflammation
- lung disease
- migraine headaches
- osteoporosis
- renal (kidney) disease
- schizophrenia
- sex drive, reduced
- strokes
- vascular disease

Cadmium gets into the environment through a number of means. These include smelting, metal plating, producing pigments, in production of NiCd batteries, as a neutron absorber in nuclear reactors, and as stabilizers in plastics.

Once it gets into the air it can fall back to earth with rain or simply by falling out of the air. It is then picked up by plants such as leafy greens, root crops (e.g. potatoes), tobacco, rice, cereals and grains. Cadmium in drinking water is typically under 1 mcg/liter (1 ppb), and it typically is not contaminated other than by mining or industrial wastewater. It can also be found in liver and kidney meats, and in some areas shellfish and mushrooms. Other sources of potential exposure include cigarette smoke which for heavy smokers can be as much as they absorb from food (which might be 0.5 - 2 mcg/cigarette, with smokers ending up with twice as much cadmium in their bodies as nonsmokers). Absorption of cadmium is highest through inhalation.

It is also in marijuana and in rolling papers to make them stiffer. There was a national study done (Public Health, "Lifetime marijuana use in relation to cadmium body burden of US adults; results from the national health and nutrition examination surveys, 2009-2016' G. Ngueta et al, Oct. 2020) that found both frequency and duration of marijuana use was associated with higher blood levels of cadmium. Long term use was associated with high urinary cadmium levels even at low frequency of exposure. For those who used for 15 or more years, there was higher cadmium in users it less than twice a week as well as 4 or more times/week.

Cadmium is concentrated in the food chain. Some plants like tobacco show cadmium tolerance and so smoking increases the risk of cadmium taking a toll on health. It is known to cross the blood-brain barrier and this leads to neurotoxicity, inflammation, oxidative stress, and cell death. There is also evidence that cadmium is involved with amyloid beta plaques accumulating, and is thought to be one factor that could be involved with Alzheimer's developing.

Ceramics and glass glazing, jewelry making, and fabric dyes are other potential sources of it. There was a recent study that looked at water and air samples along roadways and found that the majority of particles did not come from tailpipes but from brake pads and tires. Brake pads and tires can contain cadmium.

Cadmium can also be found in kids' jewelry. Lead had been used by countries like China but when they were barred from using that heavy metal some switched to using cadmium which can be more dangerous. One piece of jewelry that was tested contained 91% cadmium by weight. Other trinkets purchased at national and regional chains or franchises found 84-89% of cadmium by weight. Kids can ingest the cadmium by sucking or biting into such jewelry. One study done by the Associated Press found 12% of the jewelry tested containing at least 10% cadmium. How is this possible? There are no federal laws restricting it, although some states (e.g. California, New York, Illinois, Maryland, Minnesota, Washington) are now limiting it in children's jewelry items. There are some voluntary industry standards for cadmium in toys.

Cadmium levels in the body increase with age in industrialized societies, going from less than 1 mcg in a newborn to 15-20 mg in adults.

Other potential sources of cadmium that is in food includes:

	mcg/100 g of food (or 100 ml of liquid)
Mussels	53.1
Oyster	42
Lamb kidney	19
Crabmeat	18
Potato chips	13.5
Prawn, king size	12.8
Lamb liver	12.7
Sesame seed	7.7
Peanut	3.9
Tahini	3.1
Strawberry	3.1
Beetroot	2.1
Tuna	2.0
Peanut butter	1.9
Avocado	1.5
Celery	1.2

A more complete list can be found at

http://dietgrail.com/cadmium-in-food/

Cadmium also accumulates in raspberries, strawberries, carrots, tomatoes, snails, scallops, lobster, shrimp, fish (e.g. tuna, haddock, codfish), and dried seaweed.

Then there are gluten-free diets. National research (NHANES, 2009-2012) looked at those on a gluten-free diet and those who were not. People who were gluten-free had significantly higher

urine levels of arsenic, and blood levels of mercury, cadmium, and lead vs. those not on such a diet. (Clinical Gastroenterology & Hepatology, "Accumulation of heavy metals in people on a gluten-free diet" Stephanie Raehsler et al, 2018)

There was also research done by Healthy Babies Bright Future on 168 baby foods involving 61 different brands and 95% of them contained heavy metals. Some of the brands were organic ones including Plum Organics, Beech Nut and Earth's Best. Findings were that among the brands

- 94% contained lead
- 75% contained cadmium
- 73% contained arsenic
- 32% contained mercury

Plus

- 26% contained all four toxic metals
- 40% contained three of them
- 21% contained two of them
- 8% contained one metal
- 5% (only 9) contained zero heavy metals.

Fifteen foods accounted for over half of the heavy metal in baby food risk and choosing organic does not necessarily lower the risk. The most dangerous foods were:

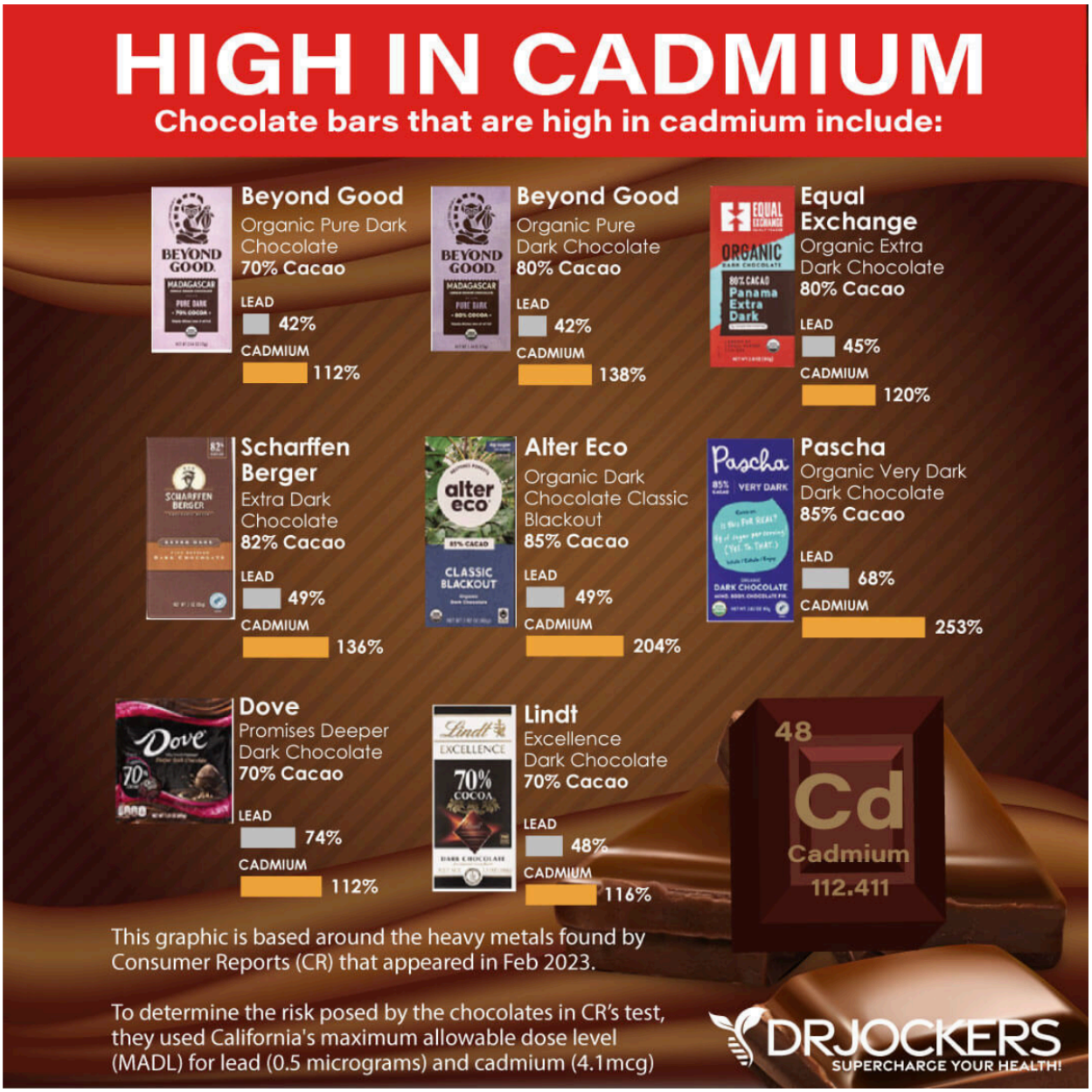
- Rice-based foods (e.g. cereal, rice dishes, rice-based snacks)
- Apple juice
- Grape juice
- Fruit juice blend (100% juice)
- Cheerios and oat ring cereals
- Mac and cheese
- Puff snacks and teething biscuits
- Soft cereal bars
- Oatmeal cookies
- Fruit yogurt
- Sweet potato baby food

But wait, you are not out of the woods yet. How often do you eat at a fast-food restaurant? One non-profit group, 'Moms Across America' did research on the Top 20 fast-food restaurants in the country. The primary finding: Of all the samples purchased at 21 locations nationwide, 100% were contaminated with lead and cadmium. Levels of cadmium found ranged between 74%-1,158% greater than the EPA's limit for what is allowed in drinking water such as from French fries at Jack-in-the-Box and In-and-Out. (https://www.momsacrossamerica.com/fast_food_heavy_metals)

Another common source of cadmium intake through food is chocolate and cocoa. Below is a table showing lead and cadmium levels of various chocolate products.

	Lead mcg/serving	Cadmium mcg/serving
NOW healthy foods certified organic cocoa powder 100 pure	7.5	10.8
Whole Foods 365 Everyday value organic dark chocolate coconut 56 cacao	6.0	16.3
Theo organic fair trade almond coconut 65 dark chocolate limited edition spring collection	4.5	10.7
Trader Joe's passport Tanzania 73	4.4	6.8
Endangered species chocolate natural dark chocolate with 88 cocoa	3.4	2.1
Godiva chocolatier 85 cacao extra dark Santo Domingo chocolate	3.0	6.8
Lindt Excellence 85 cocoa extra dark chocolate bar	2.8	5.2
Whole Foods 365 Everyday value organic dark chocolate 56 cacao	1.8	10.3
Newman's Own organics the second generation super dark chocolate premium organic chocolate 70 cocoa	1.8	33.1
Cadbury Royal Dark Chocolate Indulgent Semisweet	1.0	0.9
Godiva chocolatier 50 cacao dark chocolate sea salt	1.0	2.1
Hershey's Special Dark Mildly Sweet chocolate bar	1.0	3.8
Equal Exchange chocolate organic fairly traded dark chocolate very dark 71 cacao	1.0	8.1
M&M's dark chocolate	0.9	Not available
Toblerone of Switzerland dark chocolate with honey and almond nugat	0.9	1.1
Swiss Miss premium cocoa dark chocolate hot cocoa mix	0.7	0.7
Ghirardelli chocolate premium baking cocoa 100 unsweetened cocoa	0.7	0.6
Whole Foods 365 Everyday value organic hot cocoa rich chocolate flavor mix	0.7	4.5
Dove silky smooth dark chocolate bar	0.7	5.5
Nestle rich milk chocolate flavor hot cocoa mix	0.6	0.3
Baker's unsweetened baking chocolate bar	0.6	4.6
Hershey's kisses milk chocolate	0.5	0.6
Whitman's sampler solid milk chocolate rabbit	0.5	0.6
Hershey's cocoa 100 cacao natural unsweetened	0.4	4.0
Reeses milk chocolate peanut butter cups	0.1	0.6
Snickers bar	None detected	0.6

A more complete listing can be found at https://www.asyousow.org/environmental-health/toxic-enforcement/toxic-chocolate



"Heavy metals in chocolate: what you need to know? Dr.Jockers.com

A simpler chart is shown above of some chocolates high in cadmium.

Chocolate is also known for its lead contamination. If you want to avoid both here are some to steer clear of.

Protein powders also can contain cadmium (along with other heavy metals like lead, arsenic, and mercury). One study by the Clean Label Project in 2018 (https://cleanlabelproject.org/blog-post/new-study-of-protein-powders-from-clean-label-project-finds-elevated-levels-of-heavy-metals-and-bpa-in-53-leading-brands/) found a serving of protein powder contained on average 1.6 mcg of cadmium, but ten samples had 4.6 – 10.7 mcg/serving. This study found that about 75% of such powders had measurable levels of lead. The powders also contained detectable levels of arsenic (83.5%), cadmium (73.7%), mercury (28.6%), and BPA (55%). Certified organic products averaged twice as much of the heavy metals. Plant-based protein powders contained more heavy metals than the non-plant based ones. Based on a serving size of 35 grams none of the samples exceeded reasonable safety limits for arsenic or mercury. However, 10 were over the limit for cadmium and three were for lead. Higher cadmium levels are often found in products made with chocolate (cocoa powder).

However, there is a difference between what is eaten and what is absorbed. What research found is that the bioavailability of cadmium was greater in animal-based foods than vegetable-based. Research also has found that the uptake of heavy metals like lead and cadmium are inhibited by dietary fiber and phytate that are found in plant foods.

Acute effects of cadmium toxicity can include

- irritating the respiratory system
- headaches
- chills
- muscle aches
- nausea, vomiting
- diarrhea

Chronic toxicity primarily affects the kidneys, with less accumulating in the liver and muscles. It can also impact the lungs leading to decreased functioning and emphysema. Osteoporosis and osteomalacia can occur from it too. Occupational exposure to cadmium has been implicated in lung and prostate cancer. It can also affect the reproductive and cardiovascular systems. It blocks and mimics estrogen which can impact both male and female fertility. And by blocking estrogen receptors an imbalance in that hormone can result even though your body is making enough.

Some of the damage cadmium does is by the fact that it is similar to zinc in structure and function, and the zinc/cadmium ratio influences its toxicity and storage. Being deficient in zinc can increase the cadmium toxicity, while having appropriate levels of zinc can reduce cadmium's damage. Zinc deficiency and cadmium toxicity are more likely in diets that are high in refined grains and flours because the ratio gets altered when the grains are refined.

There is research that the cadmium:zinc ratio is associated with all-cause mortality, along with cancer and cardiovascular mortalities too based on two NHANES studies involving 15,641 people. (Nutrients, "Association between urinary cadmium-to-zinc intake ration and adult mortality in a follow-up study of NHANES 1988-1994 and 1999-2004" Kijoon Kim et all, 12/24/2019.)

Kids who do not get enough iron, calcium, zinc or protein may absorb more cadmium through their diet. Pregnant women low in calcium, iron or zinc may absorb more cadmium. It can also get into breast milk, and levels in such milk are at 5-10% of the maternal blood levels. Effects of cadmium in fetuses is not well studied. It may have an impact on birth weight, neurobehavior, and the immune system.

A 2012 study from Harvard (Environmental Health Perspectives, "Cadmium exposure and neurodevelopmental outcomes in U.S. children" May 2012, Timothy Ciesielski et al) took over 2,000 kids ages 6-15 years old from the NHANES data collected between 1999-2004. It found that kids with higher cadmium levels were three times more likely to have learning disabilities and be in special ed. The adverse health effects were with cadmium levels that are commonly found in American children and which were previously thought to be without adverse effects.

What is a safe level of cadmium?

The World Health Organization (WHO) offered that the "tolerable intake" of cadmium through food is 25 mcg/kg of body weight per month. The EPA has mandated that the maximum cadmium level in bottled drinking water is 0.005 mg/liter. California's Prop. 65 safe limit is 4.1 mcg/day.

Detoxing from cadmium

There are two half-life's for cadmium, meaning how fast does it leave the body. A half-life of 1 month would mean that it would be cut in half by then, and would be at a quarter after 2 months, etc. One half-life is of a few months and is how fast red blood cells are being turned over. The other half-life is years to decades long and reflects cadmium that is stored in the liver, kidneys, and muscle.

There are chemical chelation agents but there are concerns about their safety and efficacy. Side effects might include dehydration, low calcium levels, kidney damage, elevated liver enzymes, allergic reactions, lower levels of some nutrients like zinc, and even death. Talk to a medical doctor if you want to know more about them.

One approach to removing mercury, as well as lead and cadmium, from the human body, is through use of a lactovegetarian diet. One study found that mercury levels dropped by 25%, lead by 47%, and cadmium by 24% after three months on the diet. When the subjects went off the diet, their levels of these poisons returned to about their baseline although lead was actually 13% higher after a three year period.

Manganese when taken with appropriate amounts of zinc and coper offers a protective effect against low levels of cadmium toxicity. Egg whites as a source of protein can be effective against cadmium toxicity probably due to the high selenium content they have. Sulfur compounds may also be helpful.

Another approach to consider is what already has been mentioned as to zinc, calcium and iron offering a protective effect. Zinc is one of the more well studied metals for detoxing from heavy metals. Zinc is chemically similar to cadmium and competes for binding sites . It also helps to

make a chemical called metallothionein which has a high affinity for cadmium and causes its detoxification by binding to it.

Mice research suggests that selenium may be helpful against lead and cadmium poisoning. Selenium is also a cofactor of glutathione which is called the master antioxidant of the human body.

Iron competes with cadmium for intestinal uptake meaning that iron supplementation may limit cadmium absorption. Calcium and magnesium may also compete with lead and cadmium for intestinal absorption. Copper, sulfur, and manganese also have a two-way relationship to cadmium (meaning that each is an antagonist to the other). None of this is to say that you should start gulping down handfuls of such minerals. Nutrients need to stay in balance to each other such as maintaining a proper ratio between calcium and magnesium. The human body likes everything to be at the 'Goldilocks' level, not too much, not too little, but just right. Determining where your levels are at relative to cadmium and then discussing it with an appropriate professional who can give you guidance on supplementation or changes to your diet is advised.

There is also some research, mostly based on rats, that garlic, ginger, and onion can be helpful with lead and cadmium toxicity. Other research, again rat based, has found some benefit from green tea, tomatoes, curry, grapes, and ginseng. Vitamin C is another antagonist but it is a chelator and so high doses are not recommended. Deficiencies in vitamins B1 and B6 increases sensitivity to cadmium and lead, and supplementation with them has been proven effective in animal and human studies as to reducing such toxicity. Ginger, garlic and onion have some protective effects against cadmium and lead. Garlic helps through its antioxidant qualities, plus from sulfur compounds which aids in chelation of cadmium. Ginger and onion have similar properties to garlic. Tomato is said to have chelating properties, and has been shown to significantly reduce the accumulation of heavy metals (cadmium, mercury, and lead) in the liver of rats.

Still other mice and rat research has found various probiotic strains to be helpful including l. plantarum CCFM8661, l. rhamnosus Rosell-11, l. acidophilus Rosell-52 and b. longum Rosell-175. Other animal research suggests that spirulina and chlorella can help with cadmium or lead poisoning. How well such research into animals translates to humans, and with what doses is largely unknown. Taking excessive amounts of such foods, spices or other supplements can cause problems too. Some experts voice concern that if you try to flush out toxic elements like cadmium too fast, what might happen is that it goes from being locked up in your body to suddenly flushed into your blood stream and hits you with a more serious and acute poisoning. Consequently, they recommend that you first strengthen yourself nutritionally such as by looking at mineral and vitamin levels and getting them up to snuff, before you flush anything out of your system.

Another approach that has some research behind it is sweating through use of a steam or infrared sauna. Such sweating was found to be good in helping to eliminate heavy metals including lead, cadmium, and aluminum, along with others such as nickel (Archives of Environmental

Contamination & Toxicology, “Blood, urine and sweat (BUS) study: monitoring and elimination of bioaccumulated toxic elements” Stephen Genius, et al, Nov. 2010). You should have appropriate cardiovascular health before making use of a sauna and should talk to your doctor if you are unsure about this issue. You need to drink water before or after sauna use as to dehydration as well as consider replenishing electrolytes that are lost to sweating too.

The removal of cadmium from tissue storage occasionally causes a ‘cadmium crisis’ involving symptoms like fatigue, metallic taste in the mouth, low back pain, stomach distress, poor appetite, skin eruption, or headache. Such symptoms are temporary and can be reduced or eliminated by taking more vitamin C and calcium. Vitamin C dosage can be increased to 3000 mg, and 1600 mg for calcium, with the dose being reduced as the symptoms subside.