Heavy metals in mineral baby sunscreens

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Karen Pendergrass · Heavy Metal Index, Institute of Contaminant Standards

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Abstract

The only heavy-metal measurements of finished baby mineral sunscreens are single commercial units, and in seven of them tested for it, lead and cadmium were found in every one. Every number is a concentration in the product as sold, not a dose that reached a child, and no study measured any of these four metals crossing skin.

1 | Product anatomy

A mineral sunscreen is a leave-on emulsion whose sun-protection actives are inorganic particles rather than organic UV filters. The two mineral filters are zinc oxide and titanium dioxide. In the regulatory texts opened here each is permitted at up to 25 percent of the finished product: in the United States as a proposed generally-recognised-as-safe-and-effective active ([17]), in Canada where a sunscreen containing only these two actives is licensed as a natural health product ([18]), and in the European Union under Annex VI of the cosmetics regulation ([19]). A baby or infant sunscreen is a mineral sunscreen positioned for that age group; none of the regulatory texts sets a distinct heavy-metal specification for the baby version, and the chart and laboratory reports identify products only as baby-marked, not by a separate legal class.

The heavy metals of concern here are not deliberate ingredients. They enter as impurities of the mineral filters and, potentially, of other mineral or earth-derived components. Zinc oxide and titanium dioxide are refined from ores. The titanium dioxide applicant data summarised by[9] state that trace metals derived from ilmenite, rutile or slag ores are embedded in the lattice of the pigment, which is a claim about where the metal sits, not a measurement of how much reaches a finished sunscreen. That framing matters for this category the way the polyester-catalyst account matters for baby wipes: it names a plausible route by which a metal enters a product, and it is a hypothesis about any given finished unit until the metal is measured in that unit.

The single strongest signal that the filter is the route is a raw-material observation rather than a finished-product one. In the comparison chart a single-ingredient zinc oxide powder sold for making sunscreen at home carried 9,474.70 ppb lead and 506.20 ppb cadmium ([1], row 36), more lead than any finished sunscreen on the same chart. That is one unit of one powder, and it is a raw material, not a sunscreen. It is consistent with the hypothesis that the zinc oxide fraction carries the load, and it does not by itself establish the fraction that ends up in a formulated product.

2 | Measured evidence

Every finished-sunscreen dataset opened for this synthesis is kept on its own basis and its own analytical footing. They are not pooled. The finished baby-product values are single purchased units tested once by commercial laboratories, reported as parts per billion in the product as sold. The retail screening reports milligrams per kilogram as sold from a food-validated digestion. The two peer-reviewed product studies are adult products, one reported in micrograms per kilogram and one in micrograms per gram. The raw-material data are titanium dioxide grades reported as acid-extractable milligrams per kilogram, which is not total content. A value read from one of these is not comparable to a value read from another unless the two share a basis, and where they do not, this paper says so instead of converting across them.

The seven-unit summary below is restricted to the finished baby-marked zinc oxide units whose lead and cadmium results carry no unresolved reconciliation flag and are each counted once. It is the only product summary table in this synthesis. Two further single-unit laboratory reports and the chart rows without a published report are discussed in the text and are deliberately not in this table.

Baby-marked mineral sunscreens, single units

Seven baby-marked zinc oxide units have quantified lead and cadmium as sold, in parts per billion. Three are separately published single-unit laboratory reports; four are chart rows. Non-detects are printed against the laboratory's reporting limit, 5 ppb for lead, cadmium and mercury and 10 ppb for arsenic, and are not read as zero.

UNIT	LEAD (PPB)	CADMIUM (PPB)	TOTAL ARSENIC (PPB)	TOTAL MERCURY (PPB)
Laboratory report, case 2507165	169.2	166.1	485.3	< 5.00
Laboratory report, case 2505470	330.0	218.6	135.9	< 5.00
Laboratory report, case 2506212	495.1	232.4	< 10.00	< 5.00
Chart row 12	297.90	343.20	14.92	7.88
Chart row 25	944.20	220.70	ND < 10	ND < 5
Chart row 30	1,235.40	645.00	ND < 10	5.29
Chart row 34	2,140.30	122.70	ND < 10	ND < 5

Lead was quantified in 7 of 7 units, from 169.2 to 2,140.30 ppb. Cadmium was quantified in 7 of 7, from 122.70 to 645.00 ppb. Total arsenic was above its 10 ppb reporting limit in 3 of 7 (485.3, 135.9 and 14.92 ppb) and below it in the other four. Total mercury was above its 5 ppb reporting limit in 2 of 7 (7.88 and 5.29 ppb) and below it in the other five. Sources for this table are the comparison chart ([1]) and the three laboratory reports ([2], [3], [4]). The three laboratory-report units are the same tests as three of the chart's baby-marked rows and are counted once here, as their own reports rather than as chart rows.

The rest of the measured record

The comparison chart holds more than the seven summarised units. Its header counts, which reconcile with its rows 1 to 35, are lead positive in 33 of 35 sunscreens, cadmium in 29 of 35, arsenic in 13 of 35 and mercury in 5 of 35 ([1]). Across the twenty-seven rows charted as zinc oxide sunscreens, lead ran from 118.00 to 4,612.50 ppb and cadmium from 9.67 to 645.00 ppb. The two products charted as chemical-filter sunscreens were non-detect for all four metals. Eight rows are marked to be published and have no laboratory report in this collection; none of them is a baby-marked row, and they are not used as range ends here. The chart is a single unit per product, community-nominated, one laboratory, and a draft, with no method validation reported for zinc oxide matrices.

Two further single-unit laboratory reports name baby zinc oxide products but are held out of the summary table. One reports lead 1017.5 and cadmium 356.1 ppb; its internal lot number is printed out of sequence with the others in the same series, an unresolved records anomaly. The other reports lead 1251.1 and cadmium 575.5 ppb; it carries the same product-line name as a unit in the retail screening described below, and the two disagree once put on the same basis, so this synthesis keeps them apart and does not treat either as confirming the other. Both units sit within the same order of magnitude as the seven summarised units and neither changes the qualitative finding, but neither is placed in the abstract, the range ends or a table.

A 2026 company screening bought 35 retail sunscreens, mostly adult, and sent one unit of each to an accredited laboratory ([5]). Lead was quantified in all 35, from 0.006 to 4.960 mg/kg; cadmium in 21, from 0.005 to 0.603 mg/kg; total arsenic in 9, from 0.005 to 0.189 mg/kg; and total mercury in 3, from 0.004 to 0.009 mg/kg. Every unit with quantified cadmium had lead of at least 0.125 mg/kg, and every cadmium-non-detect unit had lead of at most 0.079 mg/kg; the report reads that co-occurrence as a pointer to a shared ingredient while stating that the panel cannot identify it. The four units whose certificate names include the word mineral were all in the cadmium-positive group. This screening used a digestion validated for foods, whose completeness for mineral particles the report states was not evaluated, and it notes that any shortfall would understate content. Its milligram-per-kilogram results are on a different digestion basis from the single-unit baby reports and are not pooled with them or placed in the summary table.

A Korean consumer federation tested 17 infant and child sunscreens against the national cosmetic standard and reported every one compliant or not detected for six metals, without printing any concentration, detection limit or limit value ([6]). Those results support a statement of compliance in that programme; they are not concentrations and cannot be placed beside the numeric results above.

Two peer-reviewed studies measured metals in finished sunscreens, both adult products. Rodríguez-Romero and colleagues characterised one SPF 50 spray containing nano titanium dioxide and reported lead 743, cadmium 16.7 and nickel 47.5 µg/kg as sold, alongside percent-level titanium (1.48 x 10^7 µg/kg) and aluminium ([7]); arsenic and mercury were not measured, and the paper prints no standard deviation for the product row despite stating triplicate analysis. Tovar-Sánchez and colleagues found titanium (6,302 to 14,855 µg/g) in three of seven sunscreens and zinc (72,688 µg/g) in one, and reported lead, cadmium, chromium, nickel and ten other elements as not detected, without printing a detection limit ([8]). Because no detection limit is given, that absence is a method statement rather than an upper bound, and it cannot be read as evidence those products were free of lead or cadmium. Both studies are adult products and bear on baby mineral sunscreens only as peer-reviewed context that lead and cadmium occur at measurable levels in at least one nano titanium dioxide sunscreen, and that titanium and zinc dominate the mass where they are present.

What was measured, by metal

The table records where each panel metal was measured in a finished baby-marked mineral sunscreen and what was not measured. Values not in the seven-unit summary are named here on their own basis. Concentrations are in the product as sold unless stated.

METAL	MEASURED IN BABY MINERAL SUNSCREENS	WHAT WAS NOT MEASURED
Lead	Seven single units, 169.2 to 2,140.30 ppb, quantified in all seven. The raw zinc oxide powder was 9,474.70 ppb (raw material, not a sunscreen).	A species other than total lead. A market prevalence or lot-to-lot distribution.
Cadmium	Seven single units, 122.70 to 645.00 ppb, quantified in all seven.	A market prevalence. The sets are single units chosen by nomination.
Total arsenic	Total arsenic. Above the 10 ppb reporting limit in three of seven units (485.3, 135.9, 14.92 ppb); below it in the other four.	Inorganic arsenic. No source speciated arsenic in any sunscreen.
Total mercury	Total mercury. Above the 5 ppb reporting limit in two of seven units (7.88, 5.29 ppb); below it in the other five.	Methylmercury.
Chromium	Not measured in any finished baby sunscreen. One adult peer-reviewed study lists chromium among elements not detected, without a detection limit.	Total chromium in a baby sunscreen. Hexavalent chromium in any sunscreen.
Nickel	Not measured in a baby product. One adult spray reported 47.5 µg/kg; one adult study reported nickel not detected without a limit.	Nickel in a baby mineral sunscreen.
Tin	No data found in any sunscreen in this collection.	Total or organotin in a sunscreen.
Aluminium	Not measured in a baby product. One adult spray reported percent-level aluminium (1.67 x 10^6 µg/kg); one adult study reported 342 and 1,071 µg/g in two products.	Aluminium in a baby mineral sunscreen.

Titanium and zinc	Filter actives, not contaminants. Adult studies report percent-level titanium and zinc where present.	These are the mineral filters; they are not treated as contaminant metals here.

3 | Toxicology

Toxicology here is the hazard each metal is known for, the endpoint that usually drives that hazard, and what, if anything, is known about the metal on infant skin or in a sunscreen. A classification or a reference dose derived from ingestion or inhalation is not a dermal sunscreen dose. Where a dermal number was not in a document opened for this paper, the cell says so.

Infant skin is the exposure surface, and this paper does not assign it an absorbed fraction. The reasons the infant surface matters are set out in a narrative review opened for this collection ([16]): the review reports that the infant stratum corneum is about 30 percent thinner than the adult and the viable epidermis about 20 percent thinner, that barrier properties come to resemble adult skin about two years after birth, and that an infant's surface area per body weight is 2.3 times the adult value, so a product applied over a large body surface reaches proportionally more skin. It also notes that sunscreens are often applied over a large body surface area and that the American Academy of Pediatrics restricts infant sunscreen use to areas not covered by clothes to limit absorption of sunscreen ingredients. These are reasons to measure the dermal route for metals in a sunscreen. They are not a measured fraction, and the review reports no heavy-metal absorption value.

Lead

Lead is a developmental neurotoxicant. The endpoint that dominates infant and child assessments is harm to the developing nervous system, with no opened threshold in this file below which a dermal dose would be called without effect. The sunscreen evidence is a concentration, not that dose. Lead was quantified in all seven summarised baby units, from 169.2 to 2,140.30 ppb as sold, and in a raw zinc oxide powder at 9,474.70 ppb. No source measured blood lead, dermal absorption or hand-to-mouth transfer from a sunscreen. Calling any of these a violation of a cosmetic or natural-health-product limit would require the same basis as the instrument and a sample taken while the instrument applied; the finished-product limits opened here are on a total-content or acid-extractable basis and were not written for a single nominated unit.

Arsenic

The arsenic hazard that regulatory food work isolates is inorganic arsenic, with carcinogenicity and, at lower exposures, developmental and dermal effects attaching to the inorganic species rather than automatically to every total-arsenic number. Every arsenic result in this collection is total arsenic. Three of the seven summarised units were above the 10 ppb reporting limit (485.3, 135.9 and 14.92 ppb). Inorganic arsenic in a sunscreen: no data found. A total-arsenic detect is a reason to speciate. It is not an inorganic-arsenic result, and it is not compared here with any inorganic-arsenic benchmark.

Mercury

Methylmercury is the organic species associated with neurodevelopmental harm after ingestion, especially from fish; elemental and inorganic mercury have different kinetics, including dermal and inhalation routes for some forms. Every mercury result here is total mercury. Two of the seven summarised units were above the 5 ppb reporting limit (7.88 and 5.29 ppb); the other five were below it. Methylmercury in a sunscreen: no data found. A total-mercury result below the reporting limit does not prove the absence of a trace beneath that limit, and a total-mercury detect is not a methylmercury result.

Cadmium

Cadmium's critical long-term endpoint in dietary assessments is kidney tubular dysfunction, with bone effects at related exposures, and that record is an oral, cumulative one. Cadmium was quantified in all seven summarised units, from 122.70 to 645.00 ppb as sold, and in the raw zinc oxide powder at 506.20 ppb. No dermal-absorption fraction for cadmium from a sunscreen was opened. The oral kidney endpoint is not a dermal sunscreen dose, and this paper does not convert one into the other.

Chromium

Chromium toxicity depends on oxidation state. Trivalent chromium is poorly absorbed by mouth; hexavalent chromium is the sensitiser and the carcinogenic species in the occupational record, which is largely inhalation and, for sensitisation, skin. No finished baby sunscreen in this collection was measured for chromium. One adult peer-reviewed study lists chromium among elements reported not detected, without a detection limit, so that absence is not an upper bound. Hexavalent chromium in a sunscreen: no data found. A total-chromium number, had one been measured, could not be read as hexavalent chromium.

Nickel

Nickel is the most common cause of metal allergic contact dermatitis. Sensitisation is acquired through skin exposure, and later contact can elicit a rash; the clinical literature expresses both sensitisation and elicitation thresholds as release per area over time, not as a bulk concentration. No baby mineral sunscreen in this collection was measured for nickel. One adult spray reported 47.5 µg/kg as sold, and one adult study reported nickel not detected without a limit. No opened study shows nickel in a sunscreen crossing skin or eliciting dermatitis, and no bulk concentration here has been converted to a release per square centimetre.

Tin

Inorganic tin in food is an acute gastric irritant at intakes far above ordinary trace levels, a record about canned food rather than skin; organotin compounds are a separate hazard class used as biocides, stabilisers and some catalysts. No tin measurement in any sunscreen, inorganic or organic, was found in this collection. No dermal threshold for tin from a sunscreen was opened.

Aluminium

Aluminium neurotoxicity and bone toxicity are documented at high systemic exposures, particularly when the kidney cannot clear the metal, as in infants on parenteral nutrition. That record does not transfer to a dermal sunscreen exposure by analogy. No baby mineral sunscreen in this collection was measured for aluminium. The adult spray reported percent-level aluminium (1.67 x 10^6 µg/kg as sold) as a formulation-level constituent, and one adult study reported 342 and 1,071 µg/g in two products; neither is a baby product and neither is a dermal-absorption measurement. Aluminium crossing skin from a sunscreen: no data found.

The mineral filters: zinc and titanium penetration

Zinc oxide and titanium dioxide are the sun-protection actives, not contaminant metals, but the penetration studies opened for this collection are all about these two, and they bound how far a topically applied mineral particle travels. They are relevant to this synthesis because the contaminant metals of concern ride in or on these same particles, and because the studies show what dermal work on this product class has and has not established. Every one used adult or animal skin; none used infant skin, and none measured lead, cadmium, arsenic or mercury crossing skin.

On excised adult human skin, zinc oxide nanoparticles labelled with a rare zinc isotope stayed in the stratum corneum while dissolved zinc reached the viable epidermis, where exogenous zinc was 1.0 ± 0.3 µg/mL against 4.3 ± 0.7 µg/mL of endogenous zinc, below the concentration cytotoxic to cultured keratinocytes ([10]). In five adult volunteers, repeated application of zinc oxide nanoparticles left the viable-epidermis particle signal indistinguishable from untreated and vehicle controls ([11]). In an outdoor trial of 20 adults using zinc oxide enriched in the stable isotope 68Zn, tracer zinc in blood after the application period was about one thousandth of total blood zinc and was still rising afterwards ([12]). Beneath a reconstructed human epidermis, zinc reached the medium at about 2,400 to 2,700 µg/L against roughly 25 to 37 µg/L in controls, while no zinc oxide particles were seen in the tissue and titanium was not distinguishable from the controls, from which the authors conclude zinc crosses as ions ([13]). Titanium dioxide nanoparticles in synthetic sweat did not reach the receiving solution of Franz cells. They were found in the epidermis of intact skin at 0.47 ± 0.33 µg/cm2, and needle-abraded skin as a whole held 0.53 ± 0.26 µg/cm2 ([14]). UVB-damaged mouse skin took up more zinc, direction only, with the numeric values in a supplement not in this collection ([15]).

Taken together, the penetration record for the mineral filters on intact adult skin is that the particles largely stay on the surface or in the stratum corneum, while a small ionic fraction of zinc reaches the viable epidermis and a trace reaches blood. That record is about zinc and titanium, on adult or animal skin, and it says nothing about the fraction of lead, cadmium, arsenic or mercury that would cross skin from the same product. It is the closest dermal evidence this collection holds, and it is an argument for measuring the contaminant metals directly, not a substitute for having done so.

4 | Raw materials

The contaminant metals enter a mineral sunscreen through its mineral components, and the collection holds more on the raw materials than on the finished baby products. It is kept separate because a raw-material concentration is not a finished-sunscreen concentration, and because the raw-material bases differ from the finished-product bases.

Zinc oxide is represented by one unit: the single-ingredient powder in the comparison chart, at 9,474.70 ppb lead and 506.20 ppb cadmium as sold ([1], row 36). It is one unit of one powder sold for home formulation, and it carried more lead than any finished sunscreen on the same chart. It is consistent with the zinc oxide fraction being a lead and cadmium carrier and does not fix the fraction that reaches a formulated product.

Titanium dioxide is represented by applicant impurity data for 84 cosmetic grades summarised by the European committee ([9]). Most grade rows print specification ceilings rather than measured numbers. The committee's summary maxima for pigmentary grades are, on an HCl-soluble basis, arsenic at most 1, lead at most 10, antimony at most 2, mercury at most 1 and cadmium at most 1 mg/kg; for nano grades the summary gives arsenic below 1, lead below 10, antimony below 2 and mercury below 1 ppm, with cadmium not provided. Three grades print numeric profiles: two pigmentary grades at 0.3 and 0.8 mg/kg lead, both with arsenic, antimony, mercury and cadmium below 0.1, and one nano grade at 3 mg/kg lead, 0.5 antimony, 0.1 mercury and arsenic below 1 mg/kg. Arsenic, lead, antimony and cadmium in these profiles are extracted in boiling dilute hydrochloric acid rather than totally digested, so they are not total content and cannot be compared directly with a total-digestion finished-product result. Mercury in the same profiles is measured after a sulfuric and nitric acid digestion, although the committee's summary table labels it HCl-soluble. The earlier committee opinions on nano zinc oxide and nano titanium dioxide record that no analytical impurity data were submitted at all, and the nano titanium dioxide opinion notes an applicant claim of conformity with pharmacopoeial and colour-additive ceilings without supporting data.

The picture the raw-material record supports is narrow and consistent with the finished-product signal: the mineral filters are refined from ores that carry trace lead, cadmium, arsenic and antimony; the one zinc oxide unit measured for total content was high in lead and cadmium; and the titanium dioxide record is mostly applicant ceilings on a partial-extraction basis. It does not quantify how much of any metal a given finished baby sunscreen inherits from its filters.

5 | Exposure framing

A sunscreen exposure has at least four inputs: how much metal is in the product, how much of the product is applied to skin, how long it stays there, and what fraction is absorbed. Application amount and reapplication frequency are real variables for a sunscreen used on a child over a day at the beach, and this paper assigns them no numbers, because no primary time-and-motion or diary study of infant sunscreen use was opened, and no dermal-absorption fraction for any of these four metals from a sunscreen was measured.

An illustrative dose is not offered. The rule used here is that every input has to come from a document that was opened, and no opened source supplied, together, an applied mass, a use frequency, a contact time and a dermal-absorption fraction for lead, cadmium, arsenic or mercury from a sunscreen. Inventing the missing inputs would produce something shaped like a dose that is not one. The zinc and titanium penetration studies bound the behaviour of the filter particles on adult skin; they do not supply an absorbed fraction for the contaminant metals, and the one infant-skin document in the collection is a barrier-function review, not an absorption measurement. The gap is the finding.

What can be said without arithmetic is qualitative and still useful. In the single baby units tested for them, lead and cadmium were present in every one, at hundreds to low thousands of parts per billion for lead and roughly a hundred to several hundred for cadmium, in the product as sold. Total arsenic and total mercury were detected in a minority of the same units. The raw zinc oxide powder was higher in lead than any finished sunscreen tested. The dermal step is unmeasured for these metals. Until it is measured, the honest consumer statement is that a concentration in a sunscreen is a concentration in a sunscreen, and that these are single units rather than a market.

6 | Regulatory landscape

A mineral sunscreen sits in more than one legal frame across the texts opened here, and the frames are not interchangeable. In the United States a sunscreen is an over-the-counter drug; in Canada a titanium-dioxide--and-zinc-oxide sunscreen is a natural health product; in the European Union a sunscreen is a cosmetic. The limits below are cited only in the unit and the legal character of the instrument. None of them is a finished-product heavy-metal limit for sunscreens in the United States, and no such limit appears in any source in this collection. The single grey-literature units are not scored against these instruments, because the bases differ and the instruments were not written for a single nominated unit.

Canada applies the topical limits of its Natural Health Products quality guide to sunscreens licensed under the primary sunscreen monograph: on a finished-product basis, 10 ppm lead, 3 ppm arsenic, 3 ppm cadmium, 1 ppm total mercury and 5 ppm antimony ([18]). The monograph's youngest subpopulation is infants from 6 months. Health Canada's separate cosmetic-impurity guidance treats the same lead, cadmium, mercury and antimony figures as technically avoidable levels for cosmetics, with arsenic at 3 ppm.

In the United States, the proposed sunscreen rule would recognise zinc oxide and titanium dioxide as generally safe and effective at up to 25 percent each and proposes no heavy-metal impurity limit for the actives or the finished product ([17]). The existing labelling it cites reads, for children under 6 months, ask a doctor. The two colour-additive specifications that do carry metal limits apply to titanium dioxide and zinc oxide as colour-additive raw materials, not as sunscreen actives, and on a raw-material basis: titanium dioxide at 10 ppm lead, 1 ppm arsenic, 1 ppm mercury and 2 ppm antimony, with lead, arsenic and antimony measured in an acid extract rather than by total digestion; zinc oxide at 20 ppm lead, 15 ppm cadmium, 3 ppm arsenic and 1 ppm mercury.

In the European Union, the cosmetics regulation prohibits lead, arsenic, cadmium, mercury and antimony and their compounds as intentional ingredients and permits only technically unavoidable traces under Article 17, setting no numeric trace ceiling ([19]). Annex VI permits titanium dioxide and zinc oxide at up to 25 percent each and sets purity and total-impurity conditions for the nano forms, titanium dioxide at least 99 percent pure and nano zinc oxide at least 96 percent pure with impurities limited to carbon dioxide and water and any others below 1 percent in total, but no element-specific lead, cadmium, arsenic or mercury limit. Numeric trace ceilings for cosmetics in the EU frame are national orientation values, such as the German figures of 2.0 mg/kg lead, 0.1 mg/kg cadmium, 0.5 mg/kg arsenic, 0.1 mg/kg mercury and 0.5 mg/kg antimony for cosmetics in general ([20]), which are orientation values rather than statutory limits and were derived from monitoring that did not include sunscreens.

Several benchmarks named by the grey-literature sources are not in this collection and are not used as comparators here. The comparison chart labels lead of 1,000 ppb and above possibly illegal under a Washington State cosmetics act, while the same page reports that state administrators treat sunscreens as outside that limit; the instrument is not in this collection, and no legal comparison is drawn. The retail screening cites a US FDA lead guidance value for cosmetics, further Washington State figures and a California Proposition 65 lead dose level; those instruments are likewise not in this collection and are not placed against any product value.

7 | Implications

For parents

A parent can take three statements from this file, and should not take a fourth. In the single baby mineral sunscreens that have been tested for them, lead and cadmium were found in every one, at concentrations in the product ranging into the low thousands of parts per billion for lead. Total arsenic and total mercury were detected in a minority of those same units, and inorganic arsenic, methylmercury and hexavalent chromium were not measured at all. The one raw zinc oxide powder tested for total content carried more lead than any finished sunscreen on the same chart, which points at the mineral filter as the likely route.

The statement not to take is a risk verdict. No opened study follows a sunscreen from the bottle onto infant skin and into the body, and no study measured how much of any of these metals crosses skin. These are single purchased units, not a survey of the market, and a concentration in a product is not a dose to a child. Sun protection itself is a health measure, and the tradeoff between using a sunscreen and avoiding one is a caregiving decision this paper does not make. What the file supports is that the metal content of these products has been measured too seldom, and on too few units, for anyone to describe the category.

For manufacturers

The mineral filter is where the metal most plausibly enters, and it is where measurement should start. The single zinc oxide powder result and the co-occurrence of lead and cadmium in the retail screening both point at the zinc oxide fraction, and the titanium dioxide record is mostly applicant ceilings on a partial-extraction basis rather than measured total content. A finished-product number cannot be assigned to the zinc oxide, the titanium dioxide or another mineral component without measuring the raw materials and the formulated product on the same basis.

Basis has to be recorded and held constant. The single-unit reports are parts per billion by an unstated digestion, the retail screening is a food-validated digestion whose recovery from mineral particles was not checked, the colour-additive limits are acid-extractable, and the titanium dioxide applicant data are HCl-soluble. A completeness check on mineral-particle digestion is the difference between a number that can be compared with a total-content limit and one that cannot.

For regulators

None of the instruments opened here is a finished-product heavy-metal limit for sunscreens in the United States, and the ones that exist elsewhere are not interchangeable. Canada reaches sunscreens through a topical natural-health-product limit; the EU reaches them through a general cosmetic trace-impurity clause with national orientation values and nano purity conditions but no element-specific metal limit; the US colour-additive figures are raw-material specifications for a different use of the same minerals. A sunscreen standard that copied only one of these would not match the others, and a raw-material acid-extractable ceiling is not a finished-product total-content limit.

Speciation rules that already exist for food should not be relaxed because the matrix is a sunscreen. Total arsenic is not inorganic arsenic, and total mercury is not methylmercury. Every arsenic and mercury result in this collection is a total, and no source speciated either in a sunscreen. Where a government has no number for a metal in this product, the gap should stay a gap rather than being filled by borrowing a limit written for another matrix or another use.

For researchers

The next useful study is small and specific. Measure the finished sunscreen and its mineral raw materials on the same total-digestion basis, with a completeness check for mineral particles, and report the result in milligrams per kilogram as sold rather than only as an instrument concentration. Include lead, cadmium, arsenic and mercury, speciate arsenic and mercury, and add chromium, nickel, tin and aluminium so the panel is not silent on the metals no one has yet measured in a baby product. Sample more than one unit and more than one lot, and draw the sample from a defined frame rather than from community nomination. Then, and only then, measure the dermal step, on skin models that include the compromised and occluded conditions relevant to infants, or state explicitly that the absorbed fraction is unknown.

Until that study exists, synthesis has to keep repeating the basis problem and the single-unit problem. The measurements that exist are real, and none of them is a market, a dose, or a total-content comparison with a finished-product limit. That is enough to justify the work and not enough to finish it.

8 | Data gaps and research agenda

No peer-reviewed measurement of heavy metals in a finished sunscreen marketed for babies is in this collection; the only baby-product values are single commercially tested units. No source measured inorganic arsenic, methylmercury or hexavalent chromium in any sunscreen or raw material. No source measured lead, cadmium, arsenic or mercury crossing skin from a sunscreen, and no penetration study used infant skin; the zinc and titanium penetration data are for adults or animals. Chromium, nickel, tin and aluminium were not measured in any baby mineral sunscreen. Digestion differs across the sources that do exist, from unspecified commercial methods to a food-validated method to acid extraction, so their values are not directly comparable, and none is shown to recover metal locked in mineral particles. The titanium dioxide raw-material data are applicant-supplied and mostly ceilings on a partial-extraction basis; the zinc oxide raw-material data are one unit from grey literature and a colour-additive specification. The Korean compliance results carry no concentrations, and several further studies named in the collection manifest were not obtained.

The research agenda follows those gaps, in order. First, total-digestion content in milligrams per kilogram for finished baby mineral sunscreens and their zinc oxide and titanium dioxide raw materials on the same basis, with a mineral-particle completeness check, across lead, cadmium, arsenic and mercury and adding chromium, nickel, tin and aluminium. Second, speciation of arsenic and mercury, and of chromium if it is measured. Third, a sampling frame that is not community nomination, with more than one unit and lot per product. Fourth, a dermal-absorption experiment for the contaminant metals on skin models relevant to infants, or an explicit statement that the fraction is unknown. Fifth, the mineral raw materials characterised apart from the finished product, so the route the metals take can be attributed rather than assumed.

9 | How to cite

Pendergrass, K. (2026). Heavy metals in mineral baby sunscreens. Institute of Contaminant Standards.

References

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DATA AVAILABILITY

Every source behind this finding is listed with its own extraction record at https://heavymetalindex.com/synthesis/heavy-metals-in-mineral-baby-sunscreens#sources, each linking to the ingest receipt, the extracted values, and the file hash of the document it was built from.

COMPETING INTERESTS

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