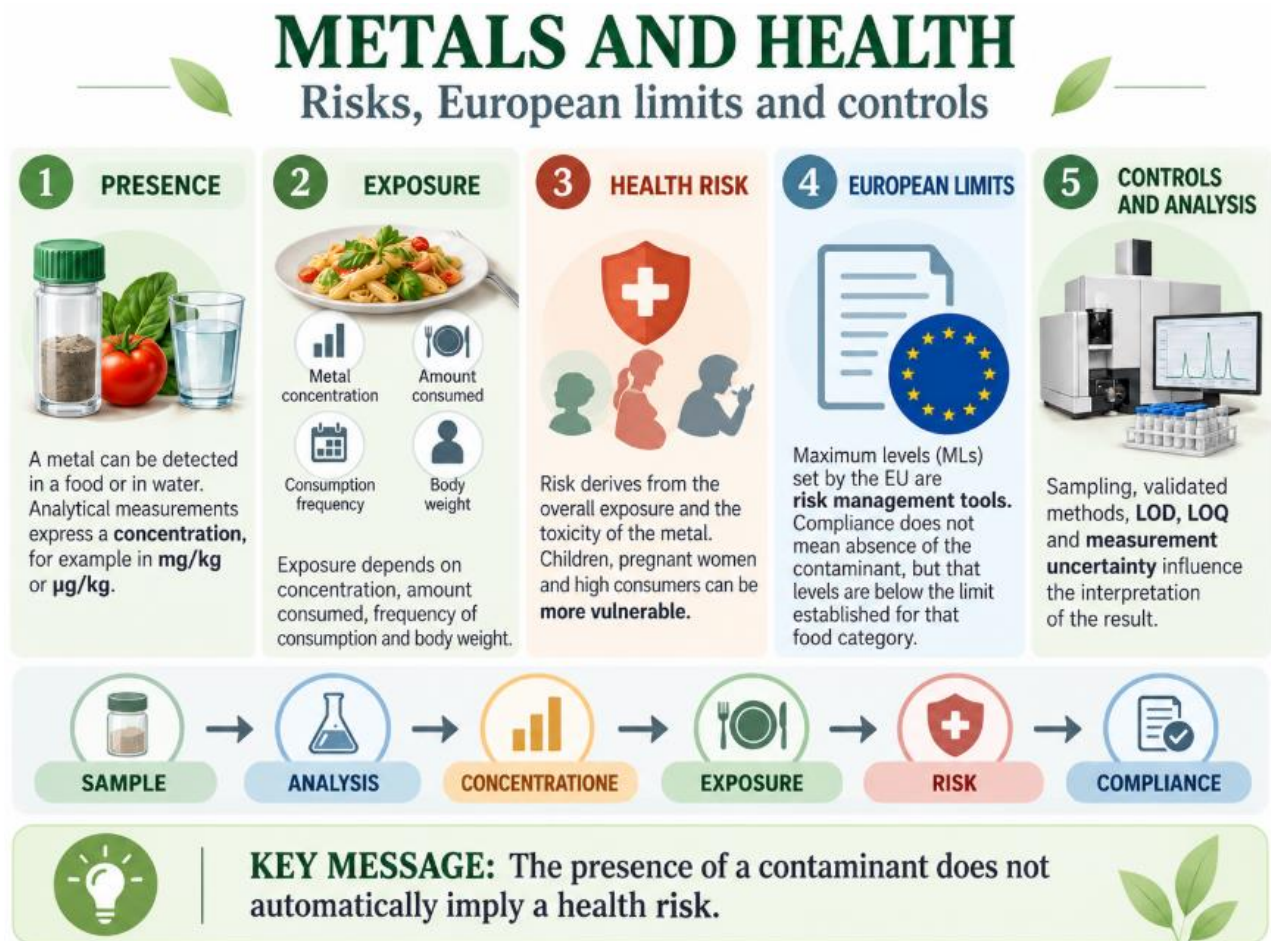


9. METALS AND HEALTH: RISKS, EUROPEAN LIMITS AND CONTROLS

The presence of metals and metalloids in food raises questions that cannot be answered with a single number. How much of the contaminant does the product contain? How much is actually ingested? Over what period? What are its chemical form and the sensitivity of the person exposed? Scientific assessment addresses these questions separately; legislation and official controls then translate available knowledge into risk prevention and management measures.



PRESENCE, EXPOSURE AND RISK: THREE DIFFERENT CONCEPTS

Presence is an analytical finding: a concentration, usually expressed in mg/kg or µg/kg of food. Exposure is the amount taken into the body over a given period and depends on concentration, portion size, consumption frequency and body weight. Risk concerns the likelihood and severity of adverse effects in relation to exposure and the hazard posed by the particular substance.

For example, a concentration of 0.10 mg/kg in a 100 g portion corresponds to 10 µg ingested with that portion. This calculation alone does not establish whether there is a risk: the metal, other dietary and environmental sources, repeated intake and available toxicological reference points must all be considered. It is incorrect to assume that two metals present at the same concentration have the same health implications.

WHY CHEMICAL FORM MATTERS

Inorganic arsenic has a different toxicological profile from the organic arsenic compounds commonly found in many marine foods. In fish, methylmercury is particularly relevant because it can accumulate through the food web and interfere with neurological development. Trivalent and hexavalent chromium have very different hazard profiles; distinguishing chemical forms is also important for tin. Therefore, a measurement of “total metal” may be useful for screening but does not always describe risk adequately.

For lead and cadmium, in addition to speciation where relevant, cumulative dose and persistence in the body are important. Cadmium can accumulate particularly in the kidneys; for lead, effects on nervous-system development are especially important, with particular attention to exposure early in life.

HEALTH EFFECTS AND MORE VULNERABLE POPULATION GROUPS

There is no single “metal-related effect”: target organs and mechanisms differ. Chronic cadmium exposure is of particular concern for the kidneys; methylmercury is relevant to the nervous system, especially during fetal development; lead is associated with neurodevelopmental and cardiovascular effects; and assessment of inorganic arsenic also considers carcinogenic outcomes. Dietary nickel requires a different approach, including the possible flare-up of skin symptoms in some already sensitised individuals.

Fetuses, children and women who are pregnant or planning pregnancy may require specific advice for certain contaminants. Other factors, such as occupational exposure or kidney function, can affect overall exposure or vulnerability. This does not mean that every measured trace is dangerous or that everyone should indiscriminately eliminate foods from their diet.

HEALTH-BASED GUIDANCE VALUES: HOW TO INTERPRET THEM

Where the evidence allows, EFSA may establish a tolerable daily or weekly intake (TDI/TWI) expressed per kilogram of body weight. For cadmium, the tolerable weekly intake is 2.5 µg/kg body weight; for methylmercury, it is 1.3 µg/kg body weight per week.

(expressed as mercury). These values concern total exposure over time, not the permitted concentration in an individual food.

For substances such as lead, for which no level of exposure free from concern has been identified for certain effects, assessments use toxicological reference points and comparisons such as the margin of exposure (MOE). An MOE is not a “legal threshold”: it is a scientific assessment tool. Exceeding a guidance value does not automatically mean that disease will occur, but indicates a need for further investigation or exposure reduction.

EU MAXIMUM LEVELS ARE NOT UNIVERSAL BIOLOGICAL THRESHOLDS

Regulation (EU) 2023/915, in its currently applicable consolidated version, sets maximum levels for specific contaminants in defined food categories. There is no single limit that applies to all metals and all foods: values vary by substance, food matrix and, in some cases, animal species or processing state. The Regulation is amended periodically; therefore, each compliance assessment must refer to the updated provisions applicable to the food category concerned.

Setting these limits takes account of health protection, observed contamination levels and what can reasonably be achieved through good practices: the principle of reducing contamination to as low as reasonably achievable (ALARA), where relevant. Exceeding a maximum level makes a product non-compliant and prevents it from being placed on the market under the applicable rules. Conversely, compliance means meeting a legal requirement: it does not certify that the substance is absent and does not, by itself, describe an individual’s total dietary exposure.

HOW OFFICIAL CONTROLS WORK

Regulation (EU) 2017/625 provides the general framework for official controls throughout the agri-food chain. Controls on contaminants are organised through risk-based plans and may include sampling at production, import, processing and distribution stages. Regulation (EC) No 333/2007 lays down specific requirements for sampling and analysis of several contaminants, including lead, cadmium, mercury, inorganic arsenic and nickel.

Laboratories use sensitive instrumental techniques, including inductively coupled plasma mass spectrometry (ICP-MS), and, where necessary, methods that distinguish chemical species. Trueness, precision, measurement uncertainty, reference materials, limit of detection (LOD) and limit of quantification (LOQ) are essential parameters for interpreting results. Compliance decisions must follow the applicable analytical and legal rules, rather than relying solely on the number displayed in the laboratory report.

WHAT OFFICIAL CONTROLS CAN — AND CANNOT — GUARANTEE

Official controls are indispensable: they identify non-compliance, guide preventive action and provide data for updating scientific assessments. Nevertheless, no sampling plan can test every unit of every batch, and contaminants may be unevenly distributed. The frequency of controls also depends on known risks; consequently, knowledge gaps may remain regarding new sources of contamination, particular origins or substances that are rarely monitored.

A result reported as “below the limit of quantification” means that, under the analytical conditions used, the concentration is below the LOQ: it does not demonstrate the absolute absence of the substance. Similarly, a batch analysis characterises the sample and the degree of representativeness supported by the sampling plan; it cannot guarantee identical characteristics in every future production run.

HOW TO READ AN ANALYTICAL REPORT

Correct interpretation of a result requires, at minimum, identification of the substance and, where relevant, its chemical form; the food matrix and edible portion analysed; the result and its unit of measurement; the LOQ and uncertainty; the method used; the date and method of sampling; and the relevant regulatory reference. It is also necessary to check whether values refer to fresh or dry weight and whether the food is raw, processed or reconstituted.

Transparent publication of these details enables informed comparisons between products, but calls for caution: comparing two figures without taking account of method, matrix, LOQ and batch can lead to misleading conclusions. Likewise, simply adding the concentrations of different metals does not, in itself, produce an index of cumulative risk; appropriate toxicological models are required.

REDUCING EXPOSURE WITHOUT OVERSIMPLIFICATION

The first measure is a varied diet that avoids persistent reliance on a single food source. For fish and seafood, diversifying species is sensible while following national advice for vulnerable groups; for grains and vegetables, origin, agricultural practices and monitoring of soil and water may be relevant. Washing, cleaning or cooking do not reliably remove all metals that have already been absorbed into food tissues.

Risk management also requires upstream measures: preventing emissions, controlling water and raw materials, selecting suitable technologies and materials, monitoring imports and updating standards. Consumer communication should avoid both false reassurance based solely on compliance with legal limits and alarmism based on the mere detection of traces.

CONCLUSIONS

Safety regarding metals in food is not synonymous with pursuing an analytically measurable “absolute zero”. It results from up-to-date toxicological assessments, legal limits reflecting available knowledge, representative controls and good practices throughout the supply chain. Greater transparency of analytical data can usefully complement the public control system, provided that concentration, exposure and risk are always distinguished and the limitations and uncertainties of measurements are made explicit.

SCIENTIFIC AND REGULATORY REFERENCES

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7. [EFSA – Mercury in food: update of the opinion on public health risks \(2012\).](#)
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