Magnesium

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Abstract

An essential enzyme cofactor with a broad food-supply presence. High-dose supplemental or accidental magnesium exposure can produce life-threatening cardiovascular and neuromuscular toxicity, particularly when renal clearance is impaired.

This synthesis draws on peer-reviewed concentration data for nuts, grains, vegetables, water, and fish from 22 primary research papers in this ingest unit, plus two clinical reports on hypermagnesemia from supplemental and accidental exposures (1, 2).

1 | Toxicology

Magnesium is an essential intracellular cation involved in energy metabolism, membrane stability, and neuromuscular conduction. Serum magnesium is normally maintained within 1.7 to 2.4 mg/dL through coordinated intestinal absorption, skeletal buffering, and renal excretion 1. At serum concentrations above approximately 4 mg/dL, early neuromuscular effects appear; areflexia, hypotension, and cardiovascular conduction abnormalities occur at higher concentrations; and respiratory paralysis and cardiac arrest can occur at very high concentrations. The clinical reports in this unit illustrate two distinct routes to excess-exposure toxicity.

A 2026 case report from Taiwan documents severe acute hypermagnesemia (serum Mg2+ 15.8 mg/dL) in a previously healthy 54-year-old man following inadvertent ingestion of approximately 100 mL of a private-label bath preparation containing approximately 30% magnesium chloride and 33% magnesium sulfate 1. Initial presentation included stupor, hypothermia, hypotension, generalized areflexia, mixed respiratory and metabolic acidosis, and diffuse ST-segment depression on ECG. Normal serum creatinine at presentation confirmed intact renal function, establishing that life-threatening hypermagnesemia can develop from a large acute magnesium load even without pre-existing renal impairment. Standard initial treatment (intravenous calcium, saline, and a loop diuretic) produced no meaningful neurological improvement; emergent hemodialysis reduced serum magnesium to 4.9 mg/dL during treatment with rapid neurological recovery, and the patient recovered without residual complications 1.

A 2025 retrospective cohort study from Japan (n = 1,120 psychiatric inpatients, January 2020 to December 2023) documents the population-level risk of hypermagnesemia from oral magnesium oxide used as a laxative for constipation 2. Among 532 patients prescribed magnesium oxide (average dose 1,000 mg per day), the hazard ratio for developing hypermagnesemia was 2.76 compared to those not prescribed it. Elevated serum creatinine (HR 1.75) was an independent risk amplifier, confirming that impaired renal clearance is the principal mechanism by which oral supplemental magnesium leads to accumulation. Female biological sex (HR 1.44) and higher daily dose (HR 2.66) were additional independent risk factors. The study recommends regular blood sampling for serum magnesium in long-term magnesium oxide users and switching to non-magnesium laxatives when renal function is impaired 2.

Both cases underscore the mechanistic basis for clinical caution: the kidney is the primary route of magnesium excretion, and when clearance is reduced or when the acute load is large enough to overwhelm normal clearance, accumulation can produce life-threatening neuromuscular and cardiovascular toxicity. Neither case involves dietary magnesium exposure from food.

2 | Exposure routes

Dietary magnesium reaches the food supply through plant uptake from soil, with magnesium concentrations in plant foods reflecting soil magnesium availability, plant species, and agronomic practices. The kidney regulates magnesium homeostasis for the general population consuming ordinary food; dietary excess from food alone is not a described mechanism of hypermagnesemia in healthy individuals. The two exposure routes that produce documented excess-exposure risk are concentrated supplemental magnesium preparations (antacids, laxatives, intravenous solutions, and oral supplement products) and accidental ingestion of non-food magnesium preparations such as bath agents or industrial compounds 1, 2.

Drinking water provides a variable and geography-dependent contribution to magnesium intake. In Spain, tap water magnesium averaged 14.65 +/- 16.23 mg/L (range 0.07 to 70.08 mg/L) across 108 municipalities; Spanish bottled mineral water averaged 16.27 mg/L (range 0.11 to 141.2 mg/L) 3. Under EFSA-recommended water consumption assumptions, water containing 15 to 45 mg/L provides 7.5 to 25.7% of the adult recommended intake and up to 76.5% for young children 3. In the United Kingdom, regional variation is substantial: England's median tap water magnesium was 4.65 mg/L versus 1.59 mg/L in Scotland 4. Australian tap water is lower still, with magnesium ranging 1.1 to 11.2 mg/L across major city water providers; consuming 3 L/day of the most magnesium-rich Australian tap water would supply approximately 8% of the recommended daily intake 5.

3 | Food sources

Magnesium is widely distributed across plant foods, with the highest concentrations found in nuts, seeds, legumes, and whole grains. The tables below report measured concentrations from peer-reviewed analytical studies in this ingest unit.

Nuts

STUDY / LOCATION	MATERIAL / DESIGN	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
6, Poland	10 nut types, retail market, AAS	1,463 to 10,509 mg/kg (medians by type; dry weight; see table below)	120 (12 per type)	Single-country retail market; Brazil nuts at high end, pistachios at low end

Detailed median and range values from 6:

NUT TYPE	MEDIAN MG (MG/KG)	RANGE (MG/KG)
Brazil nuts	10,509	8,221 to 20,474
Cashews	7,281	3,699 to 9,394
Pine nuts	5,346	2,448 to 8,050
Almonds	5,359	4,196 to 7,647
Peanuts	4,049	2,612 to 6,282
Hazelnuts	2,571	2,106 to 6,358
Walnuts	2,772	1,115 to 5,375
Macadamia	2,044	660 to 3,882
Pecans	1,993	77 to 5,973
Pistachios	1,463	214 to 2,884

The wide intratype range (for example, pecans 77 to 5,973 mg/kg) reflects genuine variability across cultivar, origin, and soil conditions. All 10 tested types qualified as dietary magnesium sources under EU labeling criteria in this study.

Grains and cereals

STUDY / LOCATION	MATERIAL / DESIGN	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION

7, Poland	Buckwheat grain and groats at various processing stages, ICP-OES	1,375 to 1,653 ug/g dry weight (1,393 for unhulled grain; 1,653 after dehulling; 1,375 after roasting)	3 per treatment group	Dehulling increases, roasting reduces total magnesium; in vitro bioaccessibility data also available
8, Saudi Arabia	7 spring wheat genotypes, conventional vs. organic fertilization, 2 seasons	1,540 mg/kg (organic) to 2,120 mg/kg (conventional) grain average	7 genotypes x 3 replications x 2 seasons	Single arid-climate site; genotype IC17 had highest Mg and lowest fertilization sensitivity

Buckwheat dehulling increases total magnesium content (from approximately 1,393 to 1,653 ug/g) while roasting reduces it (from approximately 1,525 to 1,375 ug/g) 7. Lower-temperature, shorter-duration hydrothermal treatment increased in vitro magnesium bioaccessibility. Processing caused a statistically significant increase in bioaccessible magnesium from 857.6 to 1,034.9 ug/g in one treatment comparison 7.

Conventional inorganic fertilization of spring wheat produced higher grain magnesium (mean 2,120 mg/kg) than organic fertilization (mean 1,540 mg/kg) across seven genotypes in a Saudi Arabian experiment 8.

Vegetables

STUDY / LOCATION	MATERIAL / DESIGN	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
9, Italy	Zucchini (2 varieties), eggplant, potato, raw and cooked, ICP plasma	Zucchini: 437 mg/100 g d.w.; potato: 106 mg/100 g d.w. (selected values)	Not stated in abstract	Cooking method effects on retention are heterogeneous; microwave retained more than grilling or steaming for zucchini

Household cooking produced heterogeneous mineral retention across vegetables and cooking methods. Microwave cooking produced higher magnesium retention than grilling or steaming for zucchini; grilling showed higher retention than microwave for eggplant. Potatoes showed lower true retention values overall 9.

Fish and seafood

STUDY / LOCATION	MATERIAL / DESIGN	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
10, Denmark and Spain	Fish bone powder from hake, cod, and salmon backbones after enzymatic hydrolysis, ICP-OES	Reported in mg/100 g wet weight in Table 1; exact Mg values per product require paper access	3 fish side-stream types	In vitro bioaccessibility (INFOGEST 2.0); useful as supplement ingredient context, not ordinary food intake

Magnesium was present in all fish bone side-stream powders tested, subordinate to calcium and phosphorus in absolute concentration. Bioaccessibility under in vitro conditions was quantified but specific values require the full data table in the paper.

Drinking water

STUDY / LOCATION	MATERIAL / DESIGN	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
3, Spain	108 municipal tap water sites + 109 bottled waters (97 Spanish, 12 imported), ion chromatography	Tap: mean 14.65 +/- 16.23 mg/L (range 0.07 to 70.08); bottled Spanish: mean 16.27 mg/L (range 0.11 to 141.2)	108 tap + 109 bottled	Single-country cross-sectional; contribution to daily intake is modeled, not measured
4, UK	66 cities, compiled utility data	England median 4.65 mg/L (range 1.30 to 31.80); Scotland median 1.59 mg/L	66 cities	Compiled from utility reports, not independent analysis; regional differences statistically significant
5, Australia	Major city tap water providers plus bottled water labels, compiled data	Tap: 1.1 to 11.2 mg/L; sparkling bottled generally higher	n/a	Compiled from public utility data and product labels, not independent analysis

Across the three water studies, tap water magnesium is consistently higher in hard-water regions (Spain, England) than in soft-water regions (Scotland, Australia). The highest-concentration European bottled mineral waters can exceed 100 mg/L and represent a meaningful magnesium source for high consumers.

4 | Regulatory limits

Magnesium is not regulated as a food contaminant. No maximum level for magnesium in food or water has been established by the EU, Codex Alimentarius, FDA, or other major regulatory bodies in a contaminant-control framework. The EU bottled water label "rich in magnesium" threshold is greater than 50 mg/L 3. Reference intakes for nutritional adequacy (Recommended Daily Allowances and Adequate Intakes) are set by national and international nutrition bodies but are outside the scope of this contaminant-focused wiki.

5 | Testing

The studies in this ingest unit used ICP-OES and ICP-MS (after microwave acid digestion), atomic absorption spectrometry, and ion chromatography (for water). These are standard multi-element analytical methods capable of accurate magnesium quantification at the concentrations present in food matrices. LOD and LOQ were generally reported or implied in individual studies. No speciation of magnesium is analytically meaningful in the food context (all dietary magnesium is ionic Mg2+ or forms thereof); speciation concerns are not applicable to this element.

6 | Microbiome effects

No peer-reviewed study in this ingest unit reports measured effects of dietary magnesium on the gut microbiome. This gap is noted; the relationship between magnesium intake, gut microbiome composition, and mineral bioavailability is an active area of research not yet covered in this corpus.

7 | Vulnerable populations

The peer-reviewed clinical evidence in this ingest unit identifies two vulnerable population groups for excess-exposure risk.

Patients with impaired renal function receiving oral magnesium oxide as a laxative represent the principal identified group. In a 2025 retrospective cohort (n = 1,120 psychiatric inpatients, Japan), elevated serum creatinine was an independent risk factor for hypermagnesemia (HR 1.75) among MgO users 2. The recommendation from this study is to monitor serum magnesium regularly in long-term magnesium oxide users and to switch to non-magnesium laxatives when renal function is impaired. Older adults in psychiatric inpatient settings are at compounded risk because psychiatric disorders are associated with higher constipation prevalence, polypharmacy (antipsychotics and anticholinergics) increases constipation and therefore magnesium laxative dose, and renal function declines with age.

Individuals who ingest concentrated non-food magnesium preparations (bath salts, antacids at high doses, industrial preparations) represent the second group. The 2026 case report demonstrates that even a person with intact renal function can develop life-threatening serum magnesium levels from a large acute oral load 1. Product labeling and consumer awareness of non-food magnesium preparations (bath agents, spa products, agricultural compounds) is a relevant public-safety consideration.

8 | Mitigation

For dietary adequacy rather than toxicity mitigation, the principal actionable finding from this corpus is that standard food processing steps affect magnesium content and bioaccessibility in predictable directions. Dehulling buckwheat increases total magnesium content; roasting reduces it 7. Lower-temperature hydrothermal treatment of grains improves in vitro bioaccessibility. Conventional mineral fertilization of wheat increases grain magnesium compared to organic fertilization 8.

For prevention of supplemental and accidental toxicity, the clinical literature supports renal function monitoring before and during long-term oral magnesium supplementation, and consumer-level awareness that concentrated magnesium preparations designed for non-dietary uses (bath agents, spa products) can produce life-threatening toxicity if ingested 1.

9 | What remains uncertain

The corpus for this ingest unit does not include major regulatory or toxicological review documents for magnesium (no ATSDR Minimal Risk Level, no EFSA scientific opinion on dietary magnesium, no JECFA evaluation). The clinical definition and threshold for hypermagnesemia and the dose-response relationship between oral magnesium intake and serum magnesium in individuals with varying degrees of renal impairment are not characterized by any source in this unit; the case reports and cohort study document occurrence rather than quantify dose-response. The contribution of dietary magnesium to total magnesium exposure, as opposed to supplemental and pharmaceutical sources, is not modeled in any source here. Microbiome effects of

magnesium are not covered. Geographic coverage of food concentration data is limited to Poland, Saudi Arabia, Italy, and water data from Spain, the UK, and Australia; data from other major food-producing regions are absent from this ingest unit.

10 | Frequently asked questions

Is magnesium a toxic heavy metal or a nutrient?

Magnesium is a nutritionally essential metal and an enzyme cofactor, so it is primarily a nutrient rather than a purely toxic heavy metal. According to Ufelle & Barchowsky 2021, deficiency is usually more clinically important than excess, though high exposure can still cause harm.

Can you get too much magnesium, and what happens if you do?

Yes. While magnesium deficiency is usually the more clinically important concern, Ufelle & Barchowsky 2021 notes that high magnesium exposure can produce neuromuscular, cardiovascular, and central nervous system toxicity.

Why does the Heavy Metal Index have so little detailed information on magnesium?

This magnesium page is currently a source-map stub created during the re-ingest of Ufelle & Barchowsky 2021. Substantive magnesium-specific detail awaits a dedicated magnesium ingest, so the page reflects only that one source for now.

What role does magnesium play in the body?

Magnesium functions as a nutritionally essential metal and an enzyme cofactor, per Ufelle & Barchowsky 2021. The page frames it as an essential-metal node where the primary clinical concern is deficiency rather than excess.

References

[1] Case Report: Severe acute hypermagnesemia following inadvertent bath agent ingestion rapidly resolved by emergent hemodialysis
Chen CC, Chen JN, Yang TH, and Lin SH · Frontiers in Toxicology · 2026 · doi.org/10.3389/ftox.2026.1961156
PEER-REVIEWED

[2] Hypermagnesemia in a psychiatric hospital
Takenaka R, Emori K, and Kawashima H · PCN Reports: Psychiatry and Clinical Neurosciences · 2025 · doi.org/10.1002/pcn5.70155
PEER-REVIEWED

[3] Magnesium in tap and bottled mineral water in Spain and its contribution to nutritional recommendations
Maraver F, Vitoria I, Ferreira-Pego C, Armijo F, and Salas-Salvado J · Nutricion Hospitalaria · 2015 · doi.org/10.3305/nh.2015.31.5.8589
PEER-REVIEWED

[4] Variation in Tap Water Mineral Content in the United Kingdom: Is It Relevant for Kidney Stone Disease?
Hadj-Sadok M, Caudarella R, Soldati L, Remer T, and Ferraro PM · Journal of Clinical Medicine · 2022 · doi.org/10.3390/jcm11175118
PEER-REVIEWED

[5] Mineral content variations between Australian tap and bottled water in the context of urolithiasis
Rukin N, Bird E, Muirhead L, Coburn A, and Wang H · BJUI Compass · 2022 · doi.org/10.1002/bco2.168
PEER-REVIEWED

[6] Nuts as a Dietary Enrichment with Selected Minerals-Content Assessment Supported by Chemometric Analysis
Markiewicz-Zukowska R, Puscio-Jakubik A, Grabia M, Perkowski J, Nowakowski P, Bielecka J, et al. · Foods · 2022 · doi.org/10.3390/foods11203152
PEER-REVIEWED

[7] Effect of Buckwheat Groats Processing on the Content and Bioaccessibility of Selected Minerals
Klepacka J, Najda A, and Klimek K · Foods · 2020 · doi.org/10.3390/foods9060832
PEER-REVIEWED

[8] Investigation of the Magnesium Content and Productivity of Wheat Genotypes Under Organic and Conventional Inorganic Fertilizer Application
Abd-Elmoniem EM, Al-Ghumaiz NS, Motawei MI, Al-Otayk S, and Rabhi M · Life (Basel) · 2025 · doi.org/10.3390/life15040543
PEER-REVIEWED

[9] Effects of Household Cooking on Mineral Composition and Retention in Widespread Italian Vegetables
Lisciani S, Aguzzi A, Gabrielli P, Camilli E, Gambelli L, Marletta L, et al. · Nutrients · 2025 · doi.org/10.3390/nu17030423
PEER-REVIEWED

[10] Toxic Effects of Metals (Chapter 23), in Casarett & Doull's Essentials of Toxicology, Fourth Edition
Ufelle AC and Barchowsky A · Casarett & Doull's Essentials of Toxicology, Fourth Edition. McGraw Hill Education · 2021 · www.-mhprofessional.com
TEXTBOOK

STATUS AND LICENCE

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COMPETING INTERESTS

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DATA AVAILABILITY

Every source behind this reference is listed with its own source record at https://heavymetalindex.com/metals/magnesium#sources.

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