

Cadmium (Cd) — HMTc analyte

Karen Pendergrass · ORCID 0000-0002-2348-7259

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THE ANALYTE

48 · Cd · Total elemental cadmium

Cadmium is limited because it is a cumulative nephrotoxicant with a biological half-life of 10 to 30 years that concentrates in the renal cortex, is classified by IARC as a Group 1 human carcinogen, and has no effective clinical treatment, so control is a prevention problem addressed by capping dietary intake.

Why it is limited

The government and expert-body assessments that underpin limiting cadmium in food, and what each concluded. The maximum levels in force apply these findings; this page is the rationale, not the certification threshold.

BODY	YEAR	ASSESSMENT	WHAT IT CONCLUDED
IARC	2012 (Vol. 100C)	IARC Monographs Vol. 100C, Arsenic, Metals, Fibres, and Dusts — cadmium and cadmium compounds, Group 1	Classifies cadmium and its compounds as Group 1, carcinogenic to humans, on the basis of occupational inhalation studies; general-population dietary epidemiology shows statistical associations with cancers of the lung, endometrium, bladder, and breast that the major regulatory bodies have not yet translated into quantitative dose-response reference values.
EFSA (CONTAM Panel)	2009	Scientific Opinion on cadmium in food (EFSA Journal, doi 10.2903/j.efsa.2009.980)	Established a tolerable weekly intake (TWI) of 2.5 µg/kg b.w./week for cadmium, anchored on a BMDL5 of 4 µg U-Cd/g urinary creatinine (critical endpoint: renal tubular dysfunction) with a chemical-specific adjustment factor of 3.9 and a kinetic back-translation; concluded that population-level cadmium exposure should be reduced because typical European intake sits close to or slightly above the TWI (population mean 2.3 µg/kg b.w./week).
JECFA (FAO/WHO)	2010 / 2022	PTMI established at the 73rd meeting (2010); dietary exposure reassessed at the 91st meeting, WHO Food Additives Series No. 82 (2022)	Set a provisional tolerable monthly intake (PTMI) of 25 µg/kg b.w./month, using a monthly averaging window chosen to reflect cadmium's long (decades) biological half-life; the 2022 reassessment found that cocoa-product contributions push total dietary cadmium exposure in children aged 0.5 to 12 to as high as 96% of the PTMI, essentially saturating the international reference value from diet alone.

BODY	YEAR	ASSESSMENT	WHAT IT CONCLUDED
US ATSDR	2012	Toxicological Profile for Cadmium	Derived a chronic oral Minimal Risk Level (MRL) of 0.1 µg Cd/kg/day — the tightest of the four dietary reference values — anchored on a UCDEL10 of 0.5 µg/g urinary creatinine with a toxicokinetic translation to 0.33 µg/kg/day in females at age 55 and an uncertainty factor of 3 for human variability, critical endpoint renal tubular dysfunction; ATSDR notes this MRL is below estimated typical US dietary intake (~0.3 µg/kg/day). Companion values: intermediate oral MRL 0.5 µg Cd/kg/day, chronic inhalation MRL 0.01 µg Cd/m ³ , acute inhalation MRL 0.03 µg Cd/m ³ .
US EPA (IRIS)	1989	IRIS oral reference dose (RfD) for cadmium (IRIS substance 0141)	Oral RfD of 1×10^{-3} mg/kg/day (1.0 µg/kg/day) for cadmium in food and 5×10^{-4} mg/kg/day (0.5 µg/kg/day) for cadmium in water; critical effect significant proteinuria (renal tubular dysfunction). This is the most permissive of the four daily-equivalent dietary references on the Index.
California OEHHA (Proposition 65)	1996 / 2001	Evidence on the Developmental and Reproductive Toxicity of Cadmium (1996); Prop 65 MADL for Cadmium, oral (2001)	Cadmium is listed under Proposition 65 as a developmental and male reproductive toxicant (listing effective May 1997); the oral Maximum Allowable Dose Level (MADL) is 4.1 µg/day, controlled by the developmental endpoint (Ali et al. 1986 LOEL of 0.706 mg/kg/day in rats, more sensitive than the male reproductive endpoint). This is the reference value most directly relevant to pregnancy.

Toxicological basis

What the assessment bodies found when they examined cadmium, and why every one of them concluded that dietary intake has to be capped: the cumulative renal endpoint that anchors regulation, the populations that reach it fastest, and the carcinogenicity that does and does not apply to food.

The hazard that anchors dietary regulation is cumulative and renal. Cadmium is absorbed slowly from the gut, but once absorbed it is retained with a biological half-life measured in decades, commonly summarised as 10 to 30 years, and concentrates in the proximal tubular cells of the renal cortex, where it accumulates bound to metallothionein and progressively erodes tubular function. The critical endpoint is renal tubular dysfunction, whose earliest detectable sign is increased urinary excretion of low-molecular-weight proteins such as beta-2-microglobulin. EFSA's CONTAM Panel set a tolerable weekly intake of 2.5 µg/kg body weight, anchored on a BMDL5 of 4 µg urinary cadmium per gram of creatinine at the renal-cortex burden that peaks near age 55. This is not an academic reference: mean European dietary exposure sits at roughly 2.3 µg/kg body weight per week, close to the TWI, and the Panel concluded that population-level cadmium exposure should be reduced. Because there is no clinical treatment that removes accumulated cadmium, control is a prevention problem, addressed by capping intake rather than by managing a dose.

The intake that matters is lifetime intake, and it reaches some groups faster than others. Children aged 0.5 to 12 carry mean dietary cadmium exposure about 60 percent higher than adults simply because they eat more food relative to body weight, and when cocoa-product consumption is added their total dietary exposure can reach 96 percent of the JECFA provisional tolerable monthly intake, essentially saturating the international reference value from diet alone. Women of reproductive age with low iron stores absorb cadmium more efficiently, and iron deficiency compounded across pregnancies is part of why the disease that named cadmium's chronic toxicity fell almost entirely on

women: of 196 officially recognised itai-itai cases in Japan's Jinzu River basin, 193 were women, most of them postmenopausal. Itai-itai is the severe endpoint of the same axis EFSA regulates against, renal tubular injury paired with skeletal demineralisation, the osteomalacia, osteoporosis and spontaneous fractures that give the disease its name. These are the windows a cadmium limit is built to protect.

Cadmium is also a carcinogen, and precision about the route is a matter of credibility. IARC classifies cadmium and its compounds in Group 1, carcinogenic to humans, but that classification rests on occupational cohorts inhaling cadmium dust and fume, not on people eating it. General-population dietary epidemiology has produced statistical associations with cancers of the lung, endometrium, bladder and breast, yet the major regulatory bodies have not translated those associations into a quantitative dose-response reference value for dietary cadmium. The honest statement is therefore two-part: the Group 1 designation is real and it is inhalation-anchored, while the dietary cancer signal is suggestive but not yet the basis of any food limit. The limits in force rest on the renal endpoint, not the cancer endpoint.

This is not the finding of a single body. EFSA, the US Agency for Toxic Substances and Disease Registry, JECFA and US EPA IRIS have each derived a dietary reference value anchored on the same renal tubular endpoint, and although they span about a factor of ten, with ATSDR's chronic oral minimal risk level of 0.1 µg/kg/day the tightest, EPA's oral reference dose of 1.0 µg/kg/day the most permissive, and EFSA's weekly and JECFA's monthly values between them, the spread reflects different methodological choices on overlapping data rather than disagreement about the underlying toxicology. California adds a further mark of concern, and unlike a listing-only status it carries a dietary-relevant number: [Proposition 65](#) lists cadmium both as a carcinogen and as a developmental and male reproductive toxicant, and sets an oral Maximum Allowable Dose Level of 4.1 µg/day, controlled by the developmental endpoint. That convergence of independent hazard findings, together with EFSA's exposure exceedance, is what moved the European Union to set binding cadmium maximum levels across food commodities. The science came first; the limits followed.

Occurrence & exposure

How much cadmium food actually carries, and how close everyday dietary exposure runs to the health-based guidance value. The occurrence figures are drawn from a national total diet study and the exposure figures from the EFSA assessment that set the tolerable weekly intake; the complete occurrence corpus is on the Heavy Metal Index.

By-food cadmium occurrence, FDA Total Diet Study FY2018-2020, filtered to cadmium. Values are µg/kg (ppb) on an as-consumed (table-ready) prepared-food basis; the median (P50), 95th percentile (P95) and single highest measurement are shown across each food's TDS collections, with sample counts varying (n = 3 to 27). These are reported occurrence concentrations, not safety thresholds.

F00D	N	P50 MG/KG	P95 MG/KG	MAX MG/KG
Potato chips	3	100	190	200
Celery, raw	27	32	73	100
Potato, baked with peel	27	41	65	66
Lettuce, iceberg, raw	27	27	64	73

FOOD	N	P50 MG/KG	P95 MG/KG	MAX MG/KG
Peanut butter, creamy	3	55	60	60
Collard greens, boiled	27	22	53	65
Peanuts, dry roasted	3	42	45	45
Cereal, bran with raisins	3	42	44	44
Bread, whole wheat	27	28	41	42
Potato, peeled, boiled	27	25	38	42
Bread, white, enriched	27	29	35	37
Avocado, raw	27	5.4	30	59
Rice, white, cooked	27	5.2	19	23

Dietary cadmium exposure versus the EFSA tolerable weekly intake of 2.5 µg/kg body weight per week. Mean exposures are from the EFSA CONTAM Panel (2009); the share is that mean expressed against the TWI. These are population exposure estimates, not thresholds.

CONSUMER GROUP	MEAN EXPOSURE MG/KG BW/WEEK	SHARE OF EFSA TWI	NOTE
European adults, population mean	2.3	~92%	At the TWI; driven by cereal, potato and vegetable staples eaten in volume
Regular bivalve-mollusc consumers	4.6	~184%	Roughly twofold over the TWI from a single high-concentration food habit
Regular wild-mushroom consumers	4.3	~172%	Roughly twofold over the TWI

Cadmium enters the food supply from three compounding sources: natural background in soils, anthropogenic loading from phosphate fertiliser and atmospheric deposition from metal refining, and biological concentration in filter-feeding marine invertebrates and in certain plant commodities. The by-food picture separates two things that are easy to conflate. The foods that drive population exposure, cereals, potatoes and other starchy roots, and leafy vegetables, do so because they are eaten in volume, not because they are the most contaminated. The foods with the highest concentrations, bivalve molluscs other than oysters, wild mushrooms, cocoa and chocolate, oilseeds and edible offal, matter most to the people who eat them regularly.

The reason to monitor cadmium at the category level rather than trust any single food is the combination of a decades-long half-life with staple exposure that already sits at the guidance value. There is no headroom to absorb a high-concentration habit: a diet built on staples reaches the tolerable weekly intake on its own, and regular consumption of [shellfish](#), wild mushrooms, cocoa or organ meats carries a person past it, while children and iron-deficient women accumulate faster still. For a certifier, that is the case for treating cadmium as a metal to be capped by sourcing and ingredient selection across a category, not one to be waved through because a typical portion looks unremarkable.

Anchor occurrence dataset: FDA Total Diet Study FY2018-2020 element results (A-tier government survey), filtered to cadmium. Exposure-versus-TWI figures are from the EFSA CONTAM Panel Scientific Opinion on cadmium in food (2009), the A-tier assessment that set the 2.5 µg/kg bw/week tolerable weekly intake. The full occurrence corpus is on the [Heavy Metal Index](#)^[7].

How it is regulated

Binding food maximum levels, not the health-based reference values, are what govern a product. Under Method v2.0 the standard for a (product, analyte) is the strictest maximum level any credible government sets, converted to the row's native basis. For infant and child foods the EU (Commission [Regulation \(EU\) 2023/915](#), [/regulations/eu-2023-915](#)) sets the governing cadmium MLs: baby food and processed cereal-based food for infants/young children 40 µg/kg; young-child drinks 20 µg/kg; cereals 100 µg/kg; infant/follow-on/young-child formula 5 µg/kg (cow-milk liquid, provision 3.2.17.2) / 10 µg/kg (cow-milk powder, 3.2.17.1) / 10 µg/kg (soy liquid, 3.2.17.4) / 20 µg/kg (soy powder, 3.2.17.3). Codex matrix MLs ([CXS 193](#)-1995: polished rice 0.4 mg/kg, quinoa 0.15 mg/kg, leafy vegetables 0.2, bivalve molluscs 2, cocoa powder 2.0) are aligned to the JECFA PTMI. US FDA [Closer to Zero](#) ([/regulations/us-fda-c2z](#)) has not yet set a cadmium action level (its [lead](#) action levels are in force; the cadmium document is pending), so no US federal food ML competes with the EU value for infant/child categories. Where no government regulates the exact product, the value is read across from the nearest analogous government limit rather than invented. See the per-product derivation tables (e.g. [/regulations/eu-2023-915](#)) for the government-by-government comparison; do not restate every number here.

How the HMTc program treats it

Cadmium is a priority toxic in the HMTc program, grouped with lead, [inorganic arsenic](#), and [mercury](#) as analytes with no established safe threshold. That label is toxicological clarity, not a status ladder: cadmium is equal at the gate with every other claim analyte. Any exceedance enters Remediation unmarked; no metal has a transitional overage. The certification species is total elemental cadmium, and cadmium carries no speciation trigger — the reflex-speciation controls apply to arsenic (inorganic), mercury (methyl), and [chromium](#) (hexavalent Cr-VI on total-chromium screening), not to cadmium. The HMTc cadmium limit is set by lookup to the strictest applicable government ML in the row's native basis (for example, 40 µg/kg as-sold for teething biscuits and finger snacks, binding on the EU value; formula subcategories take the EU formula-specific MLs with the 8:1 powder-to-liquid basis conversion applied only within infant formula). The regulatory hard-stop still wraps the published number: any actual legal-limit violation fails certification regardless of HMTc status. Grounded in the infant-and-child-foods manual method note and the teething-and-snacks standard master-limit and derivation tables.

Literature baseline

The complete peer-reviewed and regulatory literature for cadmium is maintained independently at the [Heavy Metal Index](#)^[7]. That reference reports what the literature says; this certification site applies it. The two are kept editorially separate by design.