

Why Single-Metal Limits Underprotect the Whole Diet

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Abstract

Regulatory limits for heavy metals in food are almost all set one metal at a time — a limit for lead, a separate limit for cadmium, another for inorganic arsenic — yet a real diet delivers those metals together. Recent population data show that a consumer can sit at or below every single-metal reference value and still carry a combined exposure that exceeds the health-protective threshold: in the cleanest-diet jurisdiction studied, the average adult's cumulative hazard index is already above one for neurotoxic and renal endpoints. The certification consequence is direct. A standard that certifies against one metal at a time can pass a product that is quietly adding to an already-saturated combined load, so the honest instrument is an eight-metal panel scored across a whole-diet framing rather than a stack of independent single-metal checks. That is how the Heavy Metal Certified mixed-meals standard is built. The full anchor-source evidence base lives on the Heavy Metal Index, the independent literature reference this analysis cites one way.

The Single-Metal Floor Is the Wrong Floor

Almost every regulatory limit for heavy metals in food is set one metal at a time. EFSA's tolerable weekly intake for cadmium, JECFA's provisional tolerable monthly intake for the same metal, the FDA's action level for inorganic arsenic in infant rice cereal, and the maximum levels in Commission Regulation (EU) 2023/915 are all single-metal reference values, each calibrated against its own metal in isolation [4][5]. A product tested for compliance is checked against each of them separately, and a pass on all of them is read as a clean result.

The difficulty is that a diet does not arrive one metal at a time. The same bowl of cereal, cup of coffee or serving of vegetables can carry lead, cadmium, inorganic arsenic, mercury, nickel and aluminium at once, and their effects on shared endpoints — the developing nervous system, the kidney — add together. Three independent assessments, using three different methods in three different jurisdictions, converge on the same conclusion: taken at face value and combined, the single-metal floors do not add up to a health-protective outcome [1]. The floor calibrated to one metal is the wrong floor for a real plate.

A Clean-Diet Population Already Over the Line

The load-bearing evidence is a national-population study of Finnish adults. Suomi and Tuominen assembled the first cumulative dietary risk assessment for a six-metal mixture — cadmium, lead, inorganic arsenic, methylmercury, nickel and aluminium — using individual consumption data from the FinDiet 2012 survey (1,295 adults aged 25 to 74) combined with national occurrence monitoring, and scored the mixture with relative potency factors referenced to lead neurotoxicity [1].

The result is that the cumulative hazard index exceeds one — the conventional non-negligible-risk threshold — for the average adult in every age group, for both neurotoxicity and kidney effects. This is not a worst-case or high-consumer framing. It is the average adult in a country with strong food-safety enforcement, clean drinking water and one of the cleanest reported food supplies in the European Union, and the inputs are the ordinary single-metal regulatory values. The breakdown sharpens it: more than 95

percent of Finnish women under 45 — the population whose developmental-risk case is strongest — are above the combined threshold for neurotoxicity [1].

The dietary attribution is the part that unsettles the usual story. The main contributors to combined exposure for adults were bread and other cereals, non-alcoholic beverages such as coffee and tea, and vegetables — everyday staples, not the high-profile culprits. Fish, chocolate and rice contributed less to the Finnish total than the foods most people eat without a second thought.

Cadmium Alone Nearly Fills the Budget

A regulator's own assessment shows how little headroom a single metal can leave. At its 91st meeting, JECFA carried the 2010 provisional tolerable monthly intake for cadmium — 25 µg per kilogram of body weight per month — forward without revision, while refreshing the exposure estimate with 2019 occurrence data. Updated cocoa-product data pushed total dietary cadmium in children aged 0.5 to 12 years to as high as 96 percent of that reference value in some subpopulations [2].

The implication for the combined picture is direct. If cadmium alone reaches 96 percent of its own permissive reference value in young children, the cumulative load for that group across the full regulated mixture is necessarily over the combined threshold before lead, arsenic, mercury, nickel and aluminium are even added. This is not an outside critic pointing at a gap; it is the body whose reference value is the operative floor in much of the world documenting near-saturation from one metal, in the population most at developmental risk.

Arsenic's Safety Margin Is Already Negative

The third line of evidence comes from arsenic, and speciation matters: the concern is inorganic arsenic specifically, not total arsenic. In a 2024 Scientific Opinion, the EFSA CONTAM Panel concluded that inorganic arsenic is a genotoxic carcinogen requiring a margin-of-exposure approach rather than a simple tolerable intake, and selected a benchmark-dose lower confidence limit of 0.06 µg per kilogram of body weight per day from a skin-cancer case-control study [3].

Applied to actual European intake, the margins of exposure for inorganic arsenic run from 2 down to 0.4 for mean adult consumers and from 0.9 down to 0.2 at the 95th percentile — every one of them below the threshold margin of one, which EFSA frames as a health concern [3]. Here a single regulated metal, assessed on its own against a rigorous carcinogenic endpoint, already sits past the protective line for the average adult. Combine that with the Finnish cumulative result and the JECFA cadmium saturation, and the three findings — different metals, different endpoints, different methods — point the same way.

What This Means for Certification

The consequence for a certification standard is not that any one government limit is wrong; it is that checking a product one metal at a time cannot see the load a real diet carries. A product can pass the lead limit, the cadmium limit and the arsenic limit as three separate tests and still be adding measurable amounts of each to a consumer whose combined exposure is already near or over the threshold. Per-metal compliance is necessary, but it is not the same as a health-protective result.

The honest response has two parts. First, measure the whole mixture: Heavy Metal Certified tests an eight-metal panel — lead, cadmium, inorganic arsenic, methylmercury, nickel, tin, aluminium and hexavalent chromium — on every product, rather than screening for one or two headline metals and treating the rest as absent. Second, frame the result against the whole diet rather than a single serving in isolation, which is what the mixed-meals standard is for: it reads a product as part of a day's eating, where the additive picture actually lives.

Each metal is still held to a real number. The default limit for any product and analyte is the strictest maximum level set by a credible government regulator, converted to the product's own basis. For the four Tier-1 toxics — lead, cadmium, inorganic arsenic and methylmercury — the program may set the stricter of that government limit and the cleaner end of the occurrence evidence; the Tier-2 metals — nickel, tin, aluminium and hexavalent chromium — adopt the government limit directly. Completeness across the panel and a whole-diet frame are what let a certification answer the combined-exposure problem that single-metal limits, on their own, leave open.

Frequently asked questions

Can a food pass every heavy-metal limit and still be unsafe?

Yes. Regulatory limits are almost all set one metal at a time, but a real diet delivers several metals together and their effects on shared organs add up. In the cleanest-diet jurisdiction studied, the average adult's combined, or cumulative, hazard index already exceeds the non-negligible-risk threshold while every input sits at an ordinary single-metal value.

What is a cumulative hazard index?

It is a way of adding up the risk from several metals at once. Each metal's exposure is expressed relative to the level considered hazardous for a shared endpoint, and the ratios are summed; a total above one signals a non-negligible combined risk. Suomi and Tuominen found values above one for neurotoxicity and kidney effects across all adult age groups in Finland.

Which foods drive combined heavy-metal exposure?

In the Finnish national data, the largest contributors were everyday staples: bread and other cereals, non-alcoholic beverages such as coffee and tea, and vegetables. Fish, chocolate and rice — the foods usually named in heavy-metal coverage — contributed less to the combined total than those staples.

Why certify against an eight-metal panel instead of the well-known metals?

Because combined exposure is additive, every metal a product contributes adds to a consumer's total load, not just lead and cadmium. Testing only the headline metals and assuming the rest are absent misses that additive picture, so Heavy Metal Certified measures all eight metals on every product and frames the result against the whole diet.

References

- [1] Cumulative risk assessment of the dietary heavy-metal and aluminium exposure of Finnish adults. Suomi and Tuominen, 2023. First cumulative dietary risk assessment of a six-metal mixture (Cd, Pb, inorganic As, MeHg, Ni, Al) in 1,295 Finnish adults; cumulative hazard index above 1 for neurotoxicity and kidney effects across all adult age groups, and above 1 for over 95 percent of women under 45.
- [2] Cadmium dietary exposure assessment, 91st meeting addendum. Joint FAO/WHO Expert Committee on Food Additives, 2022. Carried the 2010 provisional tolerable monthly intake of 25 µg per kilogram of body weight forward without revision; updated 2019 cocoa occurrence data pushed total dietary cadmium in children aged 0.5 to 12 years to as high as 96 percent of the PTMI in some subpopulations.
- [3] Update of the risk assessment of inorganic arsenic in food. EFSA CONTAM Panel, 2024. Scientific Opinion adopted November 2023 classifying inorganic arsenic as a genotoxic carcinogen; a BMDL05 of 0.06 µg per kilogram of body weight per day yields adult margins of exposure of 2 to 0.4 for mean consumers and 0.9 to 0.2 at the 95th percentile, all below the threshold margin of 1.
- [4] Maximum levels for certain contaminants in food. European Union. Commission Regulation (EU) 2023/915 sets single-metal maximum levels for lead, cadmium, arsenic and mercury in food, one metal and category at a time.

[5] Action level for inorganic arsenic in infant rice cereal. U.S. Food and Drug Administration. A single-metal action level for inorganic arsenic in infant rice cereal, one of the single-metal reference values the combined-exposure critique addresses.

[6] Heavy Metal Index — combined-exposure underprotection (synthesis with full anchor-source records). The independent literature synthesis this analysis reframes, carrying the full anchor-source records for Suomi 2023, JECFA 2022 and EFSA 2024. · heavymetalindex.com

Cite this analysis

