# Supplementary methods and results

PFOA and PFOS in California public-water monitoring and associations with cancer and chronic disease

## Supplementary Methods

### S1 Source definitions and monitoring audit

The analysis used fixed cached snapshots. All counts in this supplement distinguish the initially eligible 29,229 analyte rows from the primary revision's 29,095 rows. The 134 excluded rows were nondetects with zero reporting limits: 72 PFOA and 62 PFOS. Table S1 reports annual detection counts, and Table S2 summarizes reporting limits among initially eligible nondetects. No missing-limit numeric-result fallback was needed. The range including zero is a description of source records, not an assertion that zero is a usable limit.

There were 181 well-date-compound groups with mixed detection flags and 502 with multiple recorded collection times. Date-level aggregation is therefore described as a daily summary, not confirmed laboratory-duplicate removal. Among initially eligible records, both compounds appeared in all 2,356 wells and all 5,445 well-year units; 14,117 of 14,126 well-date units were paired (99.94%). Pairing by date does not establish the same time or aliquot.

PLACES values are modeled percentages derived from BRFSS, Census and ACS inputs. County outcomes and smoking/insurance covariates use age-adjusted prevalence; tract counterparts use crude prevalence. The cached queries select data year 2023. Their July 2026 retrieval dates, official dataset catalogs and release notes support attribution to the 2025 release. Earlier filenames containing 2023 have been preserved. The original manifest did not save the dataset title; release attribution was checked retrospectively. Release year is not the year every respondent was interviewed.

Current asthma requires a previous professional diagnosis and still having asthma. Coronary heart disease includes reported angina or coronary heart disease. Hypertension is ever professionally diagnosed, excluding pregnancy-only and borderline reports; it is not a measured blood-pressure threshold or new diagnosis in the previous year. Diabetes excludes pregnancy-only reports. Obesity is BMI at least 30 kg/m² from reported height and weight; CDC excludes height below 3 or at least 8 feet, weight below 50 or at least 650 pounds, and BMI below 12 or at least 100. These are source eligibility rules, not new exclusions of geographic rows. High cholesterol concerns ever-screened adults who report a professional diagnosis; never-screened respondents are not its denominator. Unknown, refused or missing responses are not classified as disease-free. These six outcomes concern adults aged 18 or older.

Current smoking requires at least 100 lifetime cigarettes and smoking now every day or some days, among adults aged 18 or older. Lack of insurance concerns current uninsurance among adults aged 18-64. The general adult population field is not the number of surveyed or cholesterol-screened people. It was not used to estimate a number of affected residents. Official definitions and codebooks are identified in manuscript References 7–11 and 13–14. Section S6 gives the direct links for the PLACES definitions and NHANES documentation.

## S2 County construction and robustness

The primary construction first takes daily medians, then annual means within wells, then the median across a well's available years, and finally the median across wells within county. Each compound is handled separately. Thus, repeated sampling dates do not independently weight a county, and a well with more years does not contribute more period values. Table S3 lists county values and monitoring coverage. Coverage counts use retained primary records. Years need not be consecutive.

The nine alternative definitions were recorded before the revised health fits. Zero, half-limit and full-limit substitutions apply only to nondetects with positive limits. The collection-time definition takes medians within recorded collection time and averages those time summaries within a day before the annual and period steps. The mixed-day definition removes entire days where constituent detection flags disagree. Retaining zero limits reproduces their original numerical handling as a sensitivity, not a declaration of measured zero. The community-only definition uses the later facility classification. The two population definitions average period values across wells in each system, then weight system values within principal county by positive residential or total-population fields.

The facility snapshot was retrieved in December 2025. It identifies 376 community, 92 non-transient non-community, 12 transient non-community and two non-public systems among the monitored set. Positive residential population is available for 372 systems; all 482 have a positive total-population field. Community restriction and residential weighting each cover 42 counties, omitting Inyo, Mendocino and Napa. Administrative population totals may overlap, combine different service populations or reflect a different time than monitoring. They do not establish historical water volumes or unique residents exposed. Sample-specific treatment, blending, service boundaries and county shares of multi-county systems are unavailable.

Table S4 compares each alternative measure with the revised primary measure. Spearman correlations use overlapping counties. Table S15 gives county-specific values under the primary, zero, half-limit and full-limit nondetect rules. High rank correlation does not imply equal concentrations. For example, the earlier audit's equal-well combined statistic for Tehama was 12.98 ng/L versus the submitted 118.17 ng/L, despite high statewide rank agreement. That descriptive sum is not used in revised health models.

Every county model uses inverse-variance weighting and HC3 inference. All continuous predictors are standardized with the unweighted sample population standard deviation (ddof = 0). Intervals and raw p-values use the recorded robust regression inference; the saved output also retains unweighted HC3 comparisons. Primary cancer and chronic-disease FDR families contain 38 and 12 coefficients, respectively. The complete results appear in Tables S5 and S6 and Figures S1 and S2.

County cancer models use age-adjusted incidence in cases per 100,000 and adjust for median household income and current smoking. County chronic-disease models use prevalence percentage points and additionally adjust for lack of insurance. In both, the compound measure is natural log(1 + concentration in ng/L), standardized within the model sample.

### *Supporting county sensitivity results*

There are 450 sensitivity coefficients: nine definitions multiplied by 50 primary compound-outcome combinations. Within-definition corrections use 38 cancer or 12 chronic-disease tests,

and pooled corrections use 342 or 108 tests. All seven within-definition FDR-significant coefficients also survive pooled FDR (Table S7). These are seven coefficients across definitions, not seven independent diseases. The same associations do not survive FDR in matched-county primary-reference fits. Table S16 compares nondetect choices for the five primary nominal associations and both liver-cancer coefficients. Table S17 summarizes every sensitivity family, and Table S18 gives the matched primary references for the seven corrected associations. The sensitivity analyses included 2,134 leave-one-county-out fits. For PFOS and liver/bile-duct cancer, the coefficient ranged from 0.27 to 0.46 and its raw p value from 0.0083 to 0.1227.

**S3 Spatial diagnostics**

For each model sample, county Census internal-point coordinates were approximately projected using longitude times 111.32 times the cosine of mean latitude and latitude times 110.57. The four-nearest-neighbor adjacency was symmetrized and row-normalized. The graph was rebuilt after outcome-specific exclusions. Moran's I used centered response-scale residuals from the primary weighted models and a one-sided positive-dependence permutation test with 9,999 permutations; p was calculated as (1 + number of permuted statistics at least as large as observed) / 10,000. The permutation tests used fixed deterministic seeds. FDR families included both compounds: 38 cancer and 12 chronic-disease tests.

Twelve FDR-positive cancer diagnostics triggered unweighted spatial-error follow-ups. None of the 12 chronic-disease diagnostics triggered a follow-up. The model is y = X beta + u, with u = lambda W u + error. spreg 1.9.0 GM_Error_Het used heteroskedasticity-robust generalized moments, a row-standardized libpysal 4.8.1 weights object, the same standardized predictors and an intercept. Settings were max_iter = 1, epsilon = 0.00001, step1c = False, no spatially lagged predictors, and hard_bound = True. PFAS intervals were beta plus or minus 1.96 standard errors, with two-sided normal-based p-values. The 12 follow-up coefficients formed one correction family. These selected unweighted fits are sensitivity analyses, not substitutes for the primary weighted models. All completed; none survived FDR (Table S8).

**S4 NHANES sample and models**

The PFAS subsample starts at age 12 among examined participants. Both isomers were required for each compound; missing values were not replaced by zero. The previous SAS cleanup misclassified genuine numeric zeros, including zero income-to-poverty ratios, as missing. Source-byte verification distinguished zero from special missing codes. Forty PFAS-file participants had zero income-to-poverty ratios; 34 met all other criteria and were restored. None of the previously included participants was removed. The original 3,399-person fits were reproduced before applying this correction.

Table S9 gives the ordered exclusions for the common two-compound sample. Its final column assesses each requirement separately among all 4,303 PFAS-file records. These counts overlap and cannot be added to obtain the total exclusions.

All eight revised coefficients use the same 3,433 participants, 30 strata, 60 primary sampling units and 30 design degrees of freedom. The joint models contain both log-compound terms. Weighted variance inflation factors were 1.562 for PFOA and 1.913 for PFOS; the weighted log-compound correlation was 0.580. Age includes the released top code 80. Sex uses the released binary field and race/ethnicity uses RIDRETH1, with Mexican American as the reference. These are survey categories, not biological explanations.

Table S10 reports all uncapped and capped fits. Capping uses pooled nonmissing PFAS records rather than selecting thresholds by outcome significance. A separate family correction across all four joint coefficients also yields no FDR significance. Survey weights account for the released design, but do not guarantee that complete-case exclusion is unbiased. Table S11 shows selected weighted characteristics among included and excluded positive-weight participants with available values. Denominators differ by variable; excluded participants do not form a complete-case sample. Cholesterol-lowering medication was not modeled because the cached source set lacks medication files.

## S5 Exploratory tract analysis

For each compound, the primary PFAS metric based on monitored wells within 10 km of the tract center uses the revised well-period summaries. Co-located wells were averaged first; then locations within 10 km of the Census internal point were equally averaged. Distances followed the Earth's curvature. A tract without a location inside that radius received no value. A nearby well is not assumed to supply nearby residents. The 2,356 wells represent 2,317 unique coordinate locations.

All 9,070 health tract IDs matched the cached Gazetteer and ACS files. At 10 km, 2,366 health tracts lacked a nearby well and 54 more lacked covariates, leaving 6,650 tracts in 44 counties. Six crude PLACES outcomes were modeled separately for each compound, using inverse-variance weights, current smoking, lack of health insurance, log median household income, poverty percentage and county fixed effects. Continuous predictors were standardized within model samples. County-clustered covariance included the small-sample correction; primary t inference used 43 degrees of freedom. Table S12 gives the 12 primary coefficients, also shown in Figure S4. No nearest-well replacement was used when a tract lacked a well within 10 km.

Eight exposure sensitivities examined planar versus spherical distance, equal-well versus equal-location averaging, 5 and 20 km radii, zero/half/full-limit nondetect handling, and community systems only. An additional 12 adjusted models omitted county fixed effects. Table S13 summarizes the resulting 120 fits. Corrections covered each 12-test definition, the 96 exposure-sensitivity coefficients, and all 108 secondary/sensitivity coefficients. Each matched-tract comparison refits the primary and alternative exposure definitions on identical tract IDs. The monitoring-radius comparison discussed in the manuscript is shown in Figure S3 and Table S14.

### *Supporting tract sensitivity results*

At 20 km, 7,976 tracts in 49 counties were included. Both obesity coefficients survived within-definition FDR, but only PFOS survived pooled FDR: beta -0.535, 95% CI -0.756 to -0.314; $p = 0.00001261$; 96-test FDR/Bonferroni $p = 0.001210$ and 108-test FDR/Bonferroni $p = 0.001361$. Figure S3 and Table S14 compare 10 and 20 km on the exact same 6,650 tract IDs. PFOS changes from -0.481 to -0.708 percentage points per log unit, so added tracts alone do not explain the difference.

This inverse result does not establish protection from obesity. The cached ACS files do not contain adult-age groups; crude prevalence retains age differences even though age enters CDC's prediction model. County fixed effects do not adjust age differences among tracts within a county. Nearby tracts can share wells and modeled health inputs, and county clustering does not account for every source of cross-border dependence. These limitations support supplementary exploratory treatment of the tract analysis.

## S6 Reproducibility and data availability

The supporting methods, sample accounting and results cited in the manuscript and response letter are provided in this document. The project records retain source URLs, retrieval details, SHA-256 checksums, analysis code, model-inclusion identifiers and complete outputs. These records are available from the author on request. The revised results reported here use the fixed source snapshots; manuscript preparation did not rerun the health models. Earlier submitted outputs remain historical project records and must not be substituted for the revised results.

The recorded fits used Python 3.9.6, pandas 1.5.3, NumPy 1.26.4, SciPy 1.13.1 and statsmodels 0.14.6. Spatial software versions and settings are given in Section S3. Revision entry points are src/run_nhsjs_revision_audit.py, src/run_nhsjs_revision_models.py, src/run_nhsjs_revision_tract.py and src/run_nhsjs_revision_nhanes.py. Source retrieval details are recorded in data/processed/source_manifest.csv. Large California source files are retained locally.

Official documentation: CDC PLACES measure definitions, https://www.cdc.gov/places/measure-definitions/; PLACES methods, https://www.cdc.gov/places/methodology/; NHANES survey tutorials, https://wwwn.cdc.gov/nchs/nhanes/tutorials/; and PFAS codebooks, https://wwwn.cdc.gov/Nchs/Data/Nhanes/Public/2015/DataFiles/PFAS_I.htm and https://wwwn.cdc.gov/Nchs/Data/Nhanes/Public/2017/DataFiles/PFAS_J.htm. The full source citations are in manuscript References 7–11 and 13–14.

The full cancer prediction exercise was removed from the revised article and supplement. It used the former combined monitoring index and did not answer the revised association question. It is not presented as a revised model result. Its historical files remain in the project for traceability. The retained county, spatial, tract and NHANES analyses provide the relevant checks without using prediction performance as evidence about causation.

The literature review is targeted and narrative, not systematic or a meta-analysis. It includes 26 primary studies, 25 first published in 2022-2026 plus the PLCO kidney study published online in 2020 and in a 2021 issue. All citation metadata and abstracts were checked; targeted full-text sections were checked for eight studies and the Raza correction was checked separately. Official dataset and method citations are retained separately from the primary-study count.

## S7 Additional county sensitivity comparisons

These tables provide the county-level nondetect comparisons requested during review, the correction results for all alternative exposure definitions, and the matched primary comparisons needed to interpret the seven corrected sensitivity coefficients. They summarize existing fitted results.

For Table S15, primary uses reporting limit/$\sqrt{2}$. Zero, half-limit and full-limit substitutions apply only to nondetects with positive reporting limits. All other aggregation steps are unchanged.

Table S16 includes every primary compound-outcome coefficient with raw $p < 0.05$ and both liver/bile-duct coefficients. This selection describes the principal results discussed in the manuscript; Table S17 summarizes correction outcomes across all 450 sensitivity coefficients. Full correction families were used, not only the rows shown here.

For Table S18, for each sensitivity result in Table S7, the primary exposure model was refitted on exactly the counties included by that sensitivity definition. These reference estimates use the

primary exposure values. Their FDR corrections use the full matched family of 38 cancer or 12 chronic-disease coefficients.

Table S4 reports the corresponding statewide medians, maxima and rank correlations. Zero substitution yields zero-valued county measures in 35 PFOA and 30 PFOS counties. These are monitoring summaries, not estimates of delivered household exposure.

### Supplementary Tables

Abbreviations used in the tables: PFAS, per- and polyfluoroalkyl substances; PFOA, perfluorooctanoic acid; PFOS, perfluorooctanesulfonic acid; NHANES, National Health and Nutrition Examination Survey; BMI, body mass index; CI, confidence interval; SD, standard deviation; FDR, false discovery rate; Bonf., Bonferroni; ONS, other nervous system. HC3 is the type 3 heteroskedasticity-consistent covariance estimator. In county-model tables, n counts counties.

**Table S1 | Annual detection counts in initially eligible records.**

| Year | PFAS | Rows | Detected n (%) | Nondetects | Zero limits |
|---|---|---|---|---|---|
| 2016 | PFOA | 13 | 3 (23.1%) | 10 | 0 |
| 2016 | PFOS | 13 | 1 (7.7%) | 12 | 0 |
| 2017 | PFOA | 148 | 46 (31.1%) | 102 | 0 |
| 2017 | PFOS | 148 | 44 (29.7%) | 104 | 0 |
| 2018 | PFOA | 211 | 101 (47.9%) | 110 | 70 |
| 2018 | PFOS | 211 | 99 (46.9%) | 112 | 61 |
| 2019 | PFOA | 2559 | 1073 (41.9%) | 1486 | 2 |
| 2019 | PFOS | 2557 | 1229 (48.1%) | 1328 | 0 |
| 2020 | PFOA | 3133 | 1506 (48.1%) | 1627 | 0 |
| 2020 | PFOS | 3135 | 1817 (58.0%) | 1318 | 0 |
| 2021 | PFOA | 4632 | 2287 (49.4%) | 2345 | 0 |
| 2021 | PFOS | 4634 | 2703 (58.3%) | 1931 | 0 |
| 2022 | PFOA | 3915 | 2123 (54.2%) | 1792 | 0 |
| 2022 | PFOS | 3920 | 2391 (61.0%) | 1529 | 1 |

Zero-limit nondetects are excluded from the primary revision. Early years have very small samples; these percentages are not a statewide temporal trend.

**Table S2 | Reporting limits among initially eligible nondetects.**

| PFAS | n | Min-max | 25th | Median | 75th | 95th | Zeros |
|---|---|---|---|---|---|---|---|
| PFOA | 7472 | 0-89 | 1.8 | 2.0 | 2.0 | 5.0 | 72 |
| PFOS | 6334 | 0-89 | 1.8 | 2.0 | 2.0 | 5.0 | 62 |

All limits are ng/L. The zero limits shown here were excluded; other percentiles describe the initial nondetect records. No numeric-result fallback was required.

**Table S3 | Primary county monitoring values and coverage.**

| County | Wells | Systems | Year span (n) | PFOA | PFOS |
|---|---|---|---|---|---|
| Alameda | 47 | 6 | 2018-2022 (5) | 2.132 | 10.550 |
| Butte | 70 | 9 | 2017-2022 (5) | 1.752 | 2.405 |
| Contra Costa | 7 | 3 | 2019-2022 (4) | 1.945 | 2.121 |
| Del Norte | 2 | 2 | 2019-2022 (4) | 6.101 | 6.768 |
| Fresno | 76 | 5 | 2019-2022 (4) | 1.644 | 1.750 |
| Glenn | 10 | 2 | 2020-2022 (3) | 1.964 | 2.121 |
| Inyo | 5 | 1 | 2021-2022 (2) | 1.414 | 1.414 |
| Kern | 226 | 45 | 2016-2022 (6) | 2.121 | 2.121 |
| Kings | 1 | 1 | 2020-2020 (1) | 1.414 | 1.414 |
| Lake | 1 | 1 | 2022-2022 (1) | 2.200 | 2.200 |
| Lassen | 6 | 4 | 2017-2022 (6) | 2.722 | 2.736 |
| Los Angeles | 473 | 89 | 2018-2022 (5) | 2.121 | 2.577 |
| Madera | 39 | 6 | 2019-2022 (4) | 3.536 | 3.536 |
| Marin | 9 | 1 | 2020-2020 (1) | 2.121 | 2.121 |
| Mariposa | 7 | 5 | 2019-2022 (3) | 1.414 | 1.414 |
| Mendocino | 1 | 1 | 2020-2020 (1) | 1.414 | 1.414 |
| Merced | 11 | 3 | 2017-2022 (5) | 2.475 | 2.475 |
| Mono | 4 | 3 | 2019-2020 (2) | 1.414 | 1.414 |
| Monterey | 130 | 40 | 2019-2022 (4) | 2.121 | 2.121 |

| County | Wells | Systems | Year span (n) | PFOA | PFOS |
|---|---|---|---|---|---|
| Napa | 2 | 2 | 2020-2020 (1) | 0.955 | 0.955 |
| Nevada | 3 | 2 | 2020-2022 (2) | 1.414 | 1.414 |
| Orange | 142 | 26 | 2017-2022 (6) | 6.479 | 10.648 |
| Placer | 3 | 3 | 2019-2022 (4) | 2.000 | 1.414 |
| Riverside | 177 | 19 | 2016-2022 (7) | 3.032 | 2.700 |
| Sacramento | 225 | 22 | 2017-2022 (6) | 2.121 | 2.121 |
| San Bernardino | 129 | 34 | 2019-2022 (4) | 1.414 | 1.414 |
| San Diego | 48 | 8 | 2016-2022 (7) | 2.657 | 8.319 |
| San Joaquin | 60 | 22 | 2019-2022 (4) | 1.414 | 1.917 |
| San Luis Obispo | 45 | 22 | 2018-2022 (5) | 2.850 | 4.875 |
| San Mateo | 10 | 3 | 2019-2022 (4) | 1.414 | 1.414 |
| Santa Barbara | 26 | 8 | 2019-2022 (4) | 1.414 | 1.410 |
| Santa Clara | 120 | 9 | 2018-2022 (5) | 1.085 | 1.406 |
| Santa Cruz | 14 | 6 | 2019-2022 (4) | 1.361 | 1.414 |
| Shasta | 12 | 6 | 2019-2022 (4) | 1.414 | 1.414 |
| Siskiyou | 2 | 1 | 2019-2020 (2) | 1.332 | 1.381 |
| Solano | 14 | 3 | 2019-2022 (4) | 2.121 | 2.121 |
| Sonoma | 39 | 14 | 2017-2022 (6) | 1.414 | 1.414 |
| Stanislaus | 11 | 5 | 2019-2022 (4) | 1.308 | 1.329 |
| Sutter | 2 | 1 | 2022-2022 (1) | 5.450 | 6.000 |
| Tehama | 8 | 6 | 2019-2022 (4) | 7.768 | 5.212 |
| Tulare | 65 | 4 | 2018-2022 (5) | 2.121 | 2.121 |
| Tuolumne | 2 | 2 | 2022-2022 (1) | 1.414 | 8.207 |
| Ventura | 45 | 20 | 2019-2022 (4) | 1.273 | 1.414 |

| County | Wells | Systems | Year span (n) | PFOA | PFOS |
|---|---|---|---|---|---|
| Yolo | 4 | 2 | 2018-2022 (5) | 1.414 | 1.721 |
| Yuba | 23 | 5 | 2020-2022 (3) | 1.414 | 1.414 |

Concentrations are ng/L. n in the year column is the number of distinct monitored years; years within a span need not be consecutive. Both compounds retain all listed wells and systems.

**Table S4 | Exposure-definition comparisons.**

| Definition | PFAS | County n | Median | Maximum | Zeros | Rank r |
|---|---|---|---|---|---|---|
| Collection time | PFOA | 45 | 1.752 | 7.768 | 0 | 1.000 |
| Collection time | PFOS | 45 | 2.121 | 10.648 | 0 | 1.000 |
| Community only | PFOA | 42 | 1.879 | 6.575 | 0 | 0.935 |
| Community only | PFOS | 42 | 2.121 | 15.000 | 0 | 0.891 |
| Omit mixed days | PFOA | 45 | 1.752 | 7.768 | 0 | 1.000 |
| Omit mixed days | PFOS | 45 | 2.121 | 10.648 | 0 | 1.000 |
| Full limit | PFOA | 45 | 2.069 | 8.500 | 0 | 0.964 |
| Full limit | PFOS | 45 | 2.612 | 10.648 | 0 | 0.970 |
| Half limit | PFOA | 45 | 1.250 | 7.250 | 0 | 0.988 |
| Half limit | PFOS | 45 | 1.500 | 10.648 | 0 | 0.960 |
| Residential weights | PFOA | 42 | 2.094 | 15.323 | 0 | 0.811 |
| Residential weights | PFOS | 42 | 2.590 | 26.998 | 0 | 0.742 |
| Total weights | PFOA | 45 | 2.067 | 15.315 | 0 | 0.778 |
| Total weights | PFOS | 45 | 2.397 | 27.018 | 0 | 0.778 |
| Primary | PFOA | 45 | 1.752 | 7.768 | 0 | 1.000 |
| Primary | PFOS | 45 | 2.121 | 10.648 | 0 | 1.000 |
| Retain zero limits | PFOA | 45 | 1.752 | 7.768 | 0 | 1.000 |
| Retain zero limits | PFOS | 45 | 2.121 | 10.648 | 0 | 1.000 |

| Definition | PFAS | County n | Median | Maximum | Zeros | Rank r |
|---|---|---|---|---|---|---|
| Zero nondetect | PFOA | 45 | 0.000 | 6.479 | 35 | 0.667 |
| Zero nondetect | PFOS | 45 | 0.000 | 10.648 | 30 | 0.668 |

Median and maximum are across counties, in ng/L. Rank r is Spearman correlation with the revised primary measure on common counties. County-specific nondetect comparisons are in Table S15.

**Table S5 | County PFOA and PFOS and cancer incidence, 2018–2022.**

| Outcome | PFAS | n | Beta (95% CI) | Raw p | FDR p | Bonf. p |
|---|---|---|---|---|---|---|
| Bladder | PFOA | 44 | 0.017 (-1.109 to 1.144) | 0.9761 | 0.9761 | 1.0000 |
| Brain and ONS | PFOA | 38 | 0.236 (-0.059 to 0.531) | 0.1172 | 0.8905 | 1.0000 |
| Breast | PFOA | 45 | -1.594 (-7.490 to 4.301) | 0.5960 | 0.9573 | 1.0000 |
| Childhood (ages <20) | PFOA | 31 | 0.553 (-0.225 to 1.332) | 0.1633 | 0.9573 | 1.0000 |
| Colon and rectum | PFOA | 45 | -0.555 (-1.067 to -0.044) | 0.0333 | 0.4221 | 1.0000 |
| Esophagus | PFOA | 37 | 0.069 (-0.472 to 0.611) | 0.8021 | 0.9573 | 1.0000 |
| Kidney and renal pelvis | PFOA | 44 | -0.051 (-0.875 to 0.773) | 0.9038 | 0.9573 | 1.0000 |
| Leukemia | PFOA | 43 | 0.235 (-0.329 to 0.800) | 0.4141 | 0.9573 | 1.0000 |
| Liver and bile duct | PFOA | 43 | 0.143 (-0.073 to 0.358) | 0.1944 | 0.9573 | 1.0000 |
| Lung and bronchus | PFOA | 44 | 0.832 (-1.515 to 3.179) | 0.4874 | 0.9573 | 1.0000 |
| Melanoma of the skin | PFOA | 45 | 3.322 (-2.204 to 8.848) | 0.2386 | 0.9573 | 1.0000 |
| Non-Hodgkin lymphoma | PFOA | 44 | 0.051 (-0.594 to 0.695) | 0.8775 | 0.9573 | 1.0000 |
| Oral cavity and pharynx | PFOA | 44 | 0.290 (-0.783 to 1.363) | 0.5960 | 0.9573 | 1.0000 |
| Ovary | PFOA | 39 | -0.146 (-0.901 to 0.609) | 0.7042 | 0.9573 | 1.0000 |
| Pancreas | PFOA | 44 | 0.033 (-0.352 to 0.418) | 0.8670 | 0.9573 | 1.0000 |
| Prostate | PFOA | 45 | -0.303 (-5.362 to 4.756) | 0.9066 | 0.9573 | 1.0000 |
| Stomach | PFOA | 38 | -0.194 (-0.954 to 0.565) | 0.6159 | 0.9573 | 1.0000 |
| Thyroid | PFOA | 40 | 0.129 (-1.695 to 1.953) | 0.8900 | 0.9573 | 1.0000 |
| Uterus | PFOA | 44 | -1.011 (-1.763 to -0.259) | 0.0084 | 0.3205 | 0.3205 |

| Outcome | PFAS | n | Beta (95% CI) | Raw p | FDR p | Bonf. p |
|---|---|---|---|---|---|---|
| Bladder | PFOS | 44 | -0.078 (-1.384 to 1.228) | 0.9069 | 0.9573 | 1.0000 |
| Brain and ONS | PFOS | 38 | 0.069 (-0.477 to 0.616) | 0.8037 | 0.9573 | 1.0000 |
| Breast | PFOS | 45 | -1.431 (-4.396 to 1.534) | 0.3442 | 0.9573 | 1.0000 |
| Childhood (ages <20) | PFOS | 31 | 0.469 (-0.336 to 1.274) | 0.2532 | 0.9573 | 1.0000 |
| Colon and rectum | PFOS | 45 | -0.469 (-0.987 to 0.048) | 0.0755 | 0.7171 | 1.0000 |
| Esophagus | PFOS | 37 | 0.090 (-0.382 to 0.561) | 0.7092 | 0.9573 | 1.0000 |
| Kidney and renal pelvis | PFOS | 44 | 0.100 (-0.846 to 1.046) | 0.8359 | 0.9573 | 1.0000 |
| Leukemia | PFOS | 43 | 0.273 (-0.343 to 0.888) | 0.3855 | 0.9573 | 1.0000 |
| Liver and bile duct | PFOS | 43 | 0.399 (0.036 to 0.761) | 0.0312 | 0.4221 | 1.0000 |
| Lung and bronchus | PFOS | 44 | 1.256 (-0.987 to 3.499) | 0.2724 | 0.9573 | 1.0000 |
| Melanoma of the skin | PFOS | 45 | 1.907 (-5.194 to 9.007) | 0.5987 | 0.9573 | 1.0000 |
| Non-Hodgkin lymphoma | PFOS | 44 | 0.121 (-0.204 to 0.447) | 0.4651 | 0.9573 | 1.0000 |
| Oral cavity and pharynx | PFOS | 44 | 0.264 (-0.908 to 1.436) | 0.6586 | 0.9573 | 1.0000 |
| Ovary | PFOS | 39 | -0.007 (-0.239 to 0.225) | 0.9540 | 0.9761 | 1.0000 |
| Pancreas | PFOS | 44 | 0.098 (-0.171 to 0.368) | 0.4742 | 0.9573 | 1.0000 |
| Prostate | PFOS | 45 | -0.323 (-5.190 to 4.543) | 0.8964 | 0.9573 | 1.0000 |
| Stomach | PFOS | 38 | -0.160 (-0.828 to 0.508) | 0.6383 | 0.9573 | 1.0000 |
| Thyroid | PFOS | 40 | -0.306 (-1.250 to 0.637) | 0.5245 | 0.9573 | 1.0000 |
| Uterus | PFOS | 44 | -0.583 (-1.683 to 0.517) | 0.2986 | 0.9573 | 1.0000 |

Beta is age-adjusted cases per 100,000 per one-SD higher natural log(1 + compound ng/L); intervals are unadjusted HC3 intervals. FDR and Bonferroni corrections each cover 38 tests. No primary coefficient survives either correction. Model details are in Section S2.

**Table S6 | County PFOA and PFOS and six CDC PLACES outcomes.**

| Outcome | PFAS | n | Beta (95% CI) | Raw p | FDR p | Bonf. p |
|---|---|---|---|---|---|---|
| High Cholesterol | PFOA | 45 | 0.188 (-0.119 to 0.496) | 0.2303 | 0.6908 | 1.0000 |
| Coronary Heart Disease | PFOA | 45 | 0.013 (-0.042 to 0.069) | 0.6413 | 0.8550 | 1.0000 |

| Outcome | PFAS | n | Beta (95% CI) | Raw p | FDR p | Bonf. p |
|---|---|---|---|---|---|---|
| High Blood Pressure | PFOA | 45 | -0.032 (-0.328 to 0.264) | 0.8310 | 0.8978 | 1.0000 |
| Diabetes | PFOA | 45 | 0.059 (-0.097 to 0.215) | 0.4610 | 0.7902 | 1.0000 |
| Obesity | PFOA | 45 | -0.307 (-1.062 to 0.449) | 0.4264 | 0.7902 | 1.0000 |
| Current Asthma | PFOA | 45 | -0.021 (-0.106 to 0.063) | 0.6193 | 0.8550 | 1.0000 |
| High Cholesterol | PFOS | 45 | 0.056 (-0.277 to 0.389) | 0.7419 | 0.8903 | 1.0000 |
| Coronary Heart Disease | PFOS | 45 | -0.003 (-0.054 to 0.048) | 0.8978 | 0.8978 | 1.0000 |
| High Blood Pressure | PFOS | 45 | -0.080 (-0.255 to 0.095) | 0.3713 | 0.7902 | 1.0000 |
| Diabetes | PFOS | 45 | 0.130 (-0.069 to 0.329) | 0.1991 | 0.6908 | 1.0000 |
| Obesity | PFOS | 45 | -0.582 (-1.000 to -0.164) | 0.0063 | 0.0758 | 0.0758 |
| Current Asthma | PFOS | 45 | -0.092 (-0.181 to -0.002) | 0.0454 | 0.2725 | 0.5451 |

Beta is prevalence percentage points per one-SD higher natural log(1 + compound ng/L); intervals are unadjusted HC3 intervals. FDR and Bonferroni corrections each cover 12 tests. No primary coefficient survives either correction. Model details are in Section S2.

**Table S7 | All seven FDR-significant county sensitivity coefficients.**

| Definition | Outcome and compound | Beta (95% CI) | Family FDR | Pooled FDR |
|---|---|---|---|---|
| Zero nondetect | Uterus PFOA | -1.054 (-1.455 to -0.653) | <0.0001 | <0.0001 |
| Half limit | Uterus PFOA | -1.093 (-1.664 to -0.522) | 0.0066 | 0.0149 |
| Community only | Colon and rectum PFOA | -0.580 (-0.870 to -0.291) | 0.0016 | 0.0098 |
| Community only | Uterus PFOA | -1.016 (-1.450 to -0.582) | 0.0002 | 0.0008 |
| Residential weights | Current Asthma PFOS | -0.152 (-0.236 to -0.068) | 0.0047 | 0.0210 |
| Total weights | Current Asthma PFOA | -0.132 (-0.211 to -0.053) | 0.0062 | 0.0371 |
| Total weights | Current Asthma PFOS | -0.158 (-0.226 to -0.090) | <0.0001 | 0.0006 |

Beta units, standardization and HC3 intervals follow Tables S5 and S6. Family corrections use 38 cancer or 12 chronic-disease tests; pooled corrections use 342 or 108. Every coefficient is inverse; these results do not imply independent replications or protection.

**Table S8 | FDR-positive spatial residual diagnostics and triggered sensitivities.**

**A. Residual diagnostics that triggered follow-up models**

| Outcome | PFAS | Moran's I | Diagnostic FDR p |
|---|---|---|---|
| Brain and ONS | PFOA | 0.241 | 0.0319 |
| Kidney and renal pelvis | PFOA | 0.254 | 0.0228 |
| Leukemia | PFOA | 0.263 | 0.0165 |
| Liver and bile duct | PFOA | 0.225 | 0.0287 |
| Lung and bronchus | PFOA | 0.325 | 0.0127 |
| Prostate | PFOA | 0.189 | 0.0364 |
| Brain and ONS | PFOS | 0.248 | 0.0287 |
| Kidney and renal pelvis | PFOS | 0.266 | 0.0165 |
| Leukemia | PFOS | 0.263 | 0.0165 |
| Liver and bile duct | PFOS | 0.315 | 0.0127 |
| Lung and bronchus | PFOS | 0.324 | 0.0127 |
| Prostate | PFOS | 0.187 | 0.0364 |

FDR covers 38 cancer and 12 chronic-disease diagnostics separately. The 12 significant cancer diagnostics are shown; none of the chronic-disease diagnostics triggered follow-up. Procedures are in Section S3.

**B. Spatial-error coefficients for the triggered models**

| Outcome | PFAS | Beta (95% CI) | Raw p | FDR p | Lambda |
|---|---|---|---|---|---|
| Brain and ONS | PFOA | 0.198 (-0.005 to 0.401) | 0.0561 | 0.2242 | 0.474 |
| Kidney and renal pelvis | PFOA | -0.317 (-1.021 to 0.388) | 0.3783 | 0.5750 | 0.305 |
| Leukemia | PFOA | -0.173 (-1.027 to 0.681) | 0.6912 | 0.7541 | 0.570 |
| Liver and bile duct | PFOA | 0.326 (0.013 to 0.638) | 0.0409 | 0.2242 | 0.684 |
| Lung and bronchus | PFOA | 0.361 (-1.396 to 2.118) | 0.6869 | 0.7541 | 0.482 |
| Prostate | PFOA | -2.906 (-6.601 to 0.789) | 0.1232 | 0.2956 | 0.596 |
| Brain and ONS | PFOS | 0.110 (-0.163 to 0.382) | 0.4312 | 0.5750 | 0.469 |
| Kidney and renal pelvis | PFOS | -0.337 (-0.891 to 0.218) | 0.2339 | 0.4677 | 0.333 |
| Leukemia | PFOS | -0.011 (-0.663 to 0.641) | 0.9739 | 0.9739 | 0.549 |
| Liver and bile duct | PFOS | 0.356 (0.091 to 0.620) | 0.0084 | 0.1004 | 0.706 |

| Outcome | PFAS | Beta (95% CI) | Raw p | FDR p | Lambda |
|---|---|---|---|---|---|
| Lung and bronchus | PFOS | 1.169 (-0.120 to 2.458) | 0.0756 | 0.2267 | 0.488 |
| Prostate | PFOS | -1.585 (-5.480 to 2.311) | 0.4253 | 0.5750 | 0.618 |

Beta is cases per 100,000 per one-SD higher natural log(1 + compound ng/L). Intervals use normal inference for unweighted GM_Error_Het fits. FDR covers all 12 follow-up coefficients. Lambda is the estimated residual spatial-error parameter.

**Table S9 | Sequential NHANES sample flow.**

| Requirement | Newly excluded | Remaining | Overlapping exclusions |
|---|---|---|---|
| PFAS file records | 0 | 4303 | n/a |
| Age at least 12 and examined | 0 | 4303 | 0 |
| Positive weight and complete survey design | 61 | 4242 | 61 |
| Required PFAS isomers available | 320 | 3922 | 381 |
| Total cholesterol available | 5 | 3917 | 309 |
| Income-to-poverty ratio available | 451 | 3466 | 502 |
| BMI available | 33 | 3433 | 55 |
| Remaining adjustment covariates available | 0 | 3433 | 0 |

The same sample is used for PFOA, PFOS and joint models. Zero income is retained after the source-byte correction. The complete-case sample contains 1,778 participants from 2015–2016 and 1,655 from 2017–2018. The overlapping counts describe each missing-data reason before ordered exclusions.

**Table S10 | All revised NHANES coefficients.**

| Model | PFAS | Beta (95% CI) | Raw p | FDR p | Bonf. p |
|---|---|---|---|---|---|
| Separate | PFOA | 6.00 (0.66 to 11.35) | 0.0290 | 0.0290 | 0.0579 |
| Separate | PFOS | 5.65 (1.33 to 9.96) | 0.0121 | 0.0241 | 0.0241 |
| Separate capped | PFOA | 6.90 (1.03 to 12.76) | 0.0228 | 0.0228 | 0.0456 |
| Separate capped | PFOS | 5.65 (1.29 to 10.01) | 0.0129 | 0.0228 | 0.0258 |
| Joint | PFOA | 2.55 (-3.83 to 8.93) | 0.4202 | 0.4202 | 0.8404 |
| Joint | PFOS | 4.80 (-0.32 to 9.92) | 0.0650 | 0.1300 | 0.1300 |
| Joint capped | PFOA | 3.44 (-3.53 to 10.41) | 0.3219 | 0.3219 | 0.6439 |
| Joint capped | PFOS | 4.52 (-0.71 to 9.75) | 0.0877 | 0.1755 | 0.1755 |

All n = 3,433. Coefficients are mg/dL per unit higher natural log(1 + compound ng/mL), not per SD. Intervals use the survey design and 30 degrees of freedom. Each model type has a two-compound correction family.

**Table S11 | Included and excluded participant characteristics.**

| Variable | Included n | Weighted mean | Excluded n | Weighted mean |
|---|---|---|---|---|
| Age (years) | 3433 | 44.006 | 809 | 44.244 |
| Female proportion | 3433 | 0.510 | 809 | 0.542 |
| Income-to-poverty ratio | 3433 | 3.015 | 323 | 2.799 |
| BMI (kg/m²) | 3433 | 28.936 | 757 | 28.119 |
| Cholesterol (mg/dL) | 3433 | 187.845 | 558 | 186.722 |
| PFOA (ng/mL) | 3433 | 1.864 | 489 | 1.826 |
| PFOS (ng/mL) | 3433 | 6.174 | 489 | 7.343 |

n counts participants with positive survey weights and available values for that variable. Female is a proportion. These descriptions do not correct missing-data bias.

**Table S12 | Exploratory 10-kilometer tract analysis.**

| Outcome | PFAS | Beta (95% CI) | Raw p | FDR p |
|---|---|---|---|---|
| high cholesterol | PFOA | 0.119 (-0.500 to 0.738) | 0.7009 | 0.8598 |
| coronary heart disease | PFOA | 0.008 (-0.114 to 0.130) | 0.8949 | 0.9763 |
| high blood pressure | PFOA | -0.002 (-0.422 to 0.419) | 0.9942 | 0.9942 |
| diabetes | PFOA | 0.071 (-0.238 to 0.380) | 0.6461 | 0.8598 |
| obesity | PFOA | -0.254 (-0.673 to 0.164) | 0.2274 | 0.8476 |
| current asthma | PFOA | -0.057 (-0.224 to 0.110) | 0.4944 | 0.8476 |
| high cholesterol | PFOS | 0.269 (-0.310 to 0.849) | 0.3537 | 0.8476 |
| coronary heart disease | PFOS | 0.027 (-0.121 to 0.175) | 0.7165 | 0.8598 |
| high blood pressure | PFOS | 0.157 (-0.290 to 0.604) | 0.4822 | 0.8476 |
| diabetes | PFOS | 0.140 (-0.267 to 0.547) | 0.4920 | 0.8476 |
| obesity | PFOS | -0.410 (-0.740 to -0.079) | 0.0162 | 0.1949 |
| current asthma | PFOS | -0.104 (-0.246 to 0.038) | 0.1453 | 0.8476 |

All models contain 6,650 tracts in 44 counties and county fixed effects. Beta is percentage points per one-SD higher natural log(1 + compound ng/L); intervals are county-clustered t intervals with 43 degrees of freedom. FDR covers 12 tests. Model details are in Section S5.

**Table S13 | Tract model families and corrected findings.**

| Definition | Fits | Tracts | County n | Family FDR | 96-test FDR | 108-test FDR |
|---|---|---|---|---|---|---|
| primary | 12 | 6650 | 44 | 0 | n/a | n/a |
| planar 10km | 12 | 6650 | 44 | 0 | 0 | 0 |
| equal well | 12 | 6650 | 44 | 0 | 0 | 0 |
| radius 5km | 12 | 4758 | 39 | 0 | 0 | 0 |
| radius 20km | 12 | 7976 | 49 | 2 | 1 | 1 |
| zero nd | 12 | 6650 | 44 | 0 | 0 | 0 |
| half limit nd | 12 | 6650 | 44 | 0 | 0 | 0 |
| full limit nd | 12 | 6650 | 44 | 0 | 0 | 0 |

| Definition | Fits | Tracts | County n | Family FDR | 96-test FDR | 108-test FDR |
|---|---|---|---|---|---|---|
| community only | 12 | 6509 | 41 | 0 | 0 | 0 |
| no county fe | 12 | 6650 | 44 | 0 | n/a | 0 |

Last three columns count significant coefficients; n/a means outside that correction family. The primary family is not part of the pooled secondary tests. The corrected 20 km PFOS result is reported in Section S5; no other exposure-sensitivity coefficient survives either pooled FDR family.

**Table S14 | Radius comparison on the same 6,650 tract IDs.**

| PFAS | Common tracts | 10 km beta per log unit | 20 km beta per log unit | 10 km beta on primary SD | 20 km beta on primary SD |
|---|---|---|---|---|---|
| PFOA | 6650 | -0.399 | -1.021 | -0.254 | -0.651 |
| PFOS | 6650 | -0.481 | -0.708 | -0.410 | -0.603 |

Beta is the obesity prevalence percentage-point difference. Log-unit coefficients and coefficients on the common 10 km SD distinguish exposure change from rescaling. Figure S3 shows confidence intervals for the matched 10 km and 20 km fits.

**Table S15 | County concentrations under four nondetect rules.**

Values are PFOA / PFOS in ng/L, reported separately. Primary uses limit/√2; zero, half-limit and full-limit rules apply only to positive-limit nondetects. All other aggregation steps are unchanged (Section S7).

| County | Primary | Zero | Half limit | Full limit |
|---|---|---|---|---|
| Alameda | 2.132 / 10.550 | 1.800 / 10.550 | 2.067 / 10.550 | 2.425 / 10.550 |
| Butte | 1.752 / 2.405 | 0.000 / 1.450 | 1.250 / 2.175 | 2.069 / 2.675 |
| Contra Costa | 1.945 / 2.121 | 0.000 / 0.990 | 1.375 / 1.790 | 2.300 / 2.750 |
| Del Norte | 6.101 / 6.768 | 5.500 / 6.167 | 5.925 / 6.592 | 6.350 / 7.017 |
| Fresno | 1.644 / 1.750 | 0.000 / 0.000 | 1.167 / 1.283 | 2.317 / 2.335 |
| Glenn | 1.964 / 2.121 | 0.000 / 0.000 | 1.500 / 1.500 | 2.550 / 3.000 |
| Inyo | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| Kern | 2.121 / 2.121 | 0.000 / 0.000 | 1.500 / 1.500 | 3.000 / 3.000 |
| Kings | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| Lake | 2.200 / 2.200 | 2.200 / 2.200 | 2.200 / 2.200 | 2.200 / 2.200 |
| Lassen | 2.722 / 2.736 | 0.000 / 0.000 | 1.925 / 1.983 | 3.850 / 3.850 |
| Los Angeles | 2.121 / 2.577 | 0.000 / 0.225 | 1.750 / 2.200 | 2.917 / 3.000 |

| County | Primary | Zero | Half limit | Full limit |
|---|---|---|---|---|
| Madera | 3.536 / 3.536 | 0.000 / 0.000 | 2.500 / 2.500 | 5.000 / 5.000 |
| Marin | 2.121 / 2.121 | 0.000 / 0.000 | 1.500 / 1.500 | 3.000 / 3.000 |
| Mariposa | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| Mendocino | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| Merced | 2.475 / 2.475 | 0.000 / 0.000 | 1.750 / 1.750 | 3.500 / 3.500 |
| Mono | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| Monterey | 2.121 / 2.121 | 0.000 / 0.000 | 1.500 / 1.500 | 3.000 / 3.000 |
| Napa | 0.955 / 0.955 | 0.000 / 0.000 | 0.675 / 0.675 | 1.350 / 1.350 |
| Nevada | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| Orange | 6.479 / 10.648 | 6.479 / 10.648 | 6.479 / 10.648 | 6.479 / 10.648 |
| Placer | 2.000 / 1.414 | 2.000 / 0.000 | 2.000 / 1.000 | 2.000 / 2.000 |
| Riverside | 3.032 / 2.700 | 2.767 / 2.362 | 3.006 / 2.642 | 3.050 / 2.944 |
| Sacramento | 2.121 / 2.121 | 0.000 / 0.000 | 1.500 / 1.500 | 3.000 / 3.000 |
| San Bernardino | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| San Diego | 2.657 / 8.319 | 1.115 / 7.144 | 2.546 / 8.319 | 3.142 / 8.319 |
| San Joaquin | 1.414 / 1.917 | 0.000 / 0.000 | 1.000 / 1.375 | 2.000 / 2.612 |
| San Luis Obispo | 2.850 / 4.875 | 2.600 / 4.633 | 2.717 / 4.875 | 2.850 / 4.875 |
| San Mateo | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| Santa Barbara | 1.414 / 1.410 | 0.000 / 0.000 | 1.000 / 0.997 | 2.000 / 1.994 |
| Santa Clara | 1.085 / 1.406 | 0.000 / 0.055 | 0.781 / 1.091 | 1.485 / 1.800 |
| Santa Cruz | 1.361 / 1.414 | 0.000 / 0.000 | 0.962 / 1.000 | 1.925 / 2.000 |
| Shasta | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| Siskiyou | 1.332 / 1.381 | 0.000 / 0.167 | 0.942 / 1.025 | 1.883 / 1.883 |
| Solano | 2.121 / 2.121 | 0.000 / 0.000 | 1.500 / 1.500 | 3.000 / 3.000 |
| Sonoma | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |
| Stanislaus | 1.308 / 1.329 | 0.000 / 0.000 | 0.925 / 0.992 | 1.850 / 1.850 |
| Sutter | 5.450 / 6.000 | 5.450 / 6.000 | 5.450 / 6.000 | 5.450 / 6.000 |
| Tehama | 7.768 / 5.212 | 6.263 / 3.694 | 7.250 / 4.694 | 8.500 / 5.944 |
| Tulare | 2.121 / 2.121 | 0.000 / 0.000 | 1.500 / 1.500 | 3.000 / 3.000 |
| Tuolumne | 1.414 / 8.207 | 0.000 / 7.500 | 1.000 / 8.000 | 2.000 / 8.500 |
| Ventura | 1.273 / 1.414 | 0.000 / 0.000 | 0.900 / 1.000 | 1.800 / 2.000 |

| County | Primary | Zero | Half limit | Full limit |
|---|---|---|---|---|
| Yolo | 1.414 / 1.721 | 0.000 / 0.000 | 1.000 / 1.500 | 2.000 / 2.087 |
| Yuba | 1.414 / 1.414 | 0.000 / 0.000 | 1.000 / 1.000 | 2.000 / 2.000 |

**Table S16 | Nondetect sensitivity of the principal nominal county associations.**

| Outcome / PFAS | Rule | n | Beta (95% CI) | Family FDR p | Pooled FDR p |
|---|---|---|---|---|---|
| Liver and bile duct PFOA | Primary | 43 | 0.143 (-0.073 to 0.358) | 0.9573 | n/a |
| Liver and bile duct PFOA | Zero | 43 | 0.095 (-0.206 to 0.395) | 0.8850 | 0.9961 |
| Liver and bile duct PFOA | Half limit | 43 | 0.163 (-0.073 to 0.399) | 0.8613 | 0.9961 |
| Liver and bile duct PFOA | Full limit | 43 | 0.206 (-0.122 to 0.533) | 0.9694 | 0.9961 |
| Liver and bile duct PFOS | Primary | 43 | 0.399 (0.036 to 0.761) | 0.4221 | n/a |
| Liver and bile duct PFOS | Zero | 43 | 0.291 (-0.088 to 0.669) | 0.8355 | 0.9961 |
| Liver and bile duct PFOS | Half limit | 43 | 0.399 (0.042 to 0.755) | 0.4702 | 0.6283 |
| Liver and bile duct PFOS | Full limit | 43 | 0.380 (0.008 to 0.753) | 0.5136 | 0.7062 |
| Uterus PFOA | Primary | 44 | -1.011 (-1.763 to -0.259) | 0.3205 | n/a |
| Uterus PFOA | Zero | 44 | -1.054 (-1.455 to -0.653) | <0.0001 | <0.0001 |
| Uterus PFOA | Half limit | 44 | -1.093 (-1.664 to -0.522) | 0.0066 | 0.0149 |
| Uterus PFOA | Full limit | 44 | -0.842 (-2.578 to 0.895) | 0.9694 | 0.9961 |
| Colon and rectum PFOA | Primary | 45 | -0.555 (-1.067 to -0.044) | 0.4221 | n/a |
| Colon and rectum PFOA | Zero | 45 | -0.473 (-1.027 to 0.081) | 0.8355 | 0.9004 |
| Colon and rectum PFOA | Half limit | 45 | -0.560 (-1.086 to -0.033) | 0.4702 | 0.6347 |
| Colon and rectum PFOA | Full limit | 45 | -0.603 (-1.128 to -0.077) | 0.5136 | 0.6283 |
| Obesity PFOS | Primary | 45 | -0.582 (-1.000 to -0.164) | 0.0758 | n/a |

| Outcome / PFAS | Rule | n | Beta (95% CI) | Family FDR p | Pooled FDR p |
|---|---|---|---|---|---|
| Obesity PFOS | Zero | 45 | -0.288 (-1.083 to 0.507) | 0.9546 | 0.9364 |
| Obesity PFOS | Half limit | 45 | -0.548 (-0.964 to -0.131) | 0.1195 | 0.1344 |
| Obesity PFOS | Full limit | 45 | -0.589 (-1.061 to -0.118) | 0.1109 | 0.1706 |
| Current Asthma PFOS | Primary | 45 | -0.092 (-0.181 to -0.002) | 0.2725 | n/a |
| Current Asthma PFOS | Zero | 45 | -0.098 (-0.187 to -0.009) | 0.3649 | 0.2561 |
| Current Asthma PFOS | Half limit | 45 | -0.101 (-0.186 to -0.016) | 0.1217 | 0.1991 |
| Current Asthma PFOS | Full limit | 45 | -0.076 (-0.176 to 0.024) | 0.5369 | 0.7330 |

Cancer betas are cases per 100,000; chronic-disease betas are prevalence percentage points. All are per one-SD higher log compound measure, with unadjusted HC3 confidence intervals. Family corrections use 38 cancer or 12 chronic-disease coefficients; pooled corrections use 342 or 108 sensitivity coefficients. Primary fits are outside the pooled sensitivity families. No primary coefficient survives correction. The inverse uterine-cancer results under zero and half-limit substitution do not establish protection.

**Table S17 | Corrected findings across all county sensitivity definitions.**

| Definition | Cancer FDR | Cancer Bonf. | Chronic FDR | Chronic Bonf. |
|---|---|---|---|---|
| Zero nondetect | 1 / 1 | 1 / 1 | 0 / 0 | 0 / 0 |
| Half limit | 1 / 1 | 1 / 0 | 0 / 0 | 0 / 0 |
| Full limit | 0 / 0 | 0 / 0 | 0 / 0 | 0 / 0 |
| Omit mixed days | 0 / 0 | 0 / 0 | 0 / 0 | 0 / 0 |
| Collection time | 0 / 0 | 0 / 0 | 0 / 0 | 0 / 0 |
| Community only | 2 / 2 | 2 / 2 | 0 / 0 | 0 / 0 |
| Retain zero limits | 0 / 0 | 0 / 0 | 0 / 0 | 0 / 0 |
| Residential weights | 0 / 0 | 0 / 0 | 1 / 1 | 1 / 1 |
| Total weights | 0 / 0 | 0 / 0 | 2 / 2 | 2 / 1 |

Entries count corrected $p < 0.05$ coefficients as within-definition / pooled-family counts. Families contain 38 / 342 cancer or 12 / 108 chronic-disease coefficients. The seven FDR-positive coefficients are listed in Table S7; definitions with no corrected associations are also included. Counts across definitions do not represent independent diseases or replications.

**Table S18 | Matched primary references for the seven FDR-positive county sensitivity coefficients.**

| Definition | Outcome / PFAS | n | Primary beta (95% CI) | Primary FDR p |
|---|---|---|---|---|
| Zero nondetect | Uterus PFOA | 44 | -1.011 (-1.763 to -0.259) | 0.3205 |
| Half limit | Uterus PFOA | 44 | -1.011 (-1.763 to -0.259) | 0.3205 |
| Community only | Colon and rectum PFOA | 42 | -0.557 (-1.077 to -0.037) | 0.4515 |
| Community only | Uterus PFOA | 41 | -1.021 (-1.790 to -0.252) | 0.3523 |
| Residential weights | Current Asthma PFOS | 42 | -0.092 (-0.186 to 0.003) | 0.3444 |
| Total weights | Current Asthma PFOA | 45 | -0.021 (-0.106 to 0.063) | 0.8550 |
| Total weights | Current Asthma PFOS | 45 | -0.092 (-0.181 to -0.002) | 0.2725 |

Units and standardization follow Tables S5–S7. None of these matched primary coefficients survives FDR correction. Differences therefore cannot be attributed solely to a change in the county sample; the exposure definition also changes. The inverse sensitivity findings do not establish protective effects.

## Supplementary Figures

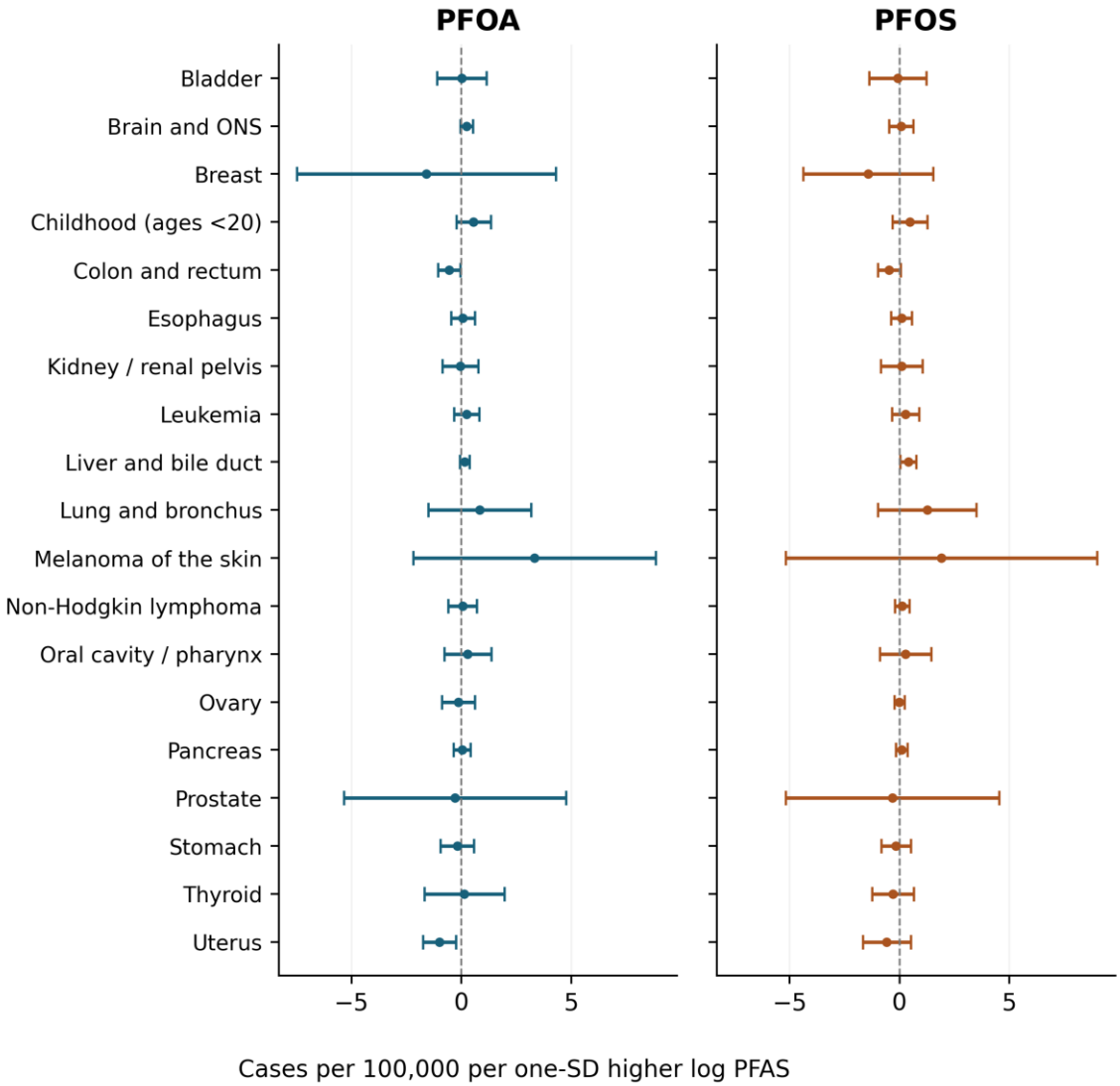



**Figure S1 | Primary county cancer coefficients.** Each point is the adjusted change in cases per 100,000 per one-SD higher log compound measure; bars are unadjusted 95% HC3 intervals. Models adjust for income and current smoking. ONS means other nervous system. No coefficient survives the 38-test FDR correction.

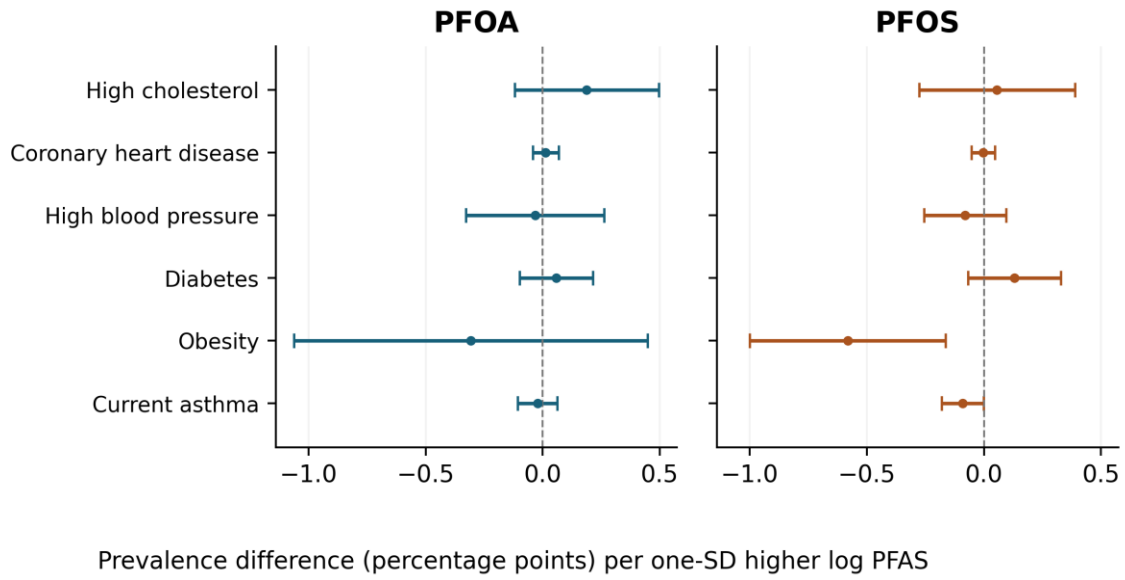



**Figure S2 | Primary county chronic-disease coefficients.** Each point is the adjusted prevalence percentage-point difference per one-SD higher log compound measure; bars are unadjusted 95% HC3 intervals. Models adjust for income, current smoking and lack of insurance. No coefficient survives 12-test FDR correction.

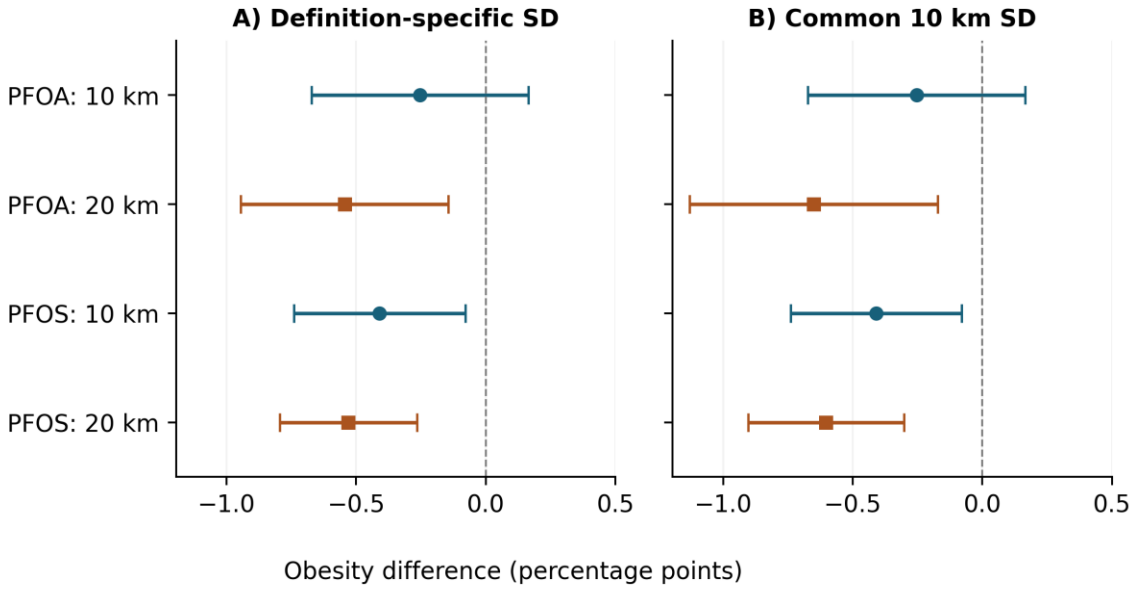



**Figure S3 | Exploratory obesity coefficients by monitoring radius.** Both radii use exactly the same 6,650 tract IDs. **A)** Each definition uses its own exposure standard deviation. **B)** Both use the 10 km standard deviation for the corresponding compound. Intervals are unadjusted and county-clustered; these matched reference comparisons do not establish protection.

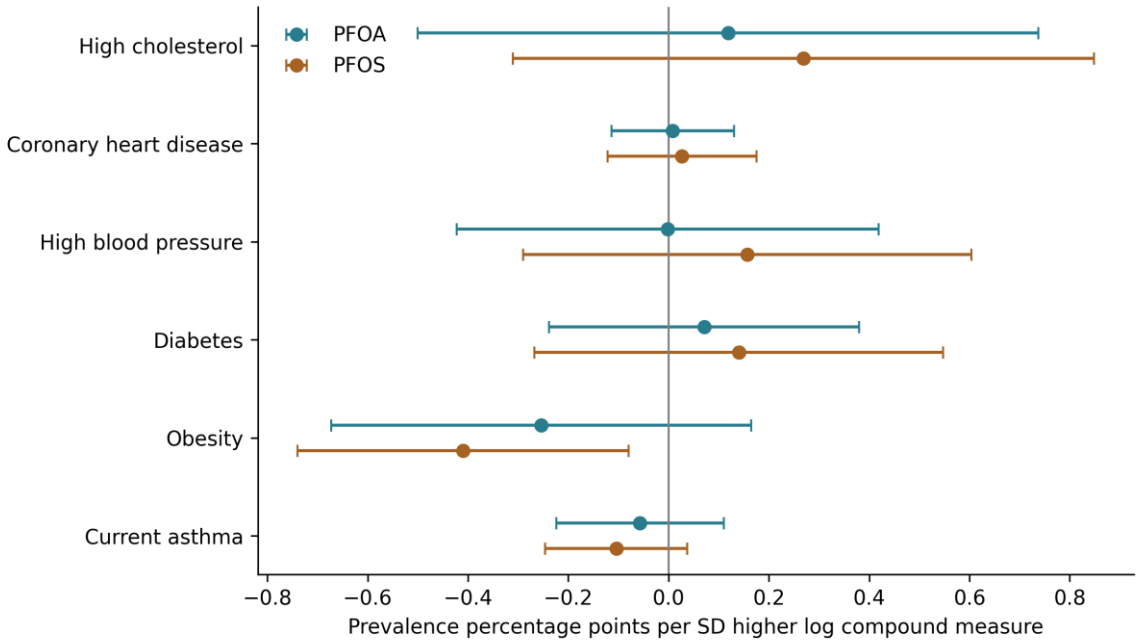



Figure S4 | Primary county-fixed-effects tract analysis. Separate PFOA and PFOS coefficients with clustered 95% confidence intervals are shown. None remained statistically significant after either correction.