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# Identifying Differences in U.S. Exposures to Ubiquitous Carcinogens

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# Identifying differences in U.S. exposure to ubiquitous carcinogens*

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**Abstract**

Cancer is one of the leading causes of death in the United States, and substantial racial-, ethnicity-, sex-, and income-based differences in cancer incidence and mortality persist despite declining overall trends. Underlying differences in exposure to carcinogenic chemicals are often cited as a likely factor contributing to persistent differences in the incidence of certain cancer types. In this exploratory analysis, we construct a novel database of actual or potential exposure to ubiquitous carcinogenic chemicals based on nationally-representative biomonitoring and environmental data to produce demographically-differentiated exposure statistics, where possible. Despite major data gaps – one or more measures of direct or indirect exposure were available for only 37% of these 622 carcinogens – our results show evidence of potential exposure disparities for at least 28 carcinogens. We also review readily-available information on exposure pathways and cancer types associated with these carcinogens to identify common pathways through which households may be exposed, and explore correlations between relative exposure levels and cancer incidence rates. We end the paper with a discussion of key data gaps and limitations that future data gathering and investigation could address.

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# 1 Introduction

Chemicals are commonly used and widely occurring in many products found in the home or used in the workplace (Helm et al., 2018; Dodson et al., 2012). Dust, furniture, and air samples indicate their presence in the indoor environment, and urine and blood samples confirm widespread exposure (Mitro et al., 2016; Schildroth et al., 2022). While exposure to some of these chemicals is nearly universal, researchers have documented substantial disparities in exposure to certain chemicals by race, ethnicity, income, and sex. For instance, studies have found that Mexican American and Non-Hispanic Black women are exposed to much higher levels of parabens and phthalates via personal care products, plastics, diet, and food packaging (Chan et al., 2021; James-Todd et al., 2016; Calafat et al., 2010). Others have found that low-income households are exposed to higher concentrations of volatile organic chemicals that off-gas from less-expensive furniture and building materials in older homes (Bi et al., 2018; Dodson et al., 2017). In addition, studies have observed that those highly exposed to one type of chemical are often highly exposed to other chemicals, including through outdoor and workplace exposure to environmental contaminants (Woodruff et al., 2011; Bertin et al., 2018; Kapraun et al., 2017). Exposure to a subset of these chemicals, individually or as part of mixtures, has been linked to adverse health effects such as higher incidence of pre-term births, gestational diabetes and other metabolic disorders, hypertension, and in some cases cancer, among specific populations.

The evidence cited above is based on the chemical content of specific products, location-specific surveys and sample collections, and national-level data for specific chemicals. In this paper, we contribute to the growing literature by combining multiple national-level datasets on actual or potential exposure to carcinogenic chemicals and calculating demographically-differentiated exposure statistics for individual chemicals where such information is available. We find the strongest evidence of potential exposure disparities for 28 carcinogens; for the chemicals arsenic, 1-naphthylamine, acrylonitrile, furan, 1,4-dichlorobenzene, 2,4-dichlorophenoxyacetic acid (2,4D), and ethylene oxide, at least three unique statistical measures indicate potential exposure disparities. We also explore broader demographic trends in carcinogen exposure. Though we observe that all of the demographic subgroups we examine likely experienced relatively high exposure to specific carcinogens, several measures indicate that non-Hispanic Black Americans – especially lower-income and male individuals – had the highest cumulative carcinogen exposure across the chemicals for which data are available. We emphasize that while these findings may identify potential disparities in exposure, they do not immediately imply national disparities in cancer hazard or risk.

As a complement to the exposure analysis, we identify what is known regarding the main pathways through which exposure to these 28 carcinogens may occur. We also discuss key data gaps where additional data gathering and future study could be useful. While it is beyond the scope of this paper to identify the contribution of individual carcinogenic chemicals to overall cancer risk, we also examine whether trends in national level incidence and mortality for specific cancer types associated with these chemicals seem consistent with demographically-differentiated exposure.

We focus our analysis on observed differences in individual or household exposure to commonly used and widely occurring (i.e., ubiquitous) carcinogenic chemicals. Cancer is the second leading cause of death in the United States, after heart disease. The National Cancer Institute estimates about 2 million new cancer diagnoses and more than 600,000 cancer deaths will occur in the United States in 2024 (NCI, 2024). Additionally, the financial burden of cancer care is substantial: annual medical care costs, alone, are expected to exceed $246 billion by 2030 in the United States (Mariotto et al., 2020). External factors such as lifestyle choice and exposure to toxic chemicals are major contributors to lifetime cancer risk (Wu et al., 2016). In

addition, while overall cancer rates have declined since the 1990s due to reduced use of tobacco products, early detection, and better treatment methods, Black individuals lag in early-stage diagnoses of cancer; Black women and people of color continue to have higher than average rates of cancer incidence; and individuals with lower socioeconomic status have higher mortality rates after being diagnosed with cancer (O'Keefe et al., 2015; Islami et al., 2024; Shaw et al., 2024).

The paper is organized as follows. Section 2 explains the methodology to identify ubiquitous carcinogens, gather exposure data from various sources, and classify carcinogens based on notable differences in exposure across demographic subgroups. Section 3 highlights our main findings: nationally-representative statistical measures of differential exposure to carcinogens by demographic (race, ethnicity, and sex) and economic categories (income level). We also summarize our findings on common exposure pathways and describe potential correlations between differences in exposure and disparities in cancer incidence by cancer type. In Section 4, we discuss the limitations of the analysis and note key data gaps. Section 5 concludes.

# 2 Methods

## 2.1 Scope of analysis

For our analysis, we combined multiple data sources that shed light on carcinogenic chemicals that are widely occurring in the environment, at home, and in the workplace. To set the scope of our analysis, we first determined the universe of carcinogenic chemicals eligible for our analysis, established criteria for classifying ubiquity, and then selected the main data sources for use in identifying national-level demographic differences in exposure.

### 2.1.1 Scoping chemicals on carcinogenicity

Several international, federal, and state agencies classify and maintain lists of carcinogens, and while there is substantial overlap, differences exist. In an attempt to be inclusive, we compiled a super-list of the carcinogens appearing on one or more of several lists, without favoring one institution over another, and we considered known, probable and possible carcinogens. Specifically, we included carcinogenic chemicals on the International Agency for Research on Cancer's (IARC) Group 1 (known carcinogens), IARC Group 2A (probable carcinogens), and IARC Group 2B (possible carcinogens) lists; known and reasonably anticipated human carcinogens from the National Toxicology Program's Report on Carcinogens (RoC); cited carcinogens from both the European Union and United Kingdom Candidate Lists for Substances of Very High Concern (SVHC); and cited carcinogens from California's Proposition 65 list.

After compiling the carcinogenic chemicals that appear on these source lists, we removed duplicates, and then matched them to the U.S. Environmental Protection Agency's (EPA) CompTox Chemicals Dashboard based on the Chemical Abstracts Service (CAS) registry number.[1] We then standardized all chemical names to the preferred name listed in the dashboard (Williams et al., 2017). Carcinogens without a CAS number or CompTox identification number (DTXSID) and those directly related to radiation, viruses, alcohol, and

[1] A CAS number is a unique identification number assigned to every chemical substance described in the open scientific literature since 1957. The CompTox Chemicals Dashboard is a free, searchable online repository of information on the chemistry, toxicity, and exposure of thousands of chemicals. It is maintained and updated regularly by the U.S. EPA. See `https://comptox.epa.gov/dashboard/`.

tobacco were considered out of scope for this exercise and dropped from the sample.[2] In total, we identified 727 chemicals as within scope for carcinogenicity.

#### 2.1.2 Scoping chemicals on ubiquity

We also limited the scope of our analysis to chemicals that can be considered ubiquitous in the human environment based on currently available data sources. Chemical ubiquity as a scientific construct remains ill-defined and ambiguous, so we explored several readily-available metrics to inform our scoping exercise. For each of the 727 carcinogens identified, we assessed whether the chemical was (1) active on EPA's Toxic Substances Control Act (TSCA) Inventory (EPA, 2024b); (2) produced in or imported to the US per the EPA's 2020 Chemical Data Reporting database (EPA, 2020); or (3) reported in the harmonized Multimedia Monitoring Database (Isaacs et al., 2022). We also assessed the chemical's (4) numeric count of related patents per PubChem (Kim et al., 2018) and (5) numeric count of scientific articles in which a chemical was mentioned per PubChem (Kim et al., 2016).[3]

We eliminated any chemical from our sample that satisfied none of (1)-(3) **and** also fell at or below the 25th percentile for either criteria (4) or (5). Jointly, these scoping requirements restricted our focus to carcinogens that are actively used or produced at volume, specialty chemicals with substantial patenting and research activity, or legacy carcinogens which are/were environmentally monitored by governmental agencies.[4]

In total, 105 chemicals did not meet these criteria, leaving 622 ubiquitous carcinogens as candidates for our analysis. 223 chemicals (36%) were on only one carcinogen source list, 230 chemicals (33%) were on two source lists, 173 chemicals (27%) were on three source lists, and 28 (4%) were on all four source lists. See panel A of Appendix Table A1 for additional details. This variance in carcinogen classification across authoritative source lists lends some prima facie support for our inclusive scoping approach.

#### 2.1.3 Scope of exposure data considered

We focused our analysis on nationally-representative data. While additional insights would likely result from reviewing alternative data sources including the academic literature, location-specific study samples, state or local governments, or community-generated activities, the primary purpose of this analysis is to screen for notable national-level differences in chemical exposure using readily-available public information.[5] We leave a systematic review of alternative data sources for future work.

### 2.2 Datasets and analytical approach

We conducted four separate descriptive statistical exercises to assess the extent of differences in exposure across demographic subgroups to the chemicals on our candidate list of 622 carcinogens.

Our first analysis used direct measures of exposure – biomonitoring data – while the other three analyses relied on indirect environmental measures of possible exposure - in the ambient air, in drinking water, and

[2]While some chemicals without CAS Numbers are recognized as possible or probable carcinogens they were dropped from consideration for this analysis because they are more difficult to link to exposure data. A full list of candidate carcinogens and their scoping attributes are available in supplemental Appendix Table E1

[3]PubChem is an open chemical database maintained by the U.S. National Institutes of Health.

[4]While legacy carcinogens may not be ubiquitous in terms of active production, exposure remains an ongoing problem. See, for example, Barr et al. (2022), Sun et al. (2016), McGoldrick and Murphy (2016).

[5]While scoping the national availability of biomonitoring data, we contacted several state biomonitoring programs to see if they could supplement the chemical coverage available through NHANES. Ultimately, additional chemical coverage was limited, so we retained a focus on national biomonitoring data. A summary of findings from this outreach is available in Appendix D.

via purchase and use of consumer products. This section describes the data sources and analytical methods used. All data processing and analysis were conducted using scripts written in the R language (version 4.4.0), which are available in an online appendix.

### 2.2.1 Analysis of NHANES biomonitoring data

The natural starting point for assessing chemical exposure is biomonitoring data. These data provide a direct measure of the amount of a chemical found in the human body via all possible routes of exposure, including inhalation, ingestion, and dermal absorption. There are two types of biomarker samples generally available: blood/serum samples and urine samples. Blood/serum samples are most useful for understanding exposure to chemicals with longer half-lives (residing in the body for months to years) or steady-state ubiquity but can be challenging to collect. Some examples of suitable chemicals include polychlorinated biphenyls (PCBs), per- and polyfluoroalkyl substances (PFAS), and metals. Urine samples are more useful for understanding exposure to chemicals with shorter half-lives (residing in the body for hours to days) such as phenols and tobacco but results can be highly variable across time (LaKind et al., 2014; Aylward et al., 2014). While biomarker concentrations are de facto evidence of exposure intensity, several factors may complicate the relationship between true exposure levels and biomarker concentrations (Tan et al., 2012). Given the lack of alternative national-level data sources, we nonetheless relied on biomarker concentrations as a proxy of carcinogen exposure.

We used chemical-specific biomonitoring data collected via blood, serum, and urine samples from the U.S. population as part of the National Health and Nutrition and Examination Survey (NHANES) administered by the Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics. This survey has been conducted periodically, including the 1988-1994 survey, and continuously since 1999 with data acquired and released at two-year intervals (i.e. survey cycles). Though the survey cycle is on a two year schedule, the analytes evaluated for a given cycle have varied over time.

While the CDC produces disaggregated national biomonitoring summary statistics for a select set of demographic subgroups (CDC, 2024), we used the underlying NHANES microdata, which allowed us to create national exposure summary statistics further stratified by intersections of age, sex, household income, and race/ethnicity (CDC, 2020). This analysis primarily relied on a merged and harmonized version of the continuous NHANES data; we analyzed examination-level biomonitoring samples drawn from individuals between 2003-2004 and 2017-2018 (Nguyen et al., 2023). For a subset of biomonitored chemicals – namely, organochloride pesticides, dioxins/furans, PCBs, and brominated flame retardants – the most recent samples available are based on pooled measurement. In those cases, we directly acquired and relied on the original, unharmonized NHANES microdata from the 2011-2012 and 2015-2016 cycles (CDC, 2020).

We examined blood, serum, and urine biomarkers only for chemicals that were on the ubiquitous carcinogen list. We followed best practices in the use of NHANES: examination or subsample survey weights were used to account for NHANES' sampling design (Nguyen et al., 2023; CDC, 2020), efforts were taken to ensure metabolites of carcinogens were correctly assigned to the parent chemical (Stanfield et al., 2024), and the analysis followed the CDC's convention of not reporting geometric mean estimates for stratification subgroups with >40% of test results below the reported limit of detection (CDC, 2024).[6] We also did not report geometric mean estimates for a carcinogen if >40% of all national test results were non-detects. For carcinogens included in multiple NHANES cycles, statistics were based on only the most recent cycle of

[6]We imputed a value of $\frac{LOD}{\sqrt{2}}$ for samples below the detection limit when reporting geometric mean values. This is a common approximation method of censored values below the detection threshold for screening work of this nature.

data.[7] In total, 106 of the 622 candidate carcinogens (17%) were surveilled in NHANES by blood, serum or urine – directly or via a metabolite – at least once since 2003. 74 carcinogens were only monitored directly, 21 carcinogens were only monitored via a metabolite, and 11 carcinogens were monitored both directly and by a metabolite.[8]

For each carcinogen and/or metabolite with individual-level biomonitoring data, we calculated the national geometric mean and 95th percentile concentrations for several demographic subgroups of interest. Our primary results focused on exposure differences by sex, race/ethnicity, and household income, and relied on samples from all age groups. In supplemental results, we also assessed statistical decompositions by age, interactions of sex and race/ethnicity, and interactions of household income and race/ethnicity.[9] Of the 106 surveilled carcinogens, only 39 (6% of candidate carcinogens) had a sufficient count of samples above the limit of detection for complete geometric mean estimates stratified by race/ethnicity, sex, and household income. Therefore, our primary analysis also considered subgroups' 95th percentile concentrations, for which a broader set of 62 carcinogens (10% of candidates) can be analyzed. See Appendix Table A2 for a list of carcinogens matched to NHANES biomonitoring data and further information on the analyzable subsets.

Based on these statistics, we extended the methods of Belova et al. (2013) and Nguyen et al. (2020) and screened for exposure differences across subgroups using both geometric mean ratios and 95th percentile ratios as metrics:

$$GMR_{bcs} = \frac{GM_{bcs}}{GM_{bcr}} \qquad (1) \qquad\qquad PR_{95,bcs} = \frac{P_{95,bcs}}{P_{95,bcr}} \qquad (2)$$

We defined the geometric mean ratio ($GMR$) as the ratio between the geometric mean of biomarker $b$ for chemical $c$ in subgroup $s$ and the geometric mean of that chemical biomarker in a reference group $r$. Analogously, the 95th percentile ratio ($PMR_{95}$) is defined as the ratio between the 95th percentile of biomarker $b$ for chemical $c$ in subgroup $s$ and the 95th percentile of that chemical biomarker in a reference group $r$. For ease of comparability across all of the different subgroups considered, we selected the entire national population as the reference group.

Turning to the 10 matched carcinogens with pooled biomonitoring data, we elected to calculate arithmetic mean concentrations by demographic subgroup. Calculation of geometric mean or percentile statistics for these carcinogens would be assumption-laden and computationally challenging due to the pooled nature of the data and the survey's complex sampling design. Instead, we followed the CDC's standard practice in using these pooled data and assessed arithmetic means differentiated by race/ethnicity, sex, and age (CDC, 2021a). Only 5 of the 10 carcinogens (1% of all candidate carcinogens) had a sufficient count of samples above the limit of detection for a complete set of arithmetic mean estimates stratified by race/ethnicity and sex. We used these estimates from the pooled data to calculate arithmetic mean ratios ($AMR$s) analogous to the geometric mean ratio described above, again using the entire national population as the reference group.

[7] The most recent cycle varied by chemical: the earliest cycle considered in this analysis was from 2003-2004 and the latest was from 2017-2018.

[8] These 106 chemicals are a broad mix of known, probable, and possible carcinogens; see panel B of Table A1 for a summary. NHANES selects chemicals based on evidence of exposure, known/potential health impacts, availability of analytical methods, and cost.

[9] Decompositions by sex are male or female; by household income, below two times the poverty line or above two times the poverty line; by race/ethnicity, non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic Other; by age, younger or older than 20 years. See Appendix C for additional details of the NHANES data construction.

### 2.2.2 Analysis of RSEI air data

In the absence of more complete biomonitoring coverage, we analyzed three additional data sources that provide indirect measures of exposure to specific chemicals via environmental contaminant pathways. We first examined potential exposure to individual carcinogens emitted into the air by industrial facilities. Research has shown that households residing in proximity to airborne industrial releases face increased risks of adverse health effects, including cancer, and that these neighborhoods are often home to lower-income, racial/ethnic minority, or non-native-English-speaking populations (Brender et al., 2011; Madrigal et al., 2024). We conducted an analysis of EPA's Risk-Screening Environmental Indicators (RSEI) geographic microdata using a spatially aggregated version of these data that provide average airborne concentrations of each chemical reported to the Toxics Release Inventory (TRI) at the census block group (CBG) resolution (EPA, 2022).[10]

After filtering the 2022 RSEI air data to only include chemicals on the ubiquitous carcinogen list, we matched CBG-level air concentrations of individual carcinogens to CBG-level sociodemographic information from the Census Bureau's latest available five-year (2018-2022) American Community Survey (Census, 2022). In total, 186 carcinogens from the candidate list are represented in the data. For each of these carcinogens, we separately calculated population-weighted national average airborne concentrations ($Conc^*_{cs}$) for subgroups of different races/ethnicities and by household poverty status:

$$Conc^*_{cs} = \sum_I \frac{Conc_{ic} Pop_{is}}{Pop_s} \tag{3}$$

where $I$ indexes the national set of census block groups, $Conc_{ic}$ is the average annual concentration of chemical $c$ in block group $i$, $Pop_{is}$ is the population count of demographic subgroup $s$ in block group $i$, and $Pop_s$ is the national population count of subgroup $s$. To ensure mutual exclusivity, we considered the following self-identified race and ethnicity subgroups: non-Hispanic Asian, non-Hispanic American Indian, non-Hispanic Black, non-Hispanic Pacific Islander, non-Hispanic White, and Hispanic. We also considered income-based subgroupings, differentiating households earning less than twice the poverty line and households earning more than twice the poverty line. Using each subgroup's nationally-weighted average concentration, we calculated carcinogen-specific relative ambient air concentration ratios as in Equation 1, again with the national average concentration for the carcinogen as the reference value. These ratios are nationally representative, as all census block groups were included.

### 2.2.3 Analysis of EPA drinking water samples

We next examined potential exposure to individual carcinogens present in public drinking water. Previous national-scale research has shown demographic subgroups face inequalities in exposure to individual chemicals present in public drinking water (Hefferon et al., 2024; Martinez-Morata et al., 2022; Nigra et al., 2020; Ravalli et al., 2022). We collected and harmonized the universe of EPA's drinking water sampling data from community water systems (CWS) for chemicals sampled via the Six Year Review process (SYR) and Unregulated Contaminant Monitoring Rules (UCMR). Our analysis only included sampling results for chemicals on the ubiquitous carcinogen list; this exercise resulted in millions of drinking water samples for 70 matched carcinogens, with temporal coverage spanning 2006 to 2019 from SYR3 through SYR4 (EPA, 2016b;

[10] These data input self-reported facility-level air emissions from the TRI into a medium-complexity fate-and-transport model over a spatial 810m by 810m national grid to develop estimates of the average airborne concentration of a specific TRI-reported chemical in a given grid cell. These grid cell averages are then spatially aggregated up to the census block group geography.

EPA, 2022b) and 2008 to 2020 from UCMR2 through UCMR4 (EPA, 2024a).

Every sample in the database is attributed to a single CWS. For each CWS, we calculated an average carcinogen concentration based on all of the system's collected samples from 2006-2020. Of the 70 matched carcinogens, only 15 had a sufficient count of samples with concentrations above the limit of detection for calculation of meaningful CWS-level averages.[11] We used information from Austin et al. (2024) on the demographic characteristics of residents within each CWSs' service area boundaries – namely, the total population count, the fraction of the population identifying as a specific race or ethnicity, and the fraction of the population earning income above and below 2x the poverty line, all as of 2022. With this information, we calculated population-weighted average carcinogen concentrations in drinking water ($DW^*_{cs}$) for each demographic subgroup:

$$DW^*_{cs} = \sum_J \frac{DW_{jc} Pop_{js}}{Pop_s} \tag{4}$$

where $J$ indexes the complete set of CWSs included in our sampling database, $DW_{jc}$ is the average concentration level of carcinogen $c$ in the drinking water of CWS $j$, $Pop_{js}$ is the population count of demographic subgroup $s$ in CWS $j$, and $Pop_s$ is the national population count of subgroup $s$ across all CWSs in our sampling database. With these average drinking water concentrations, we calculated carcinogen-specific relative concentration ratios for each racial/ethnic or household income subgroup as in Equation 1, again with the national average drinking water concentration for the carcinogen serving as the reference value. These relative concentration ratios serve as a proxy of differences in exposure via drinking water.

#### 2.2.4 Re-analysis of Stanfield et al. household product data

Our third and final analysis of potential differences in indirect exposure examined carcinogens present in household products. Stanfield et al. (2021) linked a year's worth of nationally-representative consumer product purchasing data from Nielsen with information on chemicals present in specific products from EPA's Chemical and Products Database (Dionisio et al., 2018). With this information, Stanfield et al. (2021) assessed how possible chemical co-exposures varied across demographics due to real-world purchasing patterns.

We accessed relevant portions of the 2021 paper's data, and re-purposed them to analyze the extent of differences in exposure to carcinogens via consumer products. The underlying Nielsen product purchasing data are monthly observations from 60,000 participating households for the year 2012. While there have certainly been changes to consumer markets' product and chemical mix over the ensuing decade, but we are unaware of any other readily available data of this type that has been linked to product chemical information. We found a total of 44 carcinogens from the candidate list reflected in these household purchasing and products data. See Stanfield et al. (2021) for details of the monthly household-chemical panel data construction.

We measured the *national prevalence* of potential exposure to a given carcinogen via household products as the fraction of total household-months that the chemical appears in the purchased bundle:[12]

$$Prev^*_c = \frac{\sum_H \sum_T \mathbb{I}_{cht}}{HT} \tag{5}$$

[11] See Appendix C for a description of data processing, including imputation methods for non-detect samples and a list of matched carcinogens. These data were generally representative of the US population that receives public drinking water from a CWS with SYR and UCMR samples. For the 15 carcinogens studied, 12 statistics represented >200 million Americans, and 1 statistic each represented >140 million, >32 million, and 90,000 Americans, respectively.

[12] For example, in a 60,000 household panel over 12 months, there were 720,000 observations. If a carcinogen showed up in the purchased good bundle for 360,000 household-months, our national prevalence measure would be 0.5.

where $H$ indexes the complete set of households in the Nielsen data, $t$ indexes the monthly time component of the panel data (with $T = 12$), and $\mathbb{I}_{cht}$ denotes an indicator that the household-month goods bundle contained carcinogen $c$. We calculated analogous disaggregated chemical purchase prevalence statistics for households with lower- or higher-income levels, members of a of racial/ethnic subgroup (Hispanic, Asian, Black, White), or which include a female of childbearing age (<45 years old):

$$Prev^{*}_{cs} = \frac{\sum_{H_s} \sum_{T} \mathbb{I}_{scht}}{H_s T} \tag{6}$$

where $H_s$ indexes the set of households that were members of subgroup $s$. Again following from Equation 1, we defined our measure of potential differences in exposure to a carcinogen via use of household products as the ratio of a given subgroup's purchase prevalence and the overall national purchase prevalence.

## 2.3 Synthesizing analyses to identify potential exposure disparities

With the set of differentiated exposure measurements described above, we identified at least one source of exposure for analysis for 230 (37%) of the 622 identified ubiquitous carcinogens. The final task was to synthesize statistics that identify the subset of these carcinogens with the strongest evidence of potential exposure disparities. To do this, we operationalized a set of selection criteria that balance the body of evidence available with tractability, consistency and a predisposition to inclusiveness in marginal cases.

Our primary screening for potential exposure disparities identified any carcinogen that met at least one of the following criteria based on the analyses described above:

1. NHANES geometric or arithmetic mean ratio greater than 1.5 for any primary demographic subgroup[13];
2. NHANES 95th percentile ratio greater than 1.5 for any primary demographic subgroup;
3. At least two of the measures of indirect exposure to chemicals (i.e. via ambient air, drinking water, or consumer product purchases) scored greater than 1.5 for any subgroup.

A uniform inclusion threshold value across the different criteria ensures comparability across exposure metrics and data sources. Direct evidence of differences in exposure (via biomonitoring metrics) was implicitly given heavier weight than indirect evidence. By using a value of 1.5 as the primary inclusion threshold, this approach highlighted the set of chemicals where potential disparities are most evident; a subgroup with a ratio value of 1.5 faces 50% more exposure than the nationally-representative level. In supplemental results, we also tested (i) an alternative threshold value of 1.25 and (ii) alternative NHANES-based inclusion criteria, which considered results from demographic interactions of race/ethnicity, household income, sex, and age. Throughout the results section, we note any instances where findings meaningfully differed under these alternative criteria.

## 2.4 Assessing potential exposure pathways

For all carcinogens identified based on these primary criteria, we also reviewed readily available evidence from several sources to inventory their major exposure pathways. Epidemiologists and the broader risk assessment community have compiled an immense body of research studying exposure to potential and known hazardous

[13]The primary demographic subgroups considered for the NHANES analyses include {Hispanic, non-Hispanic Black, non-Hispanic White, non-Hispanic Other, household income below 2x poverty line, household income above 2x poverty line, female sex, and male sex}.

agents. Generally speaking, exposure assessment focuses on measuring the duration, frequency, and source of exposures, and is ultimately integrated with a separate hazard and dose-response assessment to characterize risks to groups and the general population (EPA, 2019). In regulatory or policy work, exposure assessment is often highly targeted, looking at potential exposure risk for specific population subgroups (e.g., agriculture workers, industrial workers, children, consumers) or via certain products and product categories that are known to contain hazardous agents. As such, the format of exposure assessments – and exposure research more broadly – is varied, their publication locations are diffuse, and unfortunately, there is not a "one-stop-shop" for researchers aiming to compile the entirety of the available literature and secondary data relating exposure pathways to a given chemical agent.

We therefore took a tractable but ultimately limited approach to assessing potential exposure pathways for the carcinogens with notable differences in exposure. We did this by reviewing readily available evidence from several authoritative sources and categorizing the major exposure pathways that could be contributing to exposure disparities. These sources include CompTox, PubChem, Haz-Map, and NTP's 15th Report on Carcinogens (Williams et al. (2017); Kim et al. (2023); Brown (2024); NTP, 2021)[14]. Using all available information from these sources, we compiled common exposure pathways and associated product categories for each chemical. We additionally derived summaries of cancers associated with each carcinogen, separately noting when the association was based on animal or epidemiological (human) evidence.

We reviewed and presented exposure and use information in two separate but related ways. To reflect common ways of considering sources of vulnerability to chemicals, we explored **product categories** and **routes of exposure**. The former focused on classifications of products used in the home or workplace, reflecting frequently-used objects and materials that might contain carcinogens that pose a hazard. The latter focused on the activities and environments in which a chemical is used or otherwise present. We separately explored routes for general population and occupational exposures.[15] These characterizations of exposure overlapped, but each provided an angle for considering the "where" and "how" of chemical exposure.

To classify product categories for each carcinogen, we began by adapting CompTox's Chemical and Products Database (CPDat) categories, which were constructed using the methods described in Isaacs et al. (2022) for use in risk assessment. We focused on CPDat's highest-aggregation-level of product use categories in households and in industry, and expanded the set to include other major product types found across the remaining three search sources. Most carcinogens for which we found exposure disparities are used in multiple products types. For example, as a preview of our findings, in Figure A5 we observed that nearly all of our identified carcinogens with likely exposure differences are in multiple product categories, and more than half of them are associated with 5 or more.

We then delineated exposure pathways by their capacity for general population and occupational exposure, noting the activities and places in which exposure to carcinogens is possible (e.g. on furniture in the home, through art or office-related materials, in agricultural settings). We stopped short of exploring specific mechanisms or estimating the likelihood of exposure via a particular pathway, lacking enough data to consistently and confidently suggest the intensity of use or extent of influence a given classification has on vulnerability.

Finally, using the same set of databases described above plus the IARC Monographs (IARC, 2024),

[14]For more information, hyperlinks here: CompTox, PubChem, ROC15, Haz-Map.

[15]We included both general population and occupational exposure to differentiate chemicals that are strictly industrial from those that may pose risk through everyday activities. This was in part to identify chemicals which have a "double incidence", where workers may be exposed at home and at work to the same chemical, and in part to develop a better understanding of the types of chemicals to which different subpopulations are at greater risk based on their activities and occupation

we identified the forms of cancer and exposure types (e.g. inhalation, dermal, etc.) associated with each carcinogen. Because there is variability in the completeness and update frequency of each source database, we were inclusive of all listed exposure types and forms of cancer. For carcinogens with more thorough exposure and toxicological information available in the source databases – especially those with noted associations to particular cancer types in RoC and IARC reports – we emphasized the most recent available information on carcinogenicity and exposure/use. In many cases, however, the available information is limited or decades old.

# 3 Results

We begin by summarizing results on potential exposure disparities. Section 3.1 provides an overview of our findings based on the biomonitoring data, while section 3.2 summarizes our findings based on each of the indirect exposure data sources. For each individual analysis, we highlight (1) which carcinogens had the strongest evidence of potential exposure disparities, and (2) instances where media-specific evidence suggested differences in cumulative exposure to multiple carcinogens may exist. Next, in section 3.3 we discuss our cross-media synthesis of the exposure results and highlight carcinogens for which evidence was strongest. In section 3.4, we leverage additional information to better understand the main exposure pathways for each of the identified carcinogens in sections 3.1 and 3.2. Section 3.5 describes the extent to which cancer types associated with these carcinogenic chemicals also demonstrated disparities in national cancer incidence by race, ethnicity, and sex.

As a final point before presenting results, we emphasize that the following simply calls attention to **exhibited differences in exposure**; the results that follow **do not** immediately imply or explain national disparities in cancer hazard or risk. We assessed relative differences in exposure levels – not absolute exposure levels – and therefore cannot speak to potential risk. More formal risk assessment work is outside the scope of this analysis, which can best be characterized as an initial evaluation indicating areas where in-depth investigation could be beneficial.

## 3.1 Direct measures of exposure: NHANES biomonitoring data

### 3.1.1 Geometric mean ratios

We start by discussing the geometric mean (GM) ratio results. We had a sufficient fraction of detected biomarker samples to calculate GM ratios for 42 carcinogen metabolites and parent chemicals (representing 39 carcinogens in total). Of those, 13 total carcinogens – measured as 5 parent chemicals and 7 metabolites – returned a GM ratio of 1.5 or greater for at least one primary demographic subgroup. Figure 1 provides an overview of these results.

Panel (a) presents the distributions of GM ratios across all of the detected chemicals. These distributions are shown separately for each primary demographic subgroup. A few findings are visually striking. We found that the distribution of GM ratios for lower income individuals was skewed slightly higher than the distribution for higher income individuals. Similarly, the distribution of GM ratios for males was centered at a higher median value than it was for females. And while the GM distributions for Hispanic, non-Hispanic White, and non-Hispanic Other subgroups were all centered at median values close to 1, the GM ratio distribution for the non-Hispanic Black subgroup had a median value of greater than 1.25 and a considerable right tail. This last result evidences higher than national average exposure to a substantial number of

detectable chemicals for the average non-Hispanic Black American.

Panel (b) lists the subset of individual chemicals for which at least one primary demographic subgroup had a GM ratio of 1.5 or greater. We highlight some of the findings here. Lower income, Hispanic, and non-Hispanic Black subgroups showed high exposure to 1,4-dichlorobenzene (as measured by its metabolite 2,5-dichlorophenol) relative to the national average. Of particular note for 1,4-dichlorobenzene – a common ingredient in mothballs, deodorant cakes, and insecticides – the GM ratio for non-Hispanic Black individuals was 6.15, congruent with exposure levels more than 600% above the national average. GM ratios for the legacy pesticide nitrofen (as measured by its metabolite 2,4-dichlorophenol) showed potentially elevated exposure levels for Hispanic and Black individuals.[16] The tobacco-specific carcinogen NNK (as measured by its metabolite NNAL) was found to have elevated GM ratios for lower-income and non-Hispanic Black subgroups.[17] And finally, to re-emphasize a key finding, non-Hispanic Black individuals showed elevated exposure to 11 of the 13 carcinogens for which we observed *any* GM ratio of greater than 1.5, including ubiquitous carcinogens like acrylonitrile, naphthalene, acrolein, and carbaryl (i.e. 1-Naphthalenol, 1-(N-methylcarbamate)). The complete set of GM ratio results for primary demographic subgroups – including chemicals without any detected GM ratio above 1.5 – is provided in Table A4.

*Demographic interaction results*

In supplemental results, we also assessed GM ratios by demographic interactions of sex and race/ethnicity and demographic interactions of household income and race/ethnicity. These additional GM ratio results are available in Table A5, with subgroups' distributions visualized in panel (a) of Figure A2. We briefly summarize key takeaways here. The elevated incidence of GM ratios greater than 1.5 for the non-Hispanic Black subgroup was particularly pronounced among males and lower-income individuals. In addition to the chemicals noted in the primary analysis, Black males and lower-income Black individuals presented with GM ratios greater than 1.5 for several more chemicals of note, including ethylene oxide (ratio = 1.79), ethylbenzene (ratio = 1.53), crotonaldehyde (ratio = 1.62), acrylamide (ratio = 1.76), and 4-biphenylamine (ratio = 1.56). Most of these are components of tobacco smoke, but the first two are also commonly used in industrial and manufacturing settings. GM ratios for non-Hispanic males of an "Other" race implied relatively high exposure to arsenic (ratio = 1.87) and melamine (ratio = 2.13).

*Age-differentiated results*

In supplemental results, we also assessed GM ratios by age group. These additional GM ratio results are available in Table A6, with subgroups' distributions visualized in panel (b) of Figure A2. We briefly summarize key takeaways here, emphasizing exposure disparities that affect children. When considering GM ratios strictly differentiated by age group (age 19 and younger or age 20+), we did not identify any values greater than 1.5. Nevertheless, several carcinogens presented markedly higher GM ratios for the 19 and younger age group than the 20+ age group; these included di(2-ethylhexyl) phthalate (DEHP, ratio = 1.43), tris(2-chloroethyl) phosphate (TCEP, ratio = 1.44), and 2,4-dichlorophenoxyacetic acid (2,4D, ratio = 1.28). Joint consideration of age and race/ethnicity while assessing GM ratios turned up several interesting

[16] Interestingly, 2,4-dichlorophenol is also a metabolite of the still widely-used pesticide 2,4-dichlorophenoxyacetic acid (known more commonly as 2,4D); the elevated GM ratios for the metabolite 2,4-dichlorophenol contrasted with direct biomonitoring results for 2,4D that showed no evidence of exposure disparities across subgroups.

[17] The formal chemical name for NNK is 4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone. The formal chemical name for NNAL is 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol.

results. The GM ratio for TCEP was highest among non-Hispanic White individuals aged 19 and younger (ratio = 1.54), and melamine exposure was highest on average for non-Hispanic "Other" individuals aged 19 and younger (ratio = 2.32). Many of the elevated relative exposure levels identified above for the broader non-Hispanic Black subgroup were driven by higher values for those aged 20 and greater, but there were exceptions. GM ratios for non-Hispanic Black individuals aged 19 and younger were greater than 1.5 for di(2-ethylhexyl) phthalate (ratio = 1.79) and malathion (ratio = 1.79). The former chemical is a widely-used plasticizer, while the latter is a common insecticide. Moreover, the sizable difference in exposure we identified for 1,4-dichlorobenzene appeared strongest among non-Hispanic Black individuals aged 19 and younger (ratio = 7.31, versus ratio = 5.81 for Black individuals aged 20+).

### 3.1.2 Arithmetic mean ratios

We next turn to a discussion of the arithmetic mean (AM) ratio results for the set of chemicals biomonitored *with pooled samples*. There were a sufficient fraction of detected biomarker samples to calculate AM ratios for 21 carcinogens in total; 17 of these are individual PCB compounds, 2 are legacy organochlorine pesticides, 1 is a polybrominated biphenyl (PBB) compound and 1 is a chlorinated dibenzofuran.[18] Of those, 9 carcinogens returned a GM ratio of 1.5 or greater for at least one primary demographic subgroup. Figure 2 provides an overview of these results.

Panel (a) presents the distributions of AM ratios across all of the 21 detected chemicals, shown separately for each primary demographic subgroup. And again, panel (b) lists the subset of individual chemicals for which at least one primary demographic subgroup had a AM ratio of 1.5 or greater. With the exception of relatively high exposure to the legacy organochlorine pesticide DDT (ratio = 2.01), the distribution of AM ratios for Hispanic individuals fell entirely below a value of 1. The AM ratio distribution for the non-Hispanic Asian subgroup, however, had a long right tail; we observed elevated exposure levels relative to national averages for DDT (ratio = 3.42), another legacy organochlorine pesticide beta-hexachlorocyclohexane (ratio = 9.22), and seven individual PCBs. For all other demographic subgroups, we did not find evidence of substantially different exposure levels among this set of 21 carcinogens.

*Sex- and Age-differentiated results*

In supplemental results, we also assessed AM ratios differentiated by sex and age group. These additional AM ratio results are available in Table A8 and Table A9, with subgroups' distributions visualized in Figure A3. For the subset of chemicals considered here, two additional findings are worth noting. First, exposure levels were generally higher for the age 20+ subgroup. This held across all races and ethnicities and aligns with the fact that all 21 chemicals analyzed here are no longer in active use. Second, exposure to PCBs among the non-Hispanic Asian subgroup appeared more elevated for females, while exposure to DDT was relatively higher among males.

### 3.1.3 95th percentile ratios

Due to the limited number of individually-surveilled carcinogens for which we can calculate GM ratios, we next turn to a secondary biomonitoring analysis of 95th percentile ratios. These statistics inform us about cross-subgroup differences that may exist *among the most highly exposed individuals*. While there is no

[18] In our cross-analysis synthesis in Section 3.3, we treated all PCBs as a single carcinogen class, but in the results here we presented separate statistics for individual PCB compounds.

inherent reason that subgroups' P95 and GM ratio measures should be correlated, one might be curious how well the former metric can serve as a proxy for the latter. In this particular context, we found limited evidence of such correlation.[19] When calculating ratios disaggregated only by age or only by race/ethnicity, one could make a modest case for the P95 ratio acting as a meaningful signal of the GM ratio, but for all other disaggregations these correlations were weaker. Nevertheless, P95 ratios were informative of possible exposure disparities in their own right; EPA's Guidelines for Human Exposure Assessment suggest consideration of high-end exposure levels to ensure protection of potentially exposed or susceptible subpopulations (EPA, 2019).

There were a sufficient fraction of detected biomarker samples to calculate P95 ratios for 75 carcinogen metabolites and parent chemicals (representing 62 carcinogens in total). Of those, 14 total carcinogens – measured as 8 parent chemicals and 6 metabolites – returned a GM ratio of 1.5 or greater for at least one demographic subgroup. Figure 3 provides an overview of these results.

Panel (a) presents the distributions of P95 ratios across all of the detected chemicals, shown separately for each primary demographic subgroup. These distributions were similar to those observed when assessing the GM ratios, though nuanced differences existed. The distribution of P95 ratios for lower income individuals was again skewed higher than the distribution for higher income individuals. For Hispanic, non-Hispanic Other, and non-Hispanic White subgroups, the distributions were again centered at median values close to 1, though the dispersion of the latter's distribution was considerably tighter than the others. The P95 ratio distribution for the non-Hispanic Black subgroup again had a median value of greater than 1.25 and upper tail extremes larger than observed in the subgroup's GM ratio distribution.

Panel (b) lists the subset of individual chemicals for which at least one primary demographic subgroup had a P95 ratio of 1.5 or greater. Many of the chemicals that had at least one GM ratio above 1.5 also appeared on this "high-end" exposure list. Among others, these included 1,4-dichlorobenzene (non-Hispanic Black ratio = 12.67), nitrofen (non-Hispanic Black ratio = 7.21), acrylonitrile (non-Hispanic Black ratio = 1.96), and arsenic (non-Hispanic "Other" ratio = 1.64). Contrasting these particular P95 ratios with their corresponding GM ratios indicated that cross-subgroup differences in high-end exposure to these chemicals were even more substantial than average differences. Additionally, several chemicals without flagged GM ratio differences of greater than 1.5 were found to have at least one P95 ratio greater than 1.5. The non-Hispanic Black subgroup showed evidence of elevated high-end exposure to a number of common industrial chemicals including ethylene thiourea (ratio = 2.77), ethylene oxide (ratio = 1.6), vinyl chloride (ratio = 1.6), acrylamide (ratio = 1.68), and perfluorooctanesulfonic acid (i.e. PFOS, ratio = 1.5), as well as the organophosphorus pesticide diazanon (ratio = 1.91). The lower-income demographic subgroup showed a difference in high-end exposure to furan (ratio = 1.51), while results for the non-Hispanic "Other" subgroup also suggested elevated high-end exposure to the pesticide dimethylarsinic acid (i.e. DMA, ratio = 1.66). The complete set of P95 ratio results for primary demographic subgroups – including chemicals without any detected P95 ratio above 1.5 – is provided in Table A10.

*Demographic interaction results*

In supplemental results, we also assessed P95 ratios by demographic interactions of sex and race/ethnicity and demographic interactions of household income and race/ethnicity. These additional P95 ratio results are available in Table A11, with subgroups' distributions visualized in panel (a) of Figure A2. When considering demographic interactions, a broad range of chemicals presented with P95 ratios greater than 1.5 for at least

[19] See Figure A1 for visual evidence based on the set of carcinogens for which we could calculate both GM and P95 ratios.

one subgroup. In total this set included 44 carcinogens (represented in NHANES by 26 parent chemicals and 24 metabolites). Some chemicals of industrial and/or regulatory note that were flagged here but not in the previously-described GM ratio analyses nor the primary P95 ratio analysis include 1,3-butadiene, 1-bromopropane, perfluoroocatanoic acid (i.e. PFOA), benzene, tetrachloroethylene, and diisononyl phthalate (i.e. DINP). Describing the results more broadly, though the most extreme P95 ratio values were well above their corresponding GM ratio values, on the whole, these more granular subgroups had P95 ratio distributions that tracked similarly to their GM ratio distributions. The prevalence of P95 ratios greater than 1.5 for the non-Hispanic Black subgroup again predominantly originated from elevated chemical exposure among males and lower-income individuals.

*Age-differentiated results*

In supplemental results, we also assessed P95 ratios by age group. These additional P95 ratio results are available in Table A12, with subgroups' distributions visualized in panel (b) of Figure A2. When considering P95 ratios strictly differentiated by age group (age 19 and younger or age 20+), we did not identify any values greater than 1.5. Joint consideration of age and race/ethnicity while assessing P95 ratios did uncover some exposure differences. High-end melamine exposure was notably elevated for Hispanic individuals aged 19 and younger (ratio = 2.15), as were exposure to 1,4-dichlorobenzene and nitrofen (ratios = 3.28, 2.1). We also observed differential high-end exposure to di(2-ethylhexyl) phthalate and malathion for younger non-Hispanic "Other" individuals (ratios = 1.72, 1.64), and differential high-end exposure to 1,4-dichlorobenzene, nitrofen, and malathion for younger non-Hispanic Black individuals (ratios = 12.5, 4.95, 3.11).

### 3.1.4 Detected sample ratios

Before turning to our analysis of indirect exposure metrics, we briefly describe an additional set of supplemental results based on the NHANES data. In lieu of distributional statistics based on observed biomonitoring concentrations, we examined a categorical measurement of heterogeneous exposure levels across demographic subgroups in the form of *sample detection ratios*. The sample detection ratio for a given carcinogen and demographic subgroup was defined as the subgroup's survey-weighted fraction of samples with concentrations above the detection limit divided by the total population's survey-weighted fraction of samples with concentrations above the detection limit. This supplemental measure discretely indicates whether an individual was exposed to a carcinogen (above the detection limit) or less exposed (below the detection limit). Because this categorical metric only requires a single detectable sample for a carcinogen to be included in the analysis, we were able to assess 125 matched carcinogens and carcinogen-associated metabolites, of which 96 were based on individual-level biomonitoring samples and 29 were based on pooled samples.

We present a summary distributional visualization of these supplemental results in Figure A4, with complete results provided for primary demographic subgroups in Table A13, demographic interactions in Table A14, and age-differentiated subgroups in Table A15. Across the set of 125 matched carcinogens and metabolites, the non-Hispanic Black subgroup – in particular those older than 20 – had a higher median sample detection ratio than other primary demographic subgroups. Beyond this, there was little evidence suggesting systematic differences in sample detection ratios across subgroups.[20]

[20]Carcinogens for which at least one primary demographic subgroup's sample detection ratio exceeded 1.5 include: **1,1,2,2-tetrachloroethane**, 1,3-butadiene, 1,4-dichlorobenzene, **4-methyl-2-pentanone**, **acetochlor**, acrylonitrile, arsenic acid, benzene, bromoform, carbon tetrachloride, chloroethane, cumene, diazonon, **dichloromethane**, furan, **Glu-P-1**, **Glu-P-2**, **lindane**, MeA-alpha-C, **N-nitroso-N-methylethylamine**, **N-nitrosodiethylamine**, **N-nitrosomorpholine**, **N-nitrosopiperidine**, **N-nitrosopyrrolidine**, PCB66, PCB81, TCDD (dioxin), tetrachloroethylene, **tetrahydrofuran**,

## 3.2 Indirect measures of exposure

Given that NHANES biomonitoring data covered a relatively small share of identified carcinogens, we now turn to indirect evidence of differences in exposure based on national-level data sets for ambient air, drinking water, and consumer products.

### 3.2.1 Ambient Air concentrations

We begin with an assessment of potential differences in residential ambient exposure to individual carcinogens via air releases from industrial sources. Recall that we overlaid the geographic location of demographic subgroups with the geographic locations of individual chemicals' airborne releases and calculated spatially-weighted ambient concentrations for each subgroup. Our metric for identifying differences in exposure for a given carcinogen is the ratio of a subgroup's *average* ambient air concentration and the national average ambient air concentration. We were able to match 186 candidate chemicals to the RSEI data, of which 136 ultimately had an average ambient concentration ratio of greater than 1.5 for at least one subgroup of interest.

Figure 4 summarizes several key findings from this analysis; the full set of results are in Appendix Table A16 for the interested reader.[21] In panel (a), we graphed the distributions of relative concentration ratios for all 186 carcinogens, differentiating by subgroup. For each density plot, a black line indicates the distribution's median value. For all racial/ethnic groups except non-Hispanic Black, the median concentration ratio value was below 1. In fact, for the non-Hispanic Asian, non-Hispanic American Indian/Alaskan Native, and non-Hispanic Pacific Islander subgroups, much of the entire distribution laid below 1, indicating that any relative exceedances in ambient exposure were limited to just a handful of chemicals. Conversely (and by mathematical construction), the median ambient air concentration ratio value for Black individuals was around 1.6, and the subgroup's distribution had a long right tail. For 102 chemicals – well more than half of the those for which we have data – the average ambient air concentration for a Black individual was at least 1.5 times higher than the national average.

We next draw attention to panel (b), which shows the set of carcinogenic chemicals for which (i) total reported airborne emission volumes were greater than 150,000 pounds in the 2022 TRI and (ii) there was evidence of average exposure differences across population subgroups. These chemicals ranged in industrial and spatial extent of use. With the exception of sulfuric acid aerosols, which were primarily emitted from electric utility generation, many of the carcinogens listed were common to the chemical manufacturing sector. Indeed, across the 17 other chemicals highlighted, 47% of the ambient air emissions were reported from the chemical manufacturing sector, 12% from the metal manufacturing sector, and 11% from petroleum manufacturing. These emissions from the 17 chemicals overwhelmingly originated from facilities in the Southeast, Midwest, and Central-South, which respectively accounted for 24%, 17%, and 34% of total 2022 TRI emissions.

Panel (c) displays the set of carcinogens for which any subgroup had a concentration ratio greater than 4. As expected from panel (a), many of these exceptionally high ambient air concentration ratios were

**trichloroethylene**, and **Trp-P-1**. **Bolded** chemicals in above list are those for which there were insufficient detected samples for calculation of GM and P95 ratios.

[21] For both the ambient air and drinking water indirect exposure metrics, we also calculated spatially-weighted 95th percentile concentrations for each subgroup. A summary of the corresponding ambient air concentration ratios at 95th percentile values is presented in Table A17 for completeness. Results were qualitatively similar, though limited in coverage. This was due to the sizable share of TRI chemicals for which the national 95th percentile concentration was zero; concentration ratios could not be calculated when the denominator was zero.

indicative of non-Hispanic Black individuals' markedly higher potential for residential exposure. Notably, however, none of the carcinogens listed in panel (c) were on the list in panel (b), suggesting that the strongest measures of potential exposure disparity generated by this statistical exercise derived from chemicals with highly local exposure patterns. In effect, these chemicals were emitted in lower total volumes and from fewer facilities, but their emissions were concentrated in neighborhoods with a higher-than-average fraction of non-Hispanic Black residents.

### 3.2.2 Drinking water

We next examined differences in exposure to individual carcinogens via public drinking water. For the 15 matched chemicals with sufficient detection rates for analysis, we calculated relative average concentration ratios that were nationally representative for households served by public water systems. Figure 5 summarizes the findings.[22] We identified only a limited number of chemicals and subgroups for which substantial exposure differences existed. This may have been partially due to our statistical approach: any within-distribution-system differences in exposure were smoothed when we took a system-level average, and furthermore, the spatial scale of the analysis was implicitly more spatially aggregated due to water systems being larger than Census block groups. See Appendix B for further discussion on this.

In panel (a), we again graphed the distributions of relative concentration ratios, differentiating by demographic subgroup. The median concentration ratios for all seven subgroups were around 1. Only three individual concentration ratios were above the 1.5 threshold value for the American Indian and Pacific Islander subgroups. In panel (b), we present the complete set of drinking water relative concentration ratios, where we identified potential disparities in exposure to arsenic (ratio = 1.75) and chromium (VI) (ratio = 1.84) for American Indian individuals. These heavy metals are often naturally occurring but also likely affected by activities such as mining and energy production (Erickson et al., 2024); actual exposure levels may actually exceed the estimated values due to the high use rates of private groundwater wells for drinking water on Tribal lands (Spaur et al., 2021). For Pacific Islander individuals, the average drinking water concentration of chromium (VI) was almost two times higher than the national average (ratio = 1.99). This was largely driven by the residential concentration of Pacific Islander individuals across western states. Of the 50 CWSs serving the highest number of Pacific Islander residents, 46 were located in HI, NV, CA, UT, AZ, OR, and WA. CWSs in AZ had the highest state average concentration of chromium (VI) in drinking water. CWSs on tribal lands in the Pacific southwest had the second-highest average, CWSs in HI had the fourth-highest state average concentration, and CWSs in CA had the sixth-highest state average concentration. These higher chromium (VI) concentrations were naturally occurring in most cases.

### 3.2.3 Household products

Our final indirect exposure metric focused on consumer products that contain one or more carcinogens. Recall that a subgroup's prevalence rate is defined as the total fraction of household-months in which a carcinogen appeared in the purchased consumption bundle. Using these rates, we calculated purchase prevalence ratios

[22] A summary of the (N = 17) corresponding drinking water concentration ratios at 95th percentile values is presented in Table A18. Results were qualitatively similar, though the 95th percentile drinking water concentration for Hispanic individuals was substantially higher for dibromoacetic acid (a disinfection byproduct, ratio = 1.62) and trichloroethylene (ratio = 1.92). A summary of the (N = 66) drinking water *sample detection* ratios for matched carcinogens is presented in Table A19. Sample detection ratios results for drinking water should be interpreted conservatively, as detection limits for a given chemical may vary both across CWSs and within a CWS and be correlated with the size of population served and/or the population's demographics. Nevertheless, broad trends in the sample detection ratio results suggest that Hispanic individuals, in particular, had a higher than average probability of carcinogens being detected in their drinking water.

for each of the 44 candidate carcinogens that appeared in the chemical-household data panel, again with national average purchase prevalence rates as the reference value. Figure 6 summarizes the key findings from our analysis. In panel (a), we graphed the distributions of relative prevalence ratios, differentiating by subgroup. Across the six demographic subgroups considered, the median prevalence ratio values were again consistently close to one. For the Black, Hispanic, and Asian subgroups we found that several carcinogens had prevalence ratios greater than 1.5, which we investigated further in panel (b).

This list includes the 21 chemicals for which at least one subgroup was found to have relatively elevated exposure, including highly-elevated benzophenone purchase prevalence ratios for Asian households. This chemical is a flavoring agent and fragrance enhancer and our results showed that Asian individuals were greater than 700% more likely to purchase products containing it than the average national consumer. Other chemicals with notably elevated prevalence ratios included oxidized asphalt (a common ingredient in coatings for construction, electronics, and packaging; ratio = 2.48) for Asian households, phenolphthalein (a common color-changing acid-base indicator and pharmaceutical drug ingredient in laxatives and weight loss products; ratio = 2.25) for Asian or Hispanic households and those with children, coal tar (used in skin care treatments and as a base for construction coatings and paint; ratio = 2.72) and 1,4-dichlorobenzene (ratio = 2.7) for Black households, and di(2-ethylhexyl) phthalate (ratio = 3.57) for Hispanic individuals.

Also noteworthy is the elevated melamine purchase prevalence ratio for Black households; melamine is commonly used in kitchenware and as a flame retardant in plastics, paints, and paper. This finding contrasts with the earlier biomonitoring results from NHANES, which indicated *lower than average* exposure to melamine for non-Hispanic Black individuals. A possible combined interpretation of these results is that despite Black households' relatively higher purchase rates of consumer products that contain melamine, the amounts of the chemical or uptake rates from this pathway either did not translate into elevated exposure or other exposure pathways dominated such that a disparity did not show up in urine, blood, or serum samples collected via NHANES. Further investigation of this interpretation is warranted, but the results nonetheless underscore the value of jointly assessing biomonitoring and consumer purchase data. See Table A20 for the complete set of results for all 44 matched chemicals.

## 3.3 Synthesis of results: carcinogens with the strongest evidence of exposure disparities

We conducted five main analyses of differences in exposure to individual carcinogens. To synthesize our findings across the analyses, we highlight carcinogens that met the set of inclusion criteria. Table 1 presents the 28 carcinogens which met our joint inclusion criteria. Individual flags in the table denote the analyses that did or did not result in at least one differential exposure ratio of 1.5 or greater for a specific chemical. Of these 28 chemicals, 6 are known carcinogens, 14 are probable carcinogens, 6 are possible carcinogens, and 2 are not classified by the IARC or RoC.

We found robust evidence of exposure disparities for a handful of chemicals across the multiple analyses. Arsenic was one such chemical; at least one demographic subgroup had an elevated exposure ratio in each of the five analyses that were conducted. Elevated exposure to arsenic for American Indian individuals was especially widespread. The results from the biomonitoring, ambient air, and drinking water analyses all supported a finding of potentially elevated exposure to the carcinogen for this subgroup. We also found evidence of elevated exposure to this chemical for females of childbearing age based on purchasing patterns identified in the household products analysis.

Other chemicals that demonstrated evidence of elevated exposure across multiple analyses for specific

subgroups via both biomonitoring and indirect measures include ethylene oxide, 1,4-dichlorobenzene, acrylonitrile, melamine, furan, and 1-naphthylamine. These chemicals are commonly used in both industrial processes and household products. Interestingly, di(2-ethylhexyl) phthalate and 1,2-propylene oxide had no biomonitoring ratio values greater than 1.5 across the primary demographic subgroups, but were flagged in indirect analyses for having at least one subgroup with ambient air concentration and household product prevalence ratios greater than 1.5. This motivated consideration of two supplemental sets of alternative inclusion criteria.

*Alternative inclusion criteria*

Our chosen synthesis inclusion criteria relied on researcher discretion in two key dimensions. The first was our reliance on NHANES-derived statistics for **only** primary demographic subgroups. Results for subgroups created by demographic interactions of sex, race/ethnicity, income, and age can tell a more complex story.[23] With this in mind, in Table A21 we present a supplemental synthesis list in which biomonitoring results based on demographic interactions were equally considered. The second was our reliance on a ratio threshold value of 1.5. As some carcinogens may have had demographic subgroups with ratio values that fell just below this strict threshold, we present a supplemental synthesis list constructed using a ratio threshold of 1.25 in Table A22.[24] In both supplemental tables, the list of carcinogens was qualitatively similar but included a much broader range of chemicals. The former list contained 53 carcinogens and the latter contained 69. While the additional chemicals added to the supplemental synthesis lists merit consideration in future research, we focus our attention on the default inclusion list in the remainder of this paper: this more streamlined synthesis list contains the chemicals for which we had the strongest evidence of cross-demographic differences in exposure.

*Chemicals with limited exposure differences across subgroups*

Lastly, we examined the extent to which our analyses demonstrated **no evidence** of exposure disparities for some carcinogens. Using the alternative results based on the more relaxed ratio threshold of 1.25 as a conservative approach, Table A23 compiles this list of chemicals. Only a single chemical showed fairly compelling evidence of homogeneously ubiquitous exposure across the population: formaldehyde. Given the carcinogen's widespread use in home building materials and furniture, as well as its general ambient ubiquity due to industrial and vehicular combustion emissions, it is intuitive that our results point to near-universal exposure. We found that the evidence for the remaining set of chemicals in the table were inconclusive.[25] More than 10 other chemicals showed evidence of limited differences in exposure across subgroups based on results from a single indirect exposure media, but the lack of multidimensional robustness rendered any inference less compelling.

[23]For example in the case of di(2-ethylhexyl) phthalate, age may be an important factor to consider. Our air concentration ratios for the chemical showed non-Hispanic Asian and Pacific Islander subgroups may face elevated ambient exposure, while the household product prevalence ratio was greater than 1.5 for Hispanic households. Biomonitoring results differentiated by race/ethnicity *and age* for Hispanic and non-Hispanic "Other" individuals aged 19 and younger had values greater than 1.5.

[24]For example, 1,2-propylene oxide – which as discussed above had no biomonitoring metrics but two indirect exposure metrics greater than 1.5 – had a GM ratio exceeding the relaxed threshold of 1.25.

[25]Limited biomonitoring results for two arsenic acids and 2,3,4,7,8-pentachlorodibenzofuran showed no strong evidence of potential exposure disparities across groups, but the former was complicated by the metabolization patterns of arsenic, and the latter lacked support from indirect exposure metrics.

### 3.4 Main exposure pathways for carcinogens with potential exposure disparities

We next conducted a review of data and literature describing exposure pathways and product categories for each carcinogen we identified as having potential exposure disparities in Table 1. There are two primary purposes of this exercise. The first is identification of additional carcinogen-specific exposure pathways beyond drinking water, ambient pollution, and household products that may have contributed to the differential exposure we observed in biomonitoring data. The second is to highlight the most common exposure pathways and major product categories across the set of carcinogens for which we identified evidence of notable differences in exposure across subgroups.

Figure 7 visually summarizes the available information on exposure pathways and product categories for chemicals with potential exposure disparities. The complete set of chemical-specific information collected about exposure pathways – including product categories, points of exposure, and exposure routes – as well as associated cancer types can be found in Table 3.

Panel (a) explores the general relevance of several exposure pathways, distinguishing between occupational and general population exposure. Among the carcinogens we identified with potential exposures disparities, we found that occupational exposures most frequently occur via manufacturing (20 of 28 chemicals), farming and agriculture (16/28), through processing of chemicals directly or as intermediaries (16/28), through industrial cleaning products (7/28), and through vehicle use, production, or maintenance (7/28). Turning to general population exposure, the most common pathways for exposure to this set of carcinogens included food and food additives (23 of 28 chemicals), tobacco products (14/28), personal care products (10/28), home maintenance products (10/28), home vehicle use or maintenance (8/28), home cleaning products (7/28), and art supplies (7/28). Additionally, we observed that environmental releases (13/28) and drinking water (13/28) were general population exposure pathways for a large portion of the carcinogens. Such broad incidence of these two pathways corroborated the findings from the drinking water and ambient air indirect exposure analyses presented earlier in this section.

Panel (b) characterizes the relative frequency of carcinogens' association with different product categories. 21 of 28 chemicals were associated with use as an herbicide or pesticide. This high frequency included some legacy pesticide uses of carcinogens, but nonetheless aligned with the evidence above indicating that the occupational exposure pathway, farming/agriculture, was a possible source of differential carcinogen exposure. Other common product use categories that were potentially relevant to occupational exposure included metals and electronics (12 of 28 chemicals), plastics and rubber (15/28), and paint and adhesives (11/28). Common product use categories that were potentially relevant to general population exposure included food and food additives (15/28), pharmaceuticals (13/28), and textiles (14/28).

Recall that we did not collect information about, nor formally model how much exposure occurred via any specific pathway or product category. These results simply reflected the state of information available from our four primary sources regarding each individual carcinogen, and we made no additional assumptions about intensity of exposure or potential unlisted pathways. It was therefore not possible to make explicit claims about which particular pathways or product categories drove observed demographic differences in exposure. Taken as group, however, the pathways and product categories highlighted above, due to their frequent association with the 28 carcinogens on our list, likely merit further scrutiny in future work exploring exposure disparities.

## 3.5 Correlations between potential exposure disparities and cancer incidence rates

Disparities in cancer incidence by sex, race, and ethnicity are well-established (Singh and Jemal, 2017; Zavala et al., 2021; Siegel et al., 2024). While we cannot state the relative contribution of different exposure pathways to differences in body burden, nor how differences in body burden translate to disparities in cancer incidence, we can highlight the extent to which differences in exposure are positively correlated with differences in cancer incidence. Table 2 presents the five most recent years of national cancer incidence data (2017-2021) from the CDC (CDC, 2021b). These incidence rates were disaggregated by cancer type, sex, race, and ethnicity, and age-adjusted to account for potentially confounding subgroup age distributions. We included statistics for all leading and invasive cancer types. In what follows, we compared incidence rates across subgroups and noted cancer types that occurred with high frequency for a particular subgroup. To supplement our previously described findings, we contrasted these elevated cancer incidence rates with the cancer types typically caused by carcinogens that were shown to have exposure differences across subgroups.[26] Though any connections we drew between *current* cancer rates and our *concurrent* exposure metrics are purely correlational – most cancers have a latency period of several years – such findings may point to avenues worthy of investigation in future work.

There are a handful of cancer types for which multiple demographic subgroups showed substantially-higher-than-average incidence. Among non-Hispanic American Indian, non-Hispanic Asian/Pacific Islander, and Hispanic males, the incidence of liver-related cancers for males, respectively, were 50%, 68%, and 62% higher than the national male average. American Indian, Asian/Pacific Islander, and Hispanic females, respectively, had 100%, 82%, and 82% higher incidence of liver-related cancer than the national female average.[27] Stomach cancer was substantially more common among Asian, Black, and Hispanic individuals. For females, incidence rates were respectively 77%, 72%, and 74% higher than the female national average. For males, incidence rates were respectively 73%, 80%, and 58% higher than the male national average.[28] Cervical cancer incidence was also slightly higher than national average for American Indian (28%), Black (35%), and Hispanic (45%) females.

Turning to columns (4) and (5) of Table 3, liver-related cancers were associated with several chemicals for which we found large exposure differences across subgroups. In particular, epidemiological evidence has linked liver cancer with exposure to arsenic, 1,4-dichlorobenzene, diethanolamine, PCBs, vinyl chloride, and DDT.[29] When paired with findings from our direct and indirect exposure analyses, we inferred potential relationships between (1) Hispanic individuals' historic and ongoing exposure to pesticides and/or ambient diethanolamine and the subgroup's highly elevated liver cancer incidence, (2) American Indian individuals' historic and ongoing exposure to arsenic and/or pesticides and the subgroup's highly elevated liver cancer incidence, (3) Asian/Pacific Islander individuals' historically elevated exposure to several pesticides and PCBs and the subgroup's highly elevated liver cancer incidence, and (4) Black men's historic and ongoing exposure to 1,4-dichlorobenzene, PCBs, and vinyl chloride, and the subgroup's elevated liver cancer incidence.

[26] Table A24 displays cancer *mortality* rates, again differentiated by cancer type, sex, race, and ethnicity. These statistics reflect the well-documented variation in mortality rates across demographic subgroups. We included this information for completeness and the interested reader, but did not analyze them further here – disparities in mortality from cancer result from an even more complex set of environmental, social, and exposure factors that are beyond the scope of this work.

[27] The statistics also showed elevated liver-related cancer incidence among non-Hispanic Black males, though this 35% deviation from the national average was more modest.

[28] The statistics also showed slightly elevated stomach-related cancer incidence among American Indian individuals: 32% higher than the female national average and 30% higher than the male national average.

[29] Using animal-based evidence, 9 additional carcinogens with evidence of exposure disparities – furan, 4-methyl-2-pentanone, ethylene thiourea, nitrofen, PFOS, DEHP, Beta-HCH, NNK, dimethylarsinic acid – were associated with liver cancers.

Undertaking a similar exercise for chemicals with identified differences in exposure across subgroups that were associated with stomach cancers, we found epidemiological evidence of associations for arsenic, acrylonitrile, ethylene oxide, and diethanolamine.[30] When paired with findings from our direct and indirect exposure analyses, we inferred potential relationships between (1) Hispanic individuals' historic and ongoing exposure to 1,4-dichlorobenzene, 1,2-propylene oxide, and diethanolamine and the subgroup's highly elevated stomach cancer incidence, (2) American Indian individuals' historic and ongoing exposure to arsenic and the subgroup's elevated stomach cancer incidence, (3) Asian/Pacific Islander individuals' historic and ongoing exposure to 1,2-propylene oxide and the subgroup's highly elevated stomach cancer incidence, and (4) Black individuals' historic and ongoing exposure to 1,4-dichlorobenzene, acrylonitrile, ethylene oxide, and diethanolamine, and the subgroup's elevated stomach cancer incidence.

Table 2 also shows evidence of incidence disparities for other cancer types, and these cancer types are often associated with carcinogens for which we observed related potential exposure disparities. Among Black males, prostate cancer incidence – which epidemiological evidence has associated to diethanolamine and PFOS exposures – were 86% above the national average. Among Black and White males, respiratory cancer incidence – which epidemiological evidence has associated to carbaryl, vinyl chloride, 4-methyl-2-pentanone, diazinon, acrylonitrile, and arsenic exposures – were respectively 51% and 31% above the national male average. Among Black males and females and White males, larynx cancer incidence – which epidemiological evidence has associated with naphthalene exposure – were respectively 89%, 64%, and 27% above national averages. Lastly, among Black individuals, the incidence of colorectal cancers – which epidemiological evidence has associated with 2,4D, acrylonitrile, PCB, naphthalene, and acrolein exposures – were elevated compared to national averages for both males (43%) and females (38%).

To conclude this subsection, we compiled a full set of related information on exposure disparities, carcinogen-to-cancer-type associations, and cancer type incidence rates into a heatmap in Figure 8. Each cell in the heatmap denotes a demographic subgroup-cancer type pairing. Cell values (and color) denote the count of carcinogens for which we jointly found (1) subgroup-specific biomonitoring evidence of differences in exposure, and (2) epidemiological support for an association between the carcinogen and the cancer type. Visually, darker red cells are those with higher carcinogen counts, and cells with a heavy black border denote subgroup-cancer type pairings for which national statistics showed incidence was greater than the national average. Because the available cancer incidence statistics were decomposed by race/ethnicity and sex, the results in this table focused strictly on biomonitoring evidence of potentially exposure disparities for the corresponding subgroups.

Several components of the heatmap indicate alignment between our broader exposure findings and the cancer incidence statistics. Across subgroups, we found elevated incidence of liver cancers and potential disparities in exposure to at least one associated carcinogen for each group. Similarly, we found that Black males faced potential exposure disparities to multiple carcinogens associated with colorectal, liver, lung, and stomach cancers; national statistics for Black males suggest elevated incidence rates for these cancer types. Other results highlight the complexity in linking exposure metrics to cancer incidence. Among the subgroups considered here, we found broad-based potential disparities in exposure to carcinogens associated with blood cancers (leukemia, lymphomas), bladder cancers, and kidney cancers, though current data showed that only non-Hispanic American Indian females had a higher incidence of the latter cancer type. For other cancer types – cervical/uterine, esophageal, and gallbladder, among others – we observed differences in incidence

[30] Using animal-based evidence, two additional carcinogens with observed exposure disparities were associated with stomach cancer: 1,4-dichlorobenzene and 1,2-propylene oxide.

across subgroups but lacked information on carcinogens that may have contributed through differing exposure rates. These findings emphasize that environmental factors are only a single contributor to the development of cancer.

# 4 Discussion

The results from our analyses in Section 3 strictly focused on carcinogens for which nationally representative exposure data were available. These analyses have some inherent methodological limitations. But perhaps more importantly, as shown in columns 3-7 of Table A1, we lacked information for the vast majority of carcinogens in each of our analyses. The lack of chemical breadth in available exposure information is well documented (Egeghy et al., 2012), but these data limitations continue to impede a full understanding of which carcinogens pose the greatest potential risk of exposure and subsequent health effects for specific subgroups. With an eye to improving future analyses of a similar nature, section 4.1 outlines the key limitations and caveats that pertain to our results, and section 4.2 describes some key data gaps that we identified while conducting our analyses.

## 4.1 Limitations

While we leveraged the available national-level data in a rigorous fashion, there remain several limitations and caveats related to the analyses. Across all analyses, we first emphasize that lack of information about a chemical – due either to limits of detection, or the nonexistence of environmental emissions and biomonitoring data – does not imply an absence of disparity in exposure. There were substantial big-picture data gaps that limited our analyses, a subject to which we return in the next section.

We begin with limitations related to the NHANES analyses. First, we emphasize the temporal variation in source data utilized across carcinogens. To present results relevant to current national exposure levels, we used only the most recent NHANES cycle for each carcinogen. Unfortunately, not every chemical was consistently monitored over time. While our results were largely based on biomonitoring from the past 10 years, results for some chemicals – namely, legacy pesticides including dieldrin and heptachlor epoxide B – were based on data from 2003-2004. These particular legacy chemicals slowly biodegrade in the environment, but it is possible that historic exposure disparities have diminished over the pursuant decades. Second, we emphasize our reliance on biomonitoring concentrations as a reasonable proxy for true exposure. This strong assumption ignores variation in elimination half-life, frequency of exposure, and numerous biological factors (Stanfield et al., 2022; Aylward et al., 2012, 2014). We aimed to mitigate these concerns by employing a statistical focus on comparisons of strictly within-chemical variation in subgroup exposure, but we acknowledge that the methods used here stopped well short of actual exposure modeling.

We next turn to limitations related to the RSEI ambient air concentrations analysis. Two caveats related to the underlying data are important to note. First, RSEI is built from TRI point-source air emissions data, and therefore is representative of possible exposure to chemicals emitted to the air from large industrial facilities in a subset of regulated industries and for a subset of chemicals. Ambient air concentrations of a chemical do not necessarily reflect locals' individual-level exposure. Smaller airborne industrial releases of reportable chemicals were not represented in RSEI's concentration measures, nor were releases from non-industrial or non-point source emitters (cars, biogenic sources, etc.). TRI are also self-reported data, and therefore sometimes estimated instead of directly measured. Second, in instances where very few facilities reported releases of a given chemical (e.g. bis(2-Chloro-1-methylethyl) ether, which was released by two

Gulf Coast facilities in 2022), subgroup concentration ratios were largely determined by a relatively small number of census block groups in nearby communities. Thus, though the calculated concentration ratios were derived from nationally representative, population-weighted averages – and therefore are an informative national measure of potential disparities – it is important to recognize that ambient exposure to some of these chemicals is highly localized.

There are three caveats to mention related to the drinking water exposure analysis. The first emphasizes an obvious but important point: the data underlying our results were sourced from drinking water quality samples collected by CWSs, and are only reflective of actual chemical exposure insomuch as residents rely on tap water for personal consumption. Drinking water intake varies across demographics subgroups, and future exposure work of this nature should aim to quantitatively account for these differences (Brooks et al., 2017; Rosinger et al., 2022).[31] The second relates to the national representativeness of the analysis; we could not assess tap water quality for households receiving water from non-reporting CWSs nor households reliant on private wells. We showed in Appendix C that for 12 of the 15 carcinogens analyzed, the drinking water concentration ratios were representative for at least 2/3 of the US population, including those residing in most major urban and suburban areas. The remaining three carcinogens analyzed are bromate, mycrocystin-LR, and N-nitrosodimethylamine; the statistics for these carcinogens were constructed from less nationally-representative data, and therefore we advise caution in their interpretation. Lastly, to the extent that CWSs' non-reporting of detection limits – and thus, their true chemical concentrations – vary systematically with the demographics of their constituents, our assumptions regarding the imputation of sample values below level of detection limits could bias concentration ratio estimates.

With respect to the household product analysis, we note three caveats. First, the statistics in this setting were derived from a measure of chemical presence in households' purchased bundles of goods. In the data, we did not directly observe the magnitude, frequency, and duration of product use, which household member used the product, or whether products were used in unintended ways. Therefore the statistics were a proxy for true exposure. Second, Stanfield et al. (2021) noted several potential limitations of their data; of most relevance for our application are (1) potential concerns about selection bias vis-à-vis the substantial number of products for which chemical ingredient information could not be matched, and (2) potential concerns about subgroups having differential rates of specialty, ethnic, or neighborhood store visits where products were missing UPC matches or were less likely to be scanned. In either case, our results based on a non-randomly selected set of data may potentially misrepresent true subgroup prevalence ratios. And third, the Nielson scanner data underlying this analysis were from 2012; in the intervening years, it is possible that product formulations and consumer buying patterns evolved such that exposures driven by previously observed differences in purchase prevalence were mitigated (or vice versa).

Our literature and data review concerning exposure pathways and associated product categories was limited in nature. To keep the analysis tractable, our review strictly considered information from four authoritative sources, and therefore our findings were constrained in scope. For less commonly used carcinogens, it is possible that some currently active exposure categories were omitted and some obsolete exposure pathways were included due to outdated and/or missing information from our sources. For example, we only noted environmental releases as an exposure pathway for carcinogens where naturally-occurring or industrial pollution were explicitly identified. In instances where such pollution was not explicitly noted in our data sources, it was omitted as a relevant exposure pathway. Furthermore, we did not collect information

[31] We note, however, that for dermal or inhalation exposure, exposure via showering, hand-washing, produce-washing, and other direct interactions with tap water may still be an important source of exposure via tap water.

about, nor model how much exposure occurs via any specific pathway or product category, and therefore we only made claims about potentially common pathways. A more complete exposure analysis is necessary to identify the particular pathway(s) and product(s) driving potential exposure disparities.

Consideration of temporal changes over a longer time-period could inform a more formal future exposure analysis. Changes in uses of chemicals over time are expected. This, in turn, changes emission patterns, levels observed in environmental emissions data, and observed biomonitoring data. Changes in consumer product use patterns, particularly for longer-term or frequent users of specific products will influence exposures in the indoor environment. Changes in industrial use patterns will influence longer-term occupational exposures and releases into the environment, such as through ambient air or drinking water.

It is also worth noting that while exposure pathways can often be cleanly delineated by the affected population (general versus occupational), some points of exposure for a given carcinogen may be less distinct. Products in a given category can be used in different settings, and therefore many product or use categories include both occupational and general population pathways of exposure. To illustrate, one example was the cleaning product category: janitors or dishwashers may be chronically exposed to a carcinogenic product in their day-to-day work, while the general population may use a consumer-focused version of the same cleaning product in their home (Calderon et al., 2022). Another example was the vehicle product use category. Occupational exposure could involve dermal contact or inhalation of carcinogenic vehicle maintenance products by automobile mechanics or long-distance truckers, while general population exposure to carcinogens while using vehicles could result from ambient off-gassing of flame retardants in seating (Hoehn et al., 2024). To the extent that information to make these nuanced joint delineations was unavailable, we may have misallocated a given exposure to a single affected population, rather than to both.

We conclude this section by noting that most carcinogens we studied were associated with multiple product categories. And similarly, many product categories were associated with more than 10 known carcinogens. As such, the potential for multiple exposures to interact through similar (or differing) modes of action is apparent. Though we stop short of a more formal analysis in this work, we emphasize the need for future research to contextualize cumulative exposure via occupational activities, consumer products, or other sources affecting the general population (Markowitz et al., 2013; Rodgers et al., 2018), account for behavioral risk factors associated with cancer like tobacco or alcohol use, and explore how exposure patterns correlate with identified windows of particular susceptibility (Terry et al., 2019; Shaffer et al., 2017).

## 4.2 Notable data gaps

One key takeaway from our empirical efforts is the degree to which the evaluation of heterogeneity in potential exposure to carcinogenic chemicals by race, ethnicity, income or sex was data-constrained, especially at the national level. As described in Section 2.2.1, only 106 of the 622 ubiquitous carcinogens analyzed were surveilled by NHANES between 1998 and 2018. Going one step further, only 36 of these carcinogens had both biomonitoring data and environmental monitoring via the TRI and drinking water sampling. If we were to make the most complete analysis possible, including only the set of carcinogens for which we were *also* able to assess exposure via household product purchases using proprietary data, the list shrinks to 10 chemicals.[32] Reframing these limitations in the most charitable possible light: we were able to produce one or more usable direct or indirect exposure analyses for only 230 (37%) of 622 identified carcinogens. This is not sufficient for a thorough assessment of exposure disparities: reducing the size of these monitoring gaps

[32]For the interested reader: these ten chemicals are: 1,4-dichlorobenzene, 1,4-dioxane, 2,4D, arsenic, cadmium, cobalt, DEHP, dichloromethane, ethylbenzene, and perchloroethylene.

is an immediate research need.

We ask two questions regarding the limited information we have at hand. First, were known carcinogens more likely to be monitored in the data we collected? The second panel of Table A1 lays out evidence showing that this was not systematically the case. Of the 96 candidate chemicals that are known carcinogens, 17% were directly monitored by NHANES. Comparable statistics for probable carcinogens, possible carcinogens, and other carcinogens (i.e. those solely listed as carcinogenic by CA Proposition 65, the EU, or the UK) are 17%, 13%, and 8%, respectively.[33] Second, were chemicals that had a particular product use category more or less likely to be monitored? Table A3 summarizes findings for a selected subset of product use categories. Among these common categories, carcinogens used in cleaning and safety products were biomonitored with slightly higher frequency than those used in other categories. Chemicals used in home maintenance and personal care products were monitored in drinking water with the highest frequency. And perhaps unsurprisingly, chemicals found in cleaning products and personal care products were most frequently observed in the household products purchasing data. Taken together, however, these monitoring frequency differences across product categories were small, offering limited evidence that chemicals used in certain product categories had a higher propensity of being monitored.

A second key takeaway is that even when biomonitoring or environmental monitoring did occur, current laboratory analytical methods were a limiting factor. For more than half of the matched carcinogens in NHANES, we could not calculate subgroup-specific geometric mean ratios. Even when calculating 95th percentile ratios, we could only produce statistics for 80% of matched chemicals. Meeting the detection limit was even rarer when analyzing drinking water concentrations. Only 15 of the 70 matched carcinogens (21%) had a sufficient fraction of detected drinking water samples for production of nationally-representative concentration statistics. More broadly, our results illustrated that detection limit problems could be compounding when conducting a subgroup-focused statistical analysis: as subgroup categories became more and more disaggregated, we found that it was increasingly challenging to maintain a sufficient fraction of detected samples for calculation of subgroup-specific summary statistics.

A third key takeaway is related to the quality and accessibility of exposure pathway information. For most chemicals, we found that *some* degree of information was available on common exposure pathways and product uses. But despite a reliance on a structured information collection process spanning authoritative data sources, our efforts revealed the typically incomplete nature of compiled information. Exposure information was often segmented, with only a subset of production use categories or exposure routes listed by a single data source. For some chemicals, we found that PubChem contained a holistic set of information related to product uses, exposure pathways, and both human- and animal-linked cancer endpoints but for others the information available in PubChem was dated or more limited. In general, the vintage of information was especially problematic in relation to current use and exposure patterns. Much of the available information about occupational carcinogen exposure dated from the 1980s, and it was unclear whether many listed uses were still active today. Overall, the range of encountered data limitations demonstrated to us the potential value of coordinating a centralized exposure database that is regularly updated.[34]

[33]For ambient air quality, TRI reporting occurred for 23% of known carcinogens, compared to 41.2%, 25%, and 23%, respectively. For drinking water monitoring, 19% of known carcinogens were monitored, compared to 11%, 7%, and 8%, respectively.

[34]As a preliminary step in identifying potential exposure disparities for the many carcinogens that lacked biomonitoring or indirect measures of exposure, we conducted a supplemental analysis of readily-available information on exposure pathways and major product categories for the complete set of *known carcinogens*. Perhaps surprisingly, most known carcinogens lacked national-level biomonitoring data. See Appendix B for results and a brief survey of findings from this analysis. We took particular note of carcinogens, exposure pathways, and product categories that shared suggestive associations with elevated cancer incidence rates.

In summary, we identified several data gaps that could benefit from future research attention. Opportunities to expand biomonitoring have grown in recent years; continued federal support in terms of grants and person-power could broaden the set of chemicals surveilled, and improve laboratory methods and detection limits for chemicals that are currently biomonitored. For similar reasons, innovation in state biomonitoring programs could pay large dividends. New state-level methods and exposure findings could help Federal health agencies in their efforts to prioritize additional chemicals for national-level surveillance. And lastly, we note that there is broad scope for improving indirect exposure research. For example, a nationally-representative survey that conducts chemical analysis of household dust wipes, indoor air samples, outdoor soil, and collects an inventory of consumer goods present in the home at the time of sampling could provide information that is highly complementary to more direct biomonitoring metrics.[35] A nationally-representative survey and database on foodborne chemical exposure could be another valuable resource for exploring the drivers of chemical exposure disparities. Finally, while it is beyond the scope of this paper to identify where the highest added value would be if resources were spent addressing some of these carcinogen-specific data gaps, we note that others have considered questions of a similar spirit using rigorous research methods that could be applied here (Pellizzari et al., 2019; Braun and Escher, 2023).

# 5 Conclusion

In this paper, we characterized the current state of readily-available and nationally-representative exposure information for a set of 622 ubiquitous carcinogens. Usable data on direct or indirect exposure were available for only 232 of these carcinogens. With the collected data, we calculated demographically-differentiated exposure statistics for individual carcinogens. Using these statistics, we identified a subset of 28 chemicals for which there is evidence of potential exposure disparities. We also reviewed readily-available, carcinogen-specific exposure information, highlighted common exposure pathways and major product categories among the subset of carcinogens, and noted carcinogen-demographic pairings where potential exposure disparities are correlated with elevated national cancer incidence rates. Our findings point to several exposure pathways and product categories that may merit particular attention during efforts to reduce differences in chemical exposure and cancer incidence. While conducting our analysis, we noted several data gaps and provided a discussion of where additional data gathering and future study may be useful.

# Code and Data availability

All R code and non-proprietary data for this paper are available at `https://github.com/adamtheising/ubiquitous_carcinogens`.

[35]The US Department of Housing and Urban Development already conducts the occasional American Healthy Home Survey, but to date, their chemical exposure analyses have been limited to lead, formaldehyde, and some pesticides.

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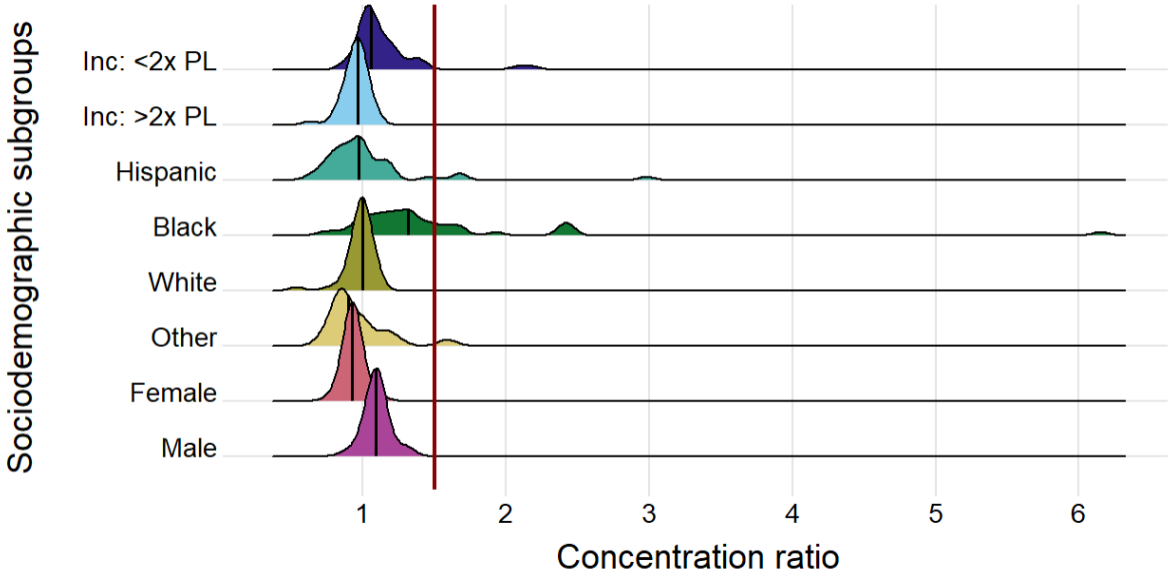
# Figures

**Figure 1:** Summary of results: NHANES geometric mean analysis

**(a)** Distribution of geometric mean ratios across (N = 39) matched carcinogens, by demographic subgroup



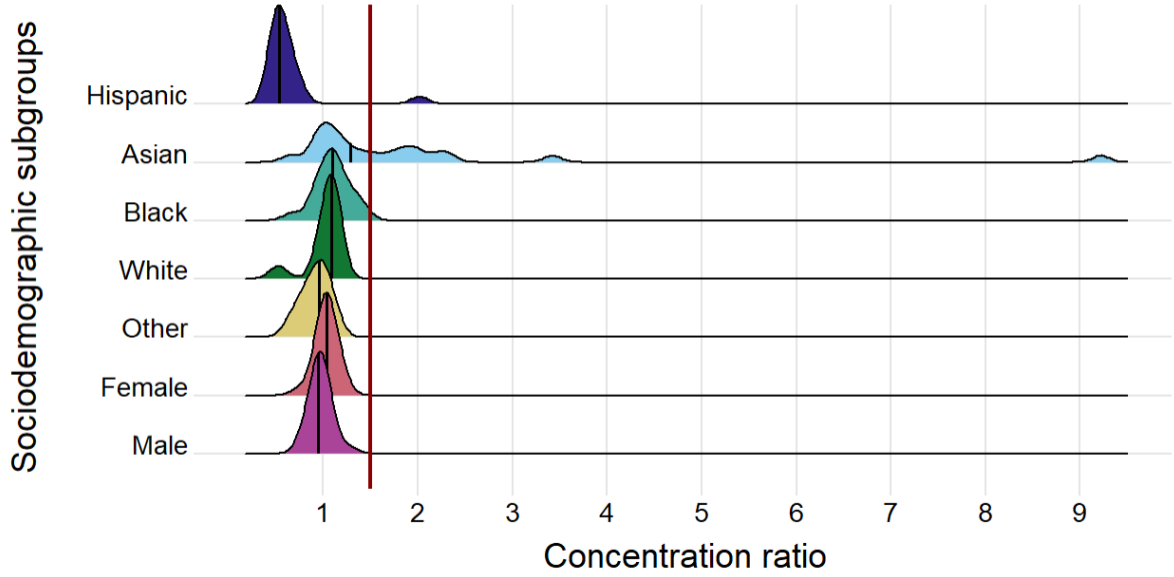

**(b)** Selected results for chemicals with ratio >= 1.5

| Chemical | Flags | Max Ratio | Demographic Subgroup |
|---|---|---|---|
| 1,4-Dichlorobenzene* | 3 | 6.15 | Hispanic, Black, Inc: <2x PL |
| Nitrofen** | 2 | 2.44 | Hispanic, Black |
| 2,4-Dichlorophenoxyacetic acid* | 2 | 2.44 | Hispanic, Black |
| 4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone** | 2 | 2.41 | Black, Inc: <2x PL |
| Acrylonitrile** | 1 | 2.39 | Black |
| 1-Naphthylamine | 1 | 1.93 | Black |
| Naphthalene** | 1 | 1.69 | Black |
| 2-Naphthylamine | 1 | 1.68 | Black |
| Acrolein** | 1 | 1.63 | Black |
| Melamine | 1 | 1.62 | Other |
| 1-Naphthalenol, 1-(N-methylcarbamate)** | 1 | 1.57 | Black |
| Arsenic | 1 | 1.56 | Other |
| 2-Methylaniline | 1 | 1.53 | Black |

**Notes:** Panel (a) illustrates the full distribution of geometric mean concentration ratios across the 39 matched carcinogens, differentiated by demographic subgroup. Each subgroup's median geometric mean ratio is marked on their respective density plot with a black line. Panel (b) presents a selected set of results highlighting the set of chemicals for which at least one primary demographic subgroup was found to have a GMR of 1.5 or greater. Results in this figure are based on individual-level NHANES biomonitoring samples. *Flags* denote the number of subgroups for which the chemical had a prevalence ratio >=1.5. *Max Ratio* is the chemical's largest prevalence ratio value across all primary subgroups. The full set of geometric mean ratio results for these primary demographic subgroups are presented in Appendix Table A4. **: Carcinogens for which only metabolite biomonitoring samples were available. *: Carcinogens for which both direct and metabolite biomonitoring samples were available.
**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female , Male.
**Return to:** Section 3.1.1.

**Figure 2:** Summary of results: NHANES pooled-sample mean analysis

**(a)** Distribution of arithmetic mean ratios across (N = 21) matched carcinogens, by demographic



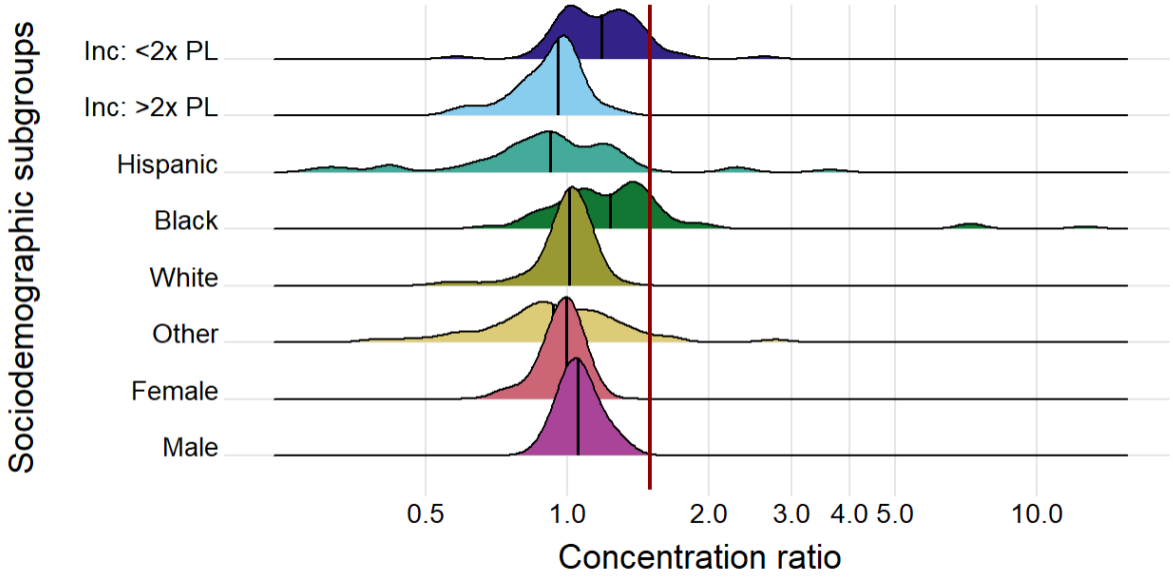

**(b)** Selected results for chemicals with ratio >= 1.5

| Chemical | Flags | Max Ratio | Demographics |
|---|---|---|---|
| DDT | 2 | 3.42 | Hispanic, Asian |
| Beta-Hexachlorocyclohexane | 1 | 9.22 | Asian |
| PCB146 | 1 | 2.33 | Asian |
| PCB187 | 1 | 2.20 | Asian |
| PCB126 | 1 | 2.02 | Asian |
| PCB183 | 1 | 1.94 | Asian |
| PCB178 | 1 | 1.84 | Asian |
| PCB105 | 1 | 1.73 | Asian |
| PCB167 | 1 | 1.56 | Asian |

**Notes:** Panel (a) illustrates the full distribution of arithmetic mean concentration ratios across the 22 matched carcinogens, differentiated by demographic subgroup. Each subgroup's median arithmetic mean ratio is marked on their respective density plot with a black line. Panel (b) presents a selected set of results highlighting the set of chemicals for which at least one primary demographic subgroup was found to have a GMR of 1.5 or greater. Results in this figure are based on *pooled* NHANES biomonitoring samples. *Flags* denote the number of subgroups for which the chemical had a prevalence ratio >=1.5. *Max Ratio* is the chemical's largest prevalence ratio value across all primary subgroups. The full set of arithmetic mean ratio results for these primary demographic subgroups are presented in Appendix Table A7.
**Demographic subgroups:** Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.
**Return to:** Section 3.1.2.

**Figure 3:** Summary of results: NHANES 95th percentile analysis

**(a)** Distribution of 95th percentile ratios across (N = 62) matched carcinogens, by demographic



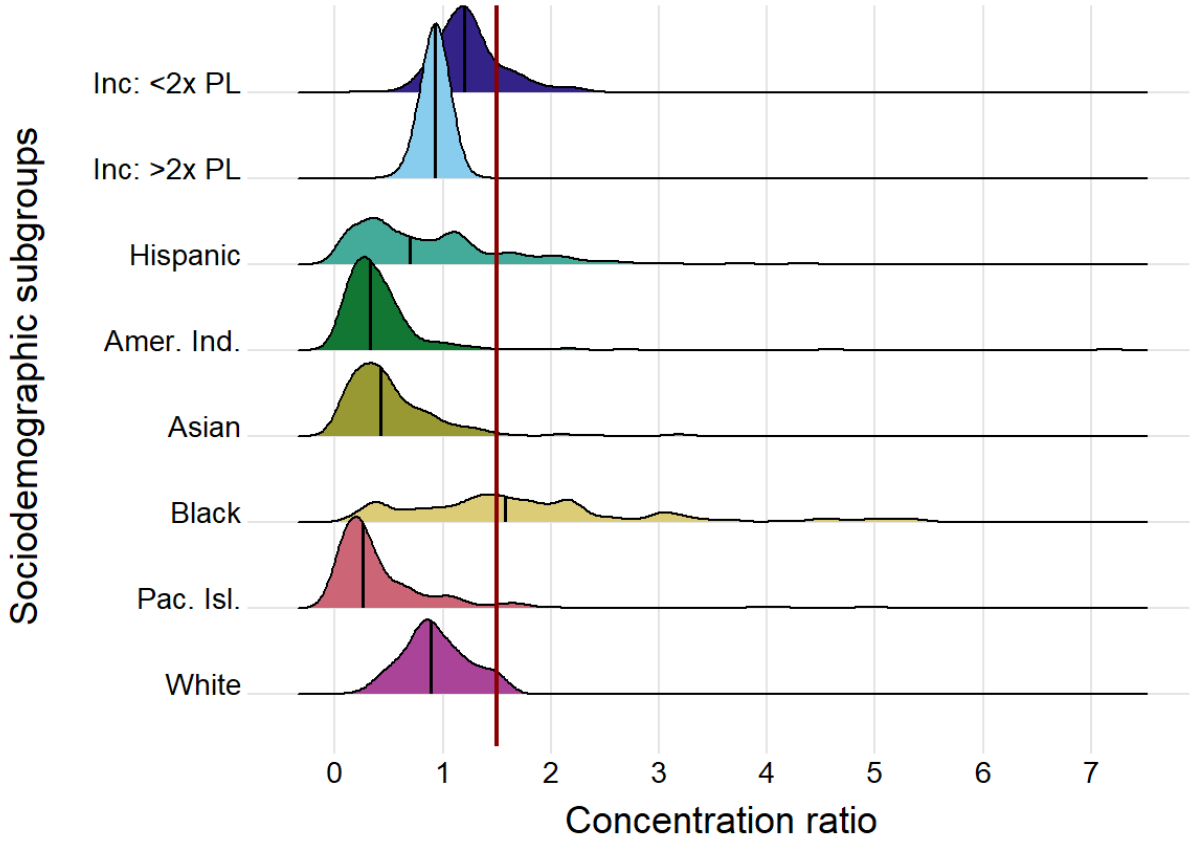

**(b)** Selected results for chemicals with ratio >= 1.5

| Chemical | Flags | Max Ratio | Demographics |
|---|---|---|---|
| 1,4-Dichlorobenzene* | 3 | 12.67 | Hispanic, Black, Inc: <2x PL |
| Nitrofen** | 3 | 7.21 | Hispanic, Black, Inc: <2x PL |
| 2,4-Dichlorophenoxyacetic acid* | 3 | 7.21 | Hispanic, Black, Inc: <2x PL |
| Ethylene thiourea | 1 | 2.77 | Other |
| Acrylonitrile** | 1 | 1.96 | Black |
| Diazinon** | 1 | 1.91 | Black |
| Acrylamide* | 1 | 1.68 | Black |
| Dimethylarsinic acid | 1 | 1.66 | Other |
| Arsenic | 1 | 1.64 | Other |
| Vinyl chloride** | 1 | 1.60 | Black |
| Ethylene oxide* | 1 | 1.60 | Black |
| Furan | 1 | 1.51 | Inc: <2x PL |
| 1-Naphthylamine | 1 | 1.51 | Black |
| Perfluorooctanesulfonic acid | 1 | 1.50 | Black |

**Notes:** Panel (a) illustrates the full distribution of 95th percentile concentration ratios across the 62 matched carcinogens, differentiated by demographic subgroup. Each subgroup's median P95 ratio is marked on their respective density plot with a black line. Panel (b) presents a selected set of results highlighting the set of chemicals for which at least one primary demographic subgroup was found to have a GMR of 1.5 or greater. Results in this figure are based on individual-level NHANES biomonitoring samples. *Flags* denote the number of subgroups for which the chemical had a prevalence ratio >=1.5. *Max Ratio* is the chemical's largest prevalence ratio value across all primary subgroups. The full set of 95th percentile ratio results for these primary demographic subgroups are presented in Appendix Table A10. **: Carcinogens for which only metabolite biomonitoring samples were available. *: Carcinogens for which both direct and metabolite biomonitoring samples were available.
**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.
**Return to:** Section 3.1.3.

**Figure 4:** Summary of results: air toxics analysis

**(a)** Distribution of relative air toxics exposure across (N = 186) matched carcinogens, by demographic




**(b)** Selected chems with high emissions and potential disparity

| Chemical | Air emissions | Facilities | Demographics |
|---|---|---|---|
| Sulfuric acid | 48,416,426.0 | 577 | PI |
| 4-Methyl-2-pentanone | 3,294,525.7 | 476 | Bl |
| Benzene | 3,251,165.8 | 1,172 | His, Bl |
| Dichloromethane | 2,864,140.7 | 231 | Bl |
| 1,3-Butadiene | 1,218,625.8 | 216 | His |
| Naphthalene | 1,157,890.4 | 1,288 | His |
| Vinyl acetate | 899,712.9 | 132 | His |
| 1-Bromopropane | 869,649.6 | 62 | Asn, PI |
| Cumene | 846,218.1 | 578 | His, Bl |
| Tetrachloroethylene | 834,234.4 | 196 | His |
| Vinyl chloride | 469,094.4 | 34 | Bl |
| 1,2-Dichloroethane | 457,365.2 | 52 | Bl |
| Acrylonitrile | 354,361.9 | 89 | Bl |
| 1,2-Propylene oxide | 290,254.0 | 94 | His |
| Chloroform | 258,528.3 | 79 | Bl |
| Vinyl fluoride | 192,790.1 | 4 | <2x PL, AmInd, Bl |
| Chloroethane | 182,415.0 | 40 | <2x PL, Bl |
| Ethylene oxide | 166,356.4 | 146 | Bl |

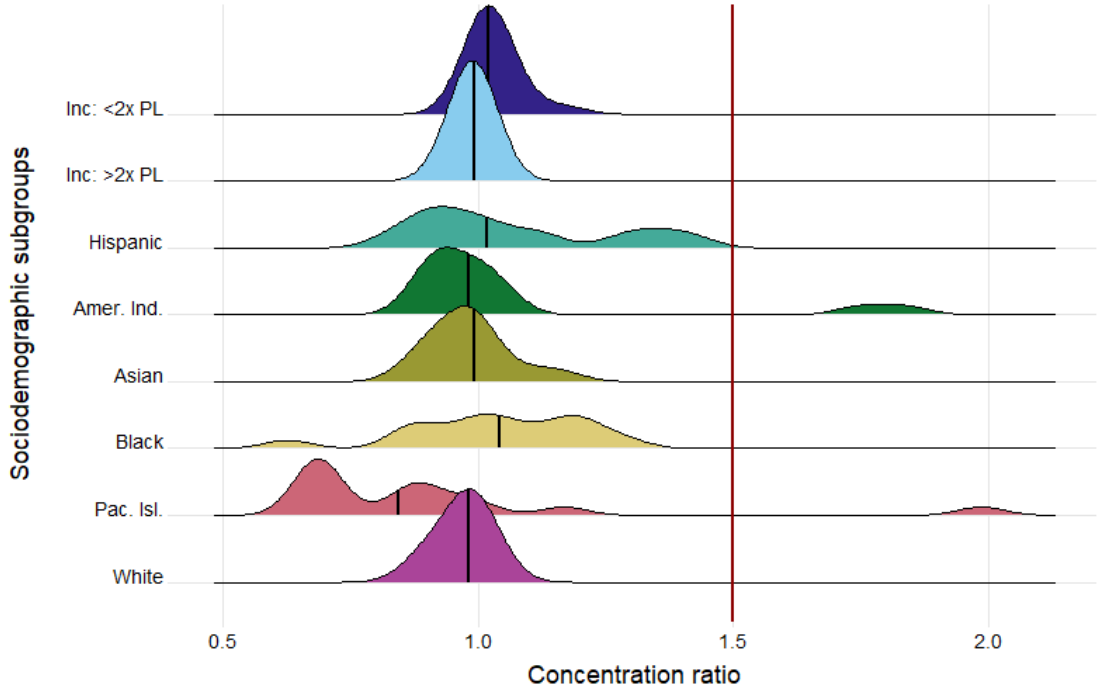
**(c)** Select chems and subgroups with largest disparites in average ambient exposure (Ratio > 4)

| Chemical | Ratio Value | Demographics |
|---|---|---|
| Bis(chloroethyl) ether | 7.17 | AmInd |
| 1,4-Dichloro-2-butene | 5.45 | Bl |
| Diazinon | 5.36 | Bl |
| N-Nitrosodiphenylamine | 5.28 | Bl |
| Malathion | 5.23 | Bl |
| Propargite | 5.11 | Bl |
| 4-Biphenylamine | 5.08 | Bl |
| 1-Bromopropane | 5.02 | PI |
| 1,2-Phenylenediamine | 4.93 | Bl |
| Nitrapyrin | 4.92 | PI |
| 2-Methoxy-5-methylaniline | 4.90 | Bl |
| Furan | 4.69 | Bl |
| Acifluorfen sodium | 4.68 | Bl |
| Arsenic | 4.58 | AmInd |
| Parathion | 4.50 | Bl |
| Propoxur | 4.47 | Bl |
| Chloroprene | 4.41 | Bl |
| Rhodamine B | 4.34 | His |
| 1,2-Benzenediol | 4.15 | PI |
| 1,2-Dibromoethane | 4.10 | Bl |

**Notes:** Panel (a) illustrates the across-chemical distribution of ambient average concentration ratios, differentiated by demographic subgroup. The ambient concentration ratio is an indirect metric summarizing demographic disparities in exposure to each carcinogen, and is measured by the ratio of a demographic subgroup's *average* ambient concentration of the chemical and its national average ambient concentration. The median ambient concentration ratio for each subgroup line are denoted by the black vertical lines, while the threshold value of 1.5 is denoted by the red vertical line. Panel (b) shows a selected set of chemicals with high levels of national air releases (>150,000 pounds in 2022 TRI), and potential evidence of exposure disparities for at least one subgroup. Panel (c) highlights a selected set of chemicals which have an ambient concentration ratio value above 4 for at least one subgroup. The full set of ambient concentration ratios results is presented in Appendix Table A16.
**Demographic subgroups:** Hispanic (*His*), non-Hispanic American Indian or Alaskan Native (*AmInd*), non-Hispanic Asian (*Asn*), non-Hispanic Black (*Bl*), non-Hispanic Pacific Islander (*PI*), non-Hispanic White, household income below 2 times the poverty line (*<2x PL*), household income above 2 times the poverty line.
**Return to:** Section 3.2.1.

**Figure 5:** Summary of results: drinking water analysis

**(a)** Distribution of relative drinking water exposure across (N = 15) matched carcinogens, by demographic



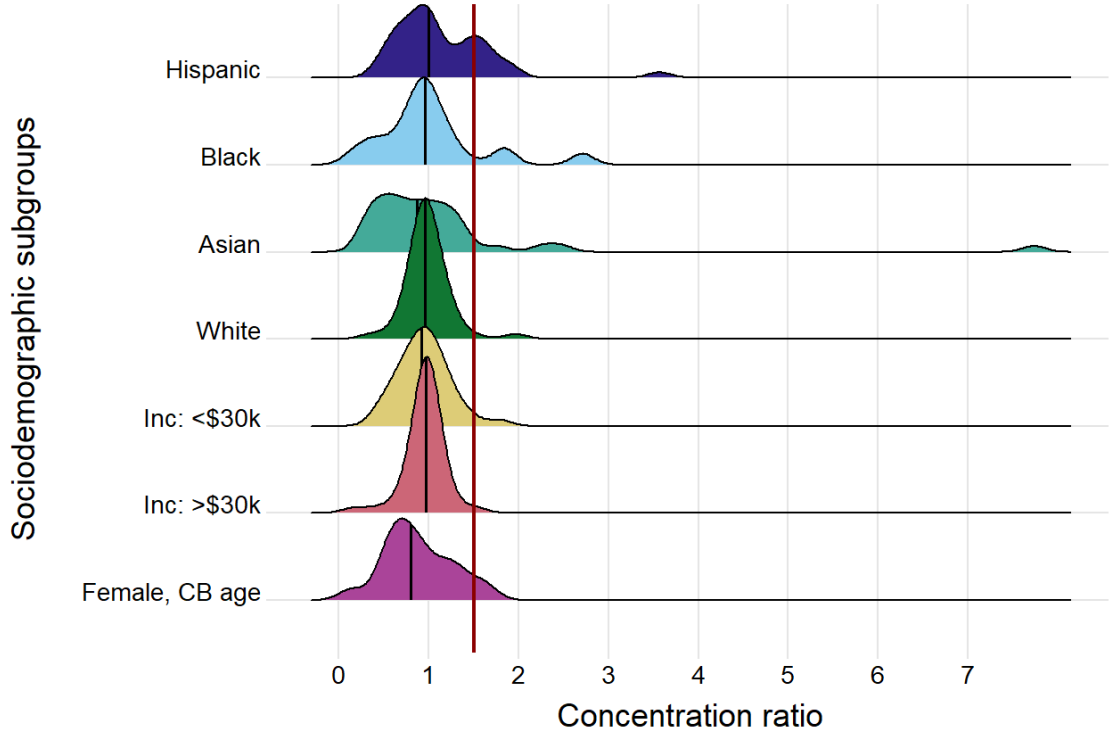

**(b)** Drinking water average concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | <2x PL | >2x PL |
|---|---|---|---|---|---|---|---|---|
| 1,4-DIOXANE | 1.1 | 0.9 | 0.94 | 1.01 | 0.89 | 0.97 | 1.02 | 0.99 |
| ARSENIC | 1.02 | **1.75** | 0.87 | 0.87 | 0.88 | 1.03 | 0.99 | 1 |
| BROMATE | 0.94 | 0.93 | 1 | 1.04 | 1 | 1.02 | 1 | 1 |
| CHROMIUM-6 | **1.42** | **1.84** | 1.16 | 0.63 | **1.99** | 0.9 | 1.07 | 0.97 |
| DIBROMOACETIC ACID | **1.28** | 0.93 | 0.96 | 0.86 | 0.97 | 0.94 | 1.04 | 0.98 |
| DICHLOROACETIC ACID | 0.89 | 0.99 | 0.99 | 1.22 | 0.68 | 0.99 | 1.02 | 0.99 |
| DICHLOROMONOBROMOMETHANE | 0.98 | 1 | 0.96 | 1.11 | 0.67 | 0.99 | 1 | 1 |
| HAA5 | 0.91 | 0.9 | 1.02 | 1.19 | 0.69 | 0.99 | 1.01 | 0.99 |
| HAA6BR | 1.13 | 1.03 | 0.91 | 0.98 | 0.71 | 0.97 | 1.02 | 0.99 |
| HAA9 | 0.95 | 0.93 | 0.99 | 1.15 | 0.68 | 0.98 | 1.01 | 0.99 |
| MICROCYSTIN-LR | **1.32** | 0.89 | 0.89 | 0.89 | 0.89 | 0.9 | 1.16 | 0.95 |
| NDMA | 1.02 | 0.98 | 0.93 | 1.06 | 0.84 | 0.98 | 1.03 | 0.99 |
| BROMOFORM | **1.38** | 0.92 | 0.99 | 0.97 | 1.17 | 0.89 | 1.04 | 0.98 |
| TRICHLOROACETIC ACID | 0.87 | 1.02 | 1.1 | **1.29** | 0.69 | 0.97 | 1.02 | 0.99 |
| CHLOROFORM | 0.82 | 1.05 | 1.01 | 1.2 | 0.68 | 1.02 | 1.01 | 0.99 |

**Notes:** Panel (a) illustrates the full distribution of chemical drinking water concentration ratios, differentiated by demographic subgroup. This concentration ratio is our metric of drinking water exposure disparities for each carcinogen, measured by the ratio of a demographic subgroup's *average* concentration of the chemical and its national average drinking water concentration. Each subgroups' median national concentration ratio is marked on the figure with a black line. Panel (b) presents subgroups' drinking water concentration ratios for each of the 15 chemicals that were monitored and detectable. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5.
**Demographic subgroups:** Hispanic, non-Hispanic American Indian or Alaskan Native, non-Hispanic Asian, non-Hispanic Black, non-Hispanic Pacific Islander, non-Hispanic White, household income below 2 times the poverty line, household income above 2 times the poverty line.
**Additional results:** 95th percentile ratio results. Sample detection ratio results.
**Return to:** Section 3.2.2

**Figure 6:** Summary of results: household product purchases analysis

**(a)** Distribution of relative household product exposure across (N = 44) matched carcinogens, by demographic



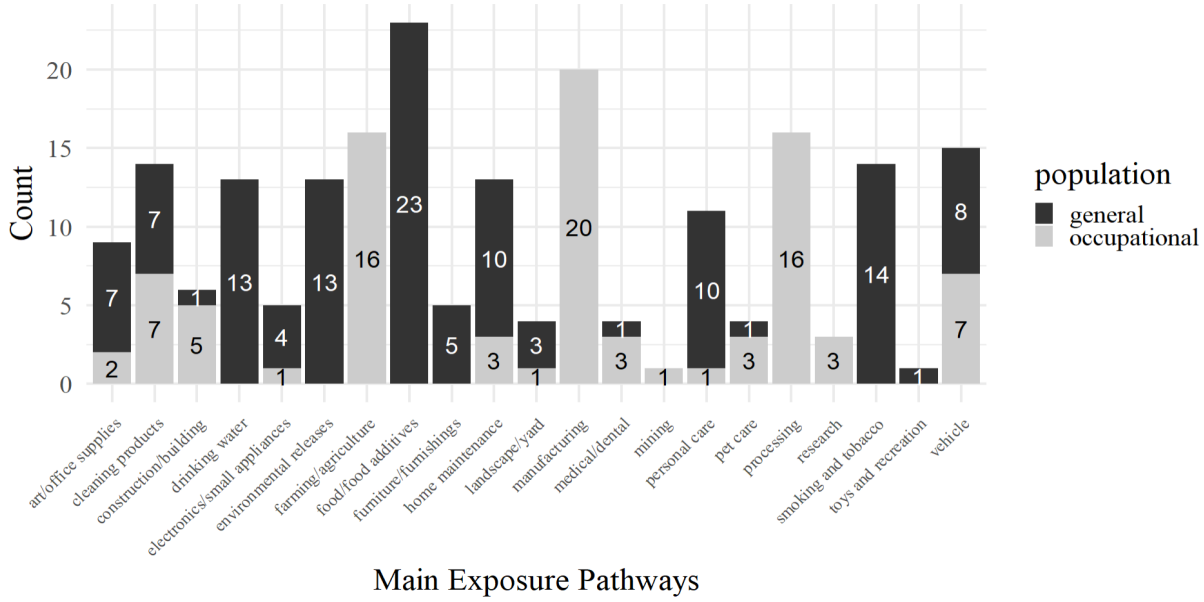

**(b)** Selected summary results for chemicals with ratio >= 1.5

| Chemical | Flags | Max Ratio | Demographics |
|---|---|---|---|
| Phenolphthalein | 3 | 2.25 | Hispanic, Asian, Female CBA |
| Di(2-ethylhexyl) phthalate | 2 | 3.57 | Hispanic, Inc: >$30k |
| Cadmium | 2 | 1.55 | Hispanic, Female CBA |
| Benzophenone | 1 | 7.74 | Asian |
| Coal tar | 1 | 2.72 | Black |
| 1,4-Dichlorobenzene | 1 | 2.70 | Black |
| Asphalt, oxidized | 1 | 2.48 | Asian |
| 1-Chloro-4-(trifluoromethyl)benzene | 1 | 1.97 | White |
| Furan | 1 | 1.90 | Hispanic |
| 1,2-Propylene oxide | 1 | 1.90 | Hispanic |
| Melamine | 1 | 1.86 | Black |
| Mineral oil - includes paraffin oil | 1 | 1.83 | Black |
| Nickel (II) oxide | 1 | 1.81 | Black |
| C.I. Solvent Yellow 14 | 1 | 1.79 | Inc: <$30k |
| Diethanolamine | 1 | 1.76 | Asian |
| 4-Methyl-2-pentanone | 1 | 1.74 | Hispanic |
| Amides, coco, N,N-bis(hydroxyethyl) | 1 | 1.63 | Hispanic |
| Diuron | 1 | 1.60 | Hispanic |
| Arsenic | 1 | 1.60 | Female CBA |
| Ethylene oxide | 1 | 1.58 | Hispanic |

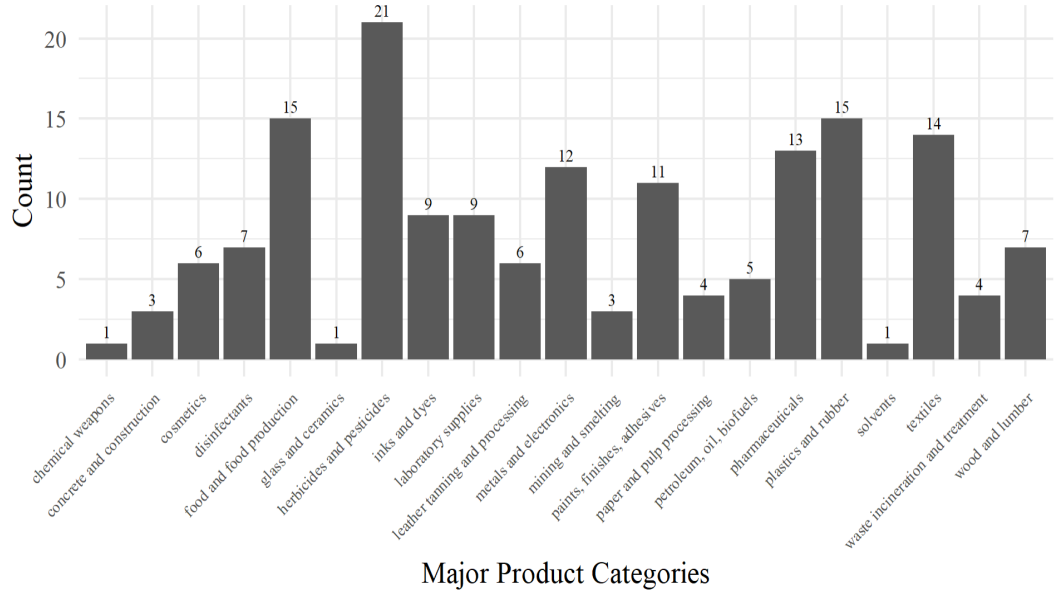
**Notes:** Panel (a) illustrates the full distribution of chemical purchase prevalence ratios, differentiated by demographic subgroup. This prevalence ratio is our metric of disparities in exposure to individual carcinogens found in consumer products, and is measured by the ratio of a demographic subgroup's *average* propensity for purchasing products with a chemical and the national average propensity for doing so. Each subgroups' median prevalence ratio is marked on the figure with a black line. Panel (b) presents subgroups' purchase prevalence ratios for the selected set of chemicals with a ratio value of 1.5 or greater for at least one demographic subgroup. *Flags* denote the number of subgroups for which the chemical had a prevalence ratio >=1.5. *Max Ratio* is the chemical's largest prevalence ratio value across subgroups. The full set of purchase prevalence ratio results is presented in Appendix Table A20.
**Demographic subgroups:** Due to the original paper's data construction, racial subgroups (Asian, Black, White) are not exclusively non-Hispanic ethnicity. All racial/ethnic subgroup assignments are based on the female head of household. Household-income subgroups differentiated by those earning above and below $30,000 in the year of data collection. Female, CBA denotes whether there is a female of child-bearing age (<45 years old) in the household.
**Return to:** Section 3.2.3.

**Figure 7:** Carcinogens with exposure disparities: likely pathways and product categories

**(a)** Frequency of identified uses (general/occupational) amongst carcinogens with exposure disparities



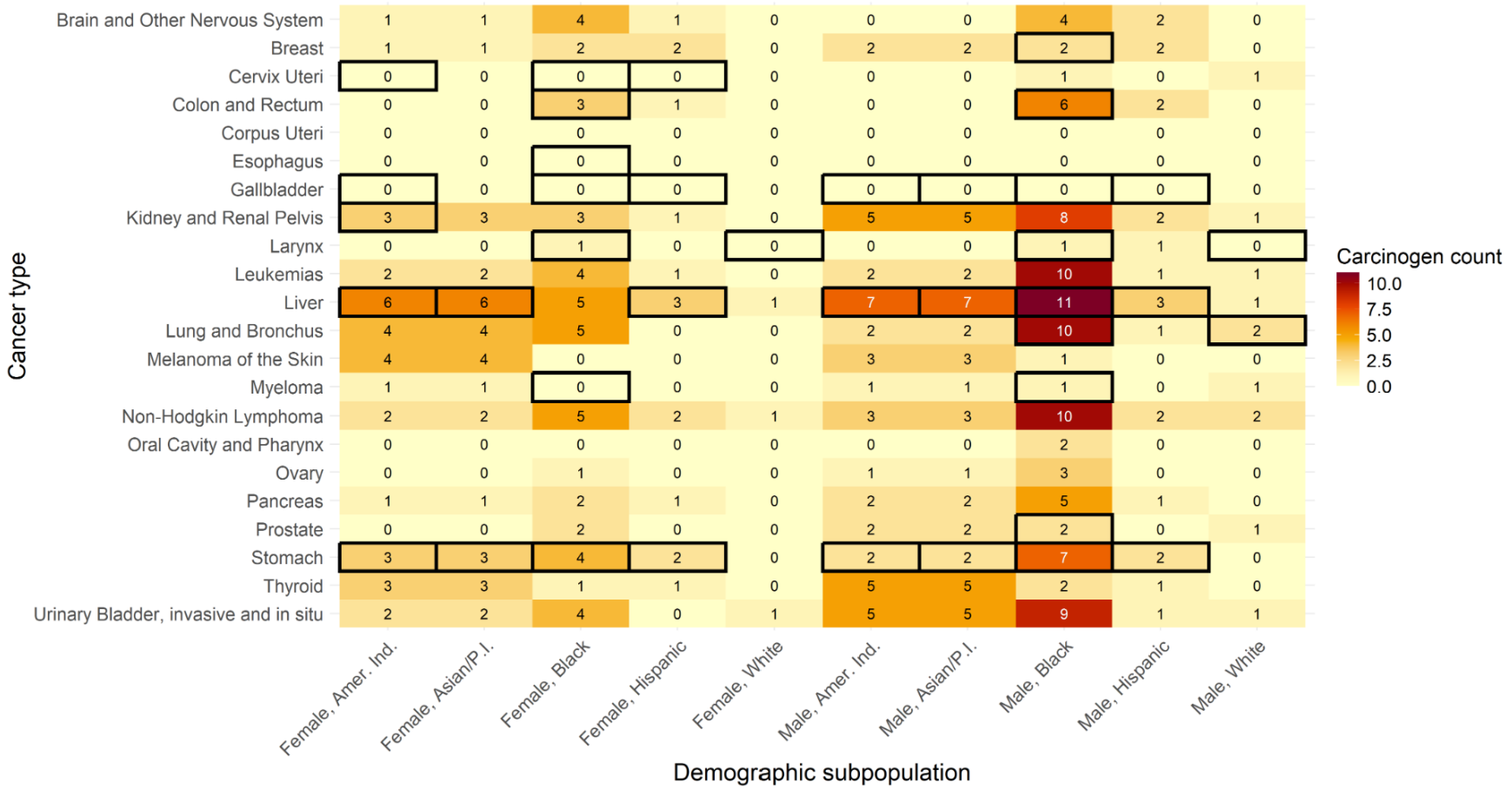

**(b)** Product category frequency amongst carcinogens with exposure disparities




**Notes:** Panel (a) illustrates the relative prevalence of particular **exposure pathways** for the set of carcinogens with likely exposure disparities. The figure distinguishes between general population and occupational pathways. Panel (b) presents the count of carcinogens with likely exposure disparities (out of N=28) which were found to be associated with a given **product category**. See Section 2.4 and Section 3.4 for description of exposure pathway information collection and product categorization methods.

**Return to:** Section 3.4.

**Figure 8:** Correlation heatmap: carcinogen exposure disparities and elevated cancer incidence.




**Notes:** Heatmap of carcinogen exposure and associated cancer types. A cell's black bordering denotes an elevated rate of cancer incidence (25% or more above the national average) for a given cancer type and associated subgroup. A cell's color (and its corresponding numeric value inside the cell) denotes the number of carcinogens which are (1) associated with the particular cancer type and (2) present at elevated levels in biomonitoring data for the relevant demographic subgroup**. A darker cell with black bordering therefore jointly indicates a cancer type and demographic subgroup for which we identified overlaps between cancer type and chemical exposure disparities.
**: We denote a subgroup's exposure as elevated if either the calculated GM ratio or P95 ratio exceed a value of 1.5. Carcinogen counts for American Indian and Asian/Pacific Islander subgroups are jointly based on the "non-Hispanic, Other" race group in the NHANES microdata.
**Return to:** Section 3.5.

# Tables

**Table 1:** Primary synthesis: carcinogens with evidence of potential exposure disparities

| Chemical | NHANES Avg | NHANES P95 | HHP | DW | RSEI | NHANES Cycle |
|---|---|---|---|---|---|---|
| Arsenic | ✓ | ✓ | ✓ | ✓ | ✓ | 2015-2016 |
| 1-Naphthylamine | ✓ | ✓ | | | ✓ | 2013-2014 |
| Acrylonitrile** | ✓ | ✓ | | | ✓ | 2015-2016 |
| Furan | | ✓ | ✓ | | ✓ | 2017-2018 |
| 1,4-Dichlorobenzene* | ✓ | ✓ | ✓ | | × | 2017-2018 |
| 2,4-Dichlorophenoxyacetic acid* | ✓ | ✓ | × | | ✓ | 2015-2016 |
| Ethylene oxide* | × | ✓ | ✓ | | ✓ | 2015-2016 |
| 4-Methyl-2-pentanone | | | ✓ | | ✓ | 2017-2018 |
| Diazinon** | | ✓ | | | ✓ | 2013-2014 |
| Diethanolamine | | | ✓ | | ✓ | |
| Ethylene thiourea | | ✓ | | | ✓ | 2007-2008 |
| Nitrofen** | ✓ | ✓ | | | | 2015-2016 |
| PCBs† | ✓ | | | | ✓ | 2015-2016 |
| Vinyl chloride** | | ✓ | | | ✓ | 2015-2016 |
| 2-Methylaniline | ✓ | × | | | ✓ | 2013-2014 |
| Acrylamide* | × | ✓ | | | ✓ | 2015-2016 |
| Melamine | ✓ | × | ✓ | | | 2003-2004 |
| Perfluorooctanesulfonic acid | × | ✓ | | | ✓ | 2017-2018 |
| 1,2-Propylene oxide** | × | × | ✓ | | ✓ | 2015-2016 |
| 1-Naphthalenol, 1-(N-methylcarbamate)** | ✓ | × | × | | ✓ | 2015-2016 |
| Di(2-ethylhexyl) phthalate** | × | × | ✓ | | ✓ | 2017-2018 |
| Naphthalene** | ✓ | × | × | | ✓ | 2015-2016 |
| Beta-Hexachlorocyclohexane† | ✓ | | | | | 2015-2016 |
| DDT† | ✓ | | | | | 2015-2016 |
| 2-Naphthylamine | ✓ | × | | | | 2013-2014 |
| 4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone** | ✓ | × | | | | 2013-2014 |
| Dimethylarsinic acid | × | ✓ | | | | 2017-2018 |
| Acrolein** | ✓ | × | | | × | 2015-2016 |

**Notes:** Cross-analysis summary of chemical-specific disparities in exposure, based on ratio inclusion threshold value of 1.5. ✓: evidence of potential exposure disparities for at least of the analysis's primary subgroups. ×: no evidence of potential disparities in exposure. Chemicals listed in first column are parent carcinogens. NHANES results may be based on metabolite or pooled concentrations. **: Carcinogens for which only metabolite biomonitoring results were available. *: Carcinogens for which both direct and metabolite biomonitoring results were available. †: NHANES average analysis based on pooled data.
**Column descriptions:** NHANES Avg refers to the GM and AM ratio results in Section 3.1.1 and Section 3.1.2. NHANES P95 refers to the P95 ratio results in Section 3.1.3. HHP refers to the household product prevalence ratio results in Section 3.2.3. DW refers to the drinking water concentration ratio results in Section 3.2.2. RSEI refers to the ambient air concentration ratio results in Section 3.2.1. NHANES Cycle notes the biomonitoring data cycle years used to calculate chemical-specific statistics.
**Parent Chems:** {1-naphthol**: 1-Naphthalenol, 1-(N-methylcarbamate), Naphthalene}; {2-naphthol**: Naphthalene}, {2,4-dichlorophenol**: Nitrofen, 2,4-Dichlorophenoxyacetic acid}; {2,4,5-trichlorophenol**: beta-Hexachlorocyclohexane, Lindane, 1,2,3,4,5,6-Hexachlorocyclohexane, Pentachlorophenol}; {2,5-dichlorophenol**: 1,4-Dichlorobenzene}; {Bis(2-chloroethyl) phosphate**: Tris(2-chloroethyl) phosphate}; {Dimethyl phosphate**: Malathion, Z-Tetrachlorvinphos, Dichlorvos}; {Malathion dicarboxylic acid**: Malathion}; {Mandelic acid**: Ethylbenzene, Styrene}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate**: Di(2-ethylhexyl) phthalate}; {Mono-(2-ethyl-5-oxohexyl) phthalate**: Di(2-ethylhexyl) phthalate}; {Mono-2-ethyl-5-carboxypentyl phthalate**: Di(2-ethylhexyl) phthalate}; {N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine**: Acrylonitrile}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine**: Acrylamide}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine**: Acrolein}; {N-acetyl-S-(2-cyanoethyl)-L-cysteine**: Acrylonitrile}; {N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine**: 1,3-Butadiene}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine**: Acrylonitrile, Vinyl chloride, Ethylene oxide}; {N-acetyl-S-(3-Hydroxypropyl)-L-cysteine**: Acrolein}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine**: Crotonaldehyde}; {N-Acetyl-S-(n-propyl)-L-cysteine**: 1-Bromopropane}; {NNAL**: NNK}; {Oxypyrimidine**: Diazinon};
**Return to:** Section 3.3, Section 3.4.

**Table 2:** National cancer incidence by race/ethnicity and sex

| Cancer Type | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brain and Other Nervous System | 5.3 | 4.1 | 3.2 | 3.6 | 4.7 | 6.3 | 7.4 | 5.7 | 4.5 | 4.8 | 6 | 8.8 |
| Breast | 129.8 | 99.3 | 95.4 | 125.3 | 97.2 | 132.4 | 1.3 | 0.6 | 0.7 | **1.9** | 0.8 | 1.3 |
| Cervix Uteri | 7.5 | **9.6** | 6.7 | **10.1** | **10.9** | 7.3 | | | | | | |
| Colon and Rectum | 32.1 | 37.6 | 28.5 | **44.2** | 31.4 | 37.8 | 41.4 | 47.9 | 38.4 | **59.1** | 44.2 | 49.8 |
| Corpus Uteri | 26.8 | 21.5 | 18.4 | 23.7 | 21.9 | 25.8 | | | | | | |
| Esophagus | 1.8 | 1.9 | 1.1 | **2.5** | 1.2 | 1.9 | 7.8 | 7.4 | 3.8 | 8 | 5.2 | 8.8 |
| Gallbladder | 1.3 | **2.7** | 1.5 | **1.9** | **2.6** | 1.1 | 0.8 | **1.5** | **1.1** | **1.3** | **1.3** | 0.7 |
| Kidney and Renal Pelvis | 12.0 | **16** | 5.1 | 12.6 | 12.2 | 11.1 | 23.4 | 28.4 | 10.8 | 24.2 | 21.4 | 21.8 |
| Larynx | 1.1 | 1.3 | 0.3 | **1.8** | 0.7 | **1.5** | 4.9 | 5.5 | 2.2 | **9.2** | 5 | **6.2** |
| Leukemias | 11.0 | 9.1 | 6.4 | 8.9 | 9.6 | 11.4 | 17.8 | 13.6 | 10 | 13.7 | 13.7 | 19.1 |
| Liver | 3.4 | **6.8** | **6.3** | 4 | **6.3** | 2.4 | 10.9 | **16.3** | **18.3** | **14.7** | **17.7** | 8.2 |
| Lung and Bronchus | 48.5 | 51.1 | 28.3 | 49.8 | 25.7 | 57.6 | 59.6 | 65.2 | 45.7 | **89.8** | 41.5 | **77.9** |
| Melanoma of the Skin | 18.4 | 6.5 | 1.2 | 1 | 4.6 | 21.5 | 28.7 | 9.7 | 1.5 | 1.1 | 5 | 32.7 |
| Myeloma | 5.8 | 5.6 | 3.1 | **11.8** | 5.6 | 4.6 | 8.6 | 7.2 | 4.8 | **15.8** | 7.9 | 7.4 |
| Non-Hodgkin Lymphoma | 15.4 | 13.3 | 11 | 12.1 | 15.6 | 16.9 | 22.3 | 16.3 | 15.9 | 17.4 | 20.5 | 24.4 |
| Oral Cavity and Pharynx | 6.6 | 5.7 | 5.3 | 5.3 | 4.4 | 6.8 | 18.0 | 15 | 11.5 | 15.3 | 10.9 | 18.7 |
| Ovary | 10.1 | 10.9 | 9.4 | 9.5 | 10.7 | 12.5 | | | | | | |
| Pancreas | 11.9 | 10.1 | 8.7 | 14.5 | 10.6 | 10.7 | 15.3 | 11.8 | 10.2 | 17.4 | 12.4 | 14.3 |
| Prostate | | | | | | | 113.1 | 93.5 | 69.3 | **210.5** | 109.1 | 128.1 |
| Stomach | 4.7 | **6.2** | **8.3** | **8.1** | **8.2** | 3.6 | 8.3 | **10.8** | **14.4** | **14.9** | **13.1** | 7.9 |
| Thyroid | 19.0 | 14.8 | 19.6 | 11.4 | 18.6 | 18.7 | 6.9 | 4.5 | 6.3 | 3.3 | 5.1 | 6.8 |
| Urinary Bladder, invasive and in situ | 8.1 | 5.2 | 3.7 | 6.7 | 5.3 | 10 | 32.5 | 20.5 | 15.3 | 19.7 | 20.3 | 40.3 |
| **Dem subgroup:** | | | | | | | | | | | | |
| Sex: | Female | Female | Female | Female | Female | Female | Male | Male | Male | Male | Male | Male |
| Race/Ethnicity: | All | Amer Ind | Asian/PI | Black | Hisp | White | All | Amer Ind | Asian/PI | Black | Hisp | White |

**Notes:** Table presents national cancer incidence rates (per 100,000 population). Data obtained from CDC, 2021b in October 2024, and are based on incidence during the years 2017-2021. Cancer sites presented in this table include all leading and invasive cancer types. All statistics are age-adjusted rates, based on 2000 U.S. standard population. Race/ethnicity subgroups are: non-Hispanic American Indian and Alaska Native, non-Hispanic Asian and Pacific Islander, non-Hispanic Black, Hispanic, non-Hispanic White. **Bold font** designates subgroup-specific incidence rates that are 25% or more above the corresponding national average. Underlined values denote concentration ratios subgroup-specific incidence rates that are 50% or more above the corresponding national average.

**Return to:** Section 3.5.

**Table 3:** Exposure pathways and cancer types for chemicals with exposure disparities

| **Chemical** | **Major Prod. Categories** | **Exp. route** | **Cancers: animal** | **Cancers: human** | **General exposure** | **Occupational exposure** |
|---|---|---|---|---|---|---|
| Arsenic | Mining And Smelting; Herbicides And Pesticides; Metals And Electronics | Ingestion | **Leukemia**; **Lung**; **Lymphoma**; **Stomach** | **Bladder**; **Skin**; **Lung**; Stomach; **Digestive**; **Liver**; **Kidney**; **Prostate**; Lymphatic; Hemtopoeitic | Electronics/ Small Appliances; Cleaning Products; Art/ Office Supplies; Home Maintenance; Vehicle; Food/ Food Additives; Smoking And Tobacco; Drinking Water; Environmental Releases | Manufacturing; Processing; Vehicle; Farming/ Agriculture; Medical/ Dental |
| 1-Naphthylamine | Plastics And Rubber; Textiles; Laboratory Supplies; Herbicides And Pesticides; Pharmaceuticals | Inhalation; Dermal | | Bladder | Food/ Food Additives; Smoking And Tobacco | Manufacturing; Processing |
| Acrylonitrile | Paints, Finishes, Adhesives; Plastics And Rubber; Inks And Dyes; Pharmaceuticals; Textiles | Inhalation; Ingestion; Dermal | **Brain**; **Breast**; **CNS**; Prostate | **Bladder**; **Lung**; Lymphatic; Stomach; Colon; Respiratory | Art/ Office Supplies; Home Maintenance; Smoking And Tobacco; Furniture/ Furnishings; Food/ Food Additives; Vehicle | Manufacturing; Processing; Home Maintenance |
| Furan | Paints, Finishes, Adhesives; Herbicides And Pesticides; Pharmaceuticals; Wood And Lumber; Petroleum, Oil, Biofuels; Food And Food Production | Inhalation; Dermal | **Liver**; **Bile-Duct**; **Adrenal**; **Leukemia** | | Smoking And Tobacco; Food/ Food Additives; Environmental Releases; Drinking Water | Manufacturing |
| 1,4-Dichlorobenzene | Food And Food Production; Herbicides And Pesticides; Disinfectants; Inks And Dyes; Pharmaceuticals; Plastics And Rubber; Metals And Electronics; Leather Tanning And Processing; Textiles; Laboratory Supplies | Inhalation; Ingestion; Dermal | Stomach; **Kidney**; **Leukemia**; **Adrenal**; **Liver** | Leukemia | Cleaning Products; Personal Care; Vehicle; Food/ Food Additives; Drinking Water; Environmental Releases | Vehicle; Manufacturing; Processing; Farming/ Agriculture |

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**Table 3:** Exposure pathways and cancer types for chemicals with exposure disparities

| **Chemical** | **Major Prod. Categories** | **Exp. route** | **Cancers: animal** | **Cancers: human** | **General exposure** | **Occupational exposure** |
|---|---|---|---|---|---|---|
| 2,4- Dichlorophenoxyacetic Acid | Herbicides And Pesticides; Food And Food Production | Ingestion; Inhalation | | Non-Hodgkin's Lymphoma; Sarcoma; Colorectal; Gastrointestinal; Breast; Brain | Landscape/ Yard | Farming/ Agriculture; Cleaning Products; Manufacturing; Processing |
| Ethylene Oxide | Laboratory Supplies; Herbicides And Pesticides; Food And Food Production; Disinfectants; Cosmetics | Inhalation; Ingestion | **Leukemia**; **Brain**; **Breast**; **Lung**; **Lymphoma**; **Uterus**; **Mesothelium** | **Leukemia**; Stomach; **Lymphatic**; **Breast**; **Myeloma** | Environmental Releases; Smoking And Tobacco; Personal Care; Home Maintenance; Food/ Food Additives; Vehicle | Medical/ Dental; Manufacturing; Farming/ Agriculture |
| 4-Methyl-2-Pentanone | Paints, Finishes, Adhesives; Pharmaceuticals; Plastics And Rubber; Textiles; Inks And Dyes; Solvents; Cosmetics; Wood And Lumber; Metals And Electronics; Food And Food Production | Inhalation; Dermal; Ingestion | Leukemia; Renal; Kidney; Liver | Bladder; Lung | Art/ Office Supplies; Food/ Food Additives; Cleaning Products; Furniture/ Furnishings; Electronics/ Small Appliances; Personal Care; Home Maintenance; Pet Care | Art/ Office Supplies; Cleaning Products; Vehicle; Personal Care |
| Diazinon | Herbicides And Pesticides | Dermal | Leukemia; Lymphoma | **Lung**; **Leukemia**; **Lymphoma** | Food/ Food Additives; Drinking Water; Environmental Releases; Landscape/ Yard | Farming/ Agriculture; Pet Care |
| Diethanolamine | Disinfectants; Concrete And Construction; Mining And Smelting; Herbicides And Pesticides; Textiles; Pharmaceuticals; Cosmetics; Inks And Dyes; Paper And Pulp Processing; Petroleum, Oil, Biofuels; Paints, Finishes, Adhesives; Plastics And Rubber; Metals And Electronics | Dermal; Inhalation | Liver; Renal | Stomach; Respiratory; Liver; Pancreas; Prostate; Leukemia | Cleaning Products; Food/ Food Additives; Art/ Office Supplies; Personal Care; Electronics/ Small Appliances | Cleaning Products; Construction/ Building; Manufacturing; Processing; Vehicle; Electronics/ Small Appliances |

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**Table 3:** Exposure pathways and cancer types for chemicals with exposure disparities

| Chemical | Major Prod. Categories | Exp. route | Cancers: animal | Cancers: human | General exposure | Occupational exposure |
|---|---|---|---|---|---|---|
| Ethylene Thiourea | Plastics And Rubber; Paints, Finishes, Adhesives; Disinfectants; Textiles; Metals And Electronics; Waste Incineration And Treatment; Herbicides And Pesticides | Inhalation; Ingestion; Dermal | **Liver**; **Thyroid**; **Leukemia** | Thyroid | Food/ Food Additives; Drinking Water; Environmental Releases | Manufacturing; Processing; Vehicle; Farming/ Agriculture |
| Nitrofen | Herbicides And Pesticides; Food And Food Production | Inhalation; Ingestion; Dermal | **Liver**; **Pancreas**; **Bile-duct** | | Food/ Food Additives | Farming/ Agriculture; Manufacturing |
| Polychlorinated Biphenyls (PCBs) | Metals And Electronics; Paints, Finishes, Adhesives; Herbicides And Pesticides; Inks And Dyes; Food And Food Production; Laboratory Supplies; Plastics And Rubber; Waste Incineration And Treatment | Inhalation | **Liver**; **Bile-duct**; **Lung**; **Oral cavity**; **Pancreas**; **Spleen**; **Uterus** | **Melanoma**; **Liver**; Bile-Duct; Gastro-Intestinal; **Lymphoma**; **Breast** | Environmental Releases; Drinking Water; Food/ Food Additives | Farming/ Agriculture; Manufacturing; Research |
| Vinyl Chloride | Plastics And Rubber; Food And Food Production; Metals And Electronics; Wood And Lumber; Leather Tanning And Processing | Ingestion; Inhalation; Dermal | **Breast**; **Kidney**; **Liver**; **Bile-duct**; **Lung**; **Nasal cavity**; **Skin**; **Stomach** | **Liver**; Brain; Lung; Lymphoma; Leukemia | Smoking And Tobacco; Environmental Releases; Drinking Water; Food/ Food Additives; Vehicle; Home Maintenance | Manufacturing; Processing; Vehicle; Construction/ Building |
| 2-Methylaniline | Textiles; Pharmaceuticals; Herbicides And Pesticides | Dermal; Inhalation; Ingestion | | Bladder | Personal Care; Smoking And Tobacco | Manufacturing; Research |
| Acrylamide | Waste Incineration And Treatment; Inks And Dyes; Pharmaceuticals; Cosmetics; Paper And Pulp Processing; Textiles; Mining And Smelting; Petroleum, Oil, Biofuels; Food And Food Production; Concrete And Construction; Paints, Finishes, Adhesives | Ingestion; Dermal; Inhalation | **Breast**; **Thyroid**; **Testicular**; **Adrenal**; **Oral**; **Uterus Lung** | Pancreatic; Breast | Food/ Food Additives; Vehicle; Home Maintenance; Smoking And Tobacco; Landscape/ Yard; Personal Care; Drinking Water | Mining; Processing; Manufacturing; Farming/ Agriculture; Art/ Office Supplies; Home Maintenance |

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**Table 3:** Exposure pathways and cancer types for chemicals with exposure disparities

| Chemical | Major Prod. Categories | Exp. route | Cancers: animal | Cancers: human | General exposure | Occupational exposure |
|---|---|---|---|---|---|---|
| Melamine | Laboratory Supplies; Paints, Finishes, Adhesives; Wood And Lumber; Leather Tanning And Processing; Metals And Electronics; Textiles; Paper And Pulp Processing; Plastics And Rubber | Ingestion; Inhalation; Dermal | Bladder | Bladder; Kidney | Furniture/ Furnishings; Food/ Food Additives | Cleaning Products; Construction/ Building; Manufacturing; Processing |
| Perfluorooctanesulfonic Acid | Paints, Finishes, Adhesives; Metals And Electronics; Food And Food Production; Textiles; Paper And Pulp Processing; Petroleum, Oil, Biofuels; Herbicides And Pesticides | Ingestion; Inhalation; Dermal | Liver; Thyroid; Testicular; Breast; Pancreas | Bladder; Testicular; Kidney; Thyroid; Prostate; Breast; Ovarian | Food/ Food Additives; Environmental Releases; Home Maintenance; Cleaning Products; Furniture/ Furnishings; Drinking Water | Farming/ Agriculture; Manufacturing |
| 1,2-Propylene Oxide | Food And Food Production; Pharmaceuticals; Disinfectants; Textiles; Paints, Finishes, Adhesives; Herbicides And Pesticides; Food And Food Production; Plastics And Rubber; Concrete And Construction | Dermal; Inhalation | Nasal/Sinus; Adrenal; Stomach; Mammary | Lymphatic | Personal Care; Food/ Food Additives; Vehicle; Home Maintenance; Cleaning Products | Farming/ Agriculture; Research; Processing; Cleaning Products |
| 1-Naphthalenol | Inks And Dyes; Cosmetics; Pharmaceuticals; Plastics And Rubber; Leather Tanning And Processing; Metals And Electronics; Herbicides And Pesticides | Inhalation; Dermal | Nasal/Sinus; Lung | Bladder; Lung; Breast | Personal Care; Art/ Office Supplies; Food/ Food Additives; Smoking And Tobacco | Farming/ Agriculture; Processing |
| Di(2-Ethylhexyl) Phthalate | Plastics And Rubber; Herbicides And Pesticides; Inks And Dyes; Metals And Electronics; Laboratory Supplies; Food And Food Production; Cosmetics; Paints, Finishes, Adhesives | Ingestion; Inhalation; Medical Procedure | **Liver**; Pancreas; **Testicular** | Breast; Ovarian; Thyroid; Testicular | Furniture/ Furnishings; Vehicle; Home Maintenance; Personal Care; Art/ Office Supplies; Construction/ Building; Food/ Food Additives; Toys And Recreation; Environmental Releases; Drinking Water | Medical/ Dental; Construction/ Building; Processing |

Continued, next page...

**Table 3:** Exposure pathways and cancer types for chemicals with exposure disparities

| **Chemical** | **Major Prod. Categories** | **Exp. route** | **Cancers: animal** | **Cancers: human** | **General exposure** | **Occupational exposure** |
|---|---|---|---|---|---|---|
| Naphthalene | Herbicides And Pesticides; Leather Tanning And Processing; Wood And Lumber; Textiles; Disinfectants; Petroleum, Oil, Biofuels; Plastics And Rubber; Pharmaceuticals | Inhalation; Ingestion | **Lung**; **Nasal/Sinus**; Brain | Larynx; Colorectal | Medical/ Dental; Home Maintenance; Smoking And Tobacco; Environmental Releases; Electronics/ Small Appliances; Food/ Food Additives | Vehicle; Cleaning Products; Construction/ Building; Home Maintenance; Manufacturing; Processing |
| Beta- Hexachlorocyclohexane | Laboratory Supplies; Herbicides And Pesticides | Inhalation; Dermal | Liver | Leukemia; Melanoma | Food/ Food Additives; Environmental Releases; Drinking Water | Farming/ Agriculture |
| DDT | Laboratory Supplies; Pharmaceuticals; Food And Food Production; Herbicides And Pesticides | Ingestion | **Liver**; **Lung**; **Lymphoma**; Thyroid | Breast; **Non-Hodgkin's Lymphoma**; **Testicular**; **Liver**; **Bile-duct** | Food/ Food Additives; Drinking Water; Smoking And Tobacco; Personal Care | Farming/ Agriculture; Manufacturing; Pet Care |
| 2-Naphthylamine | Plastics And Rubber; Textiles | Dermal; Inhalation; Ingestion | **Liver**; **Bile-duct**; **Bladder** | **Bladder** | Cleaning Products; Smoking And Tobacco; Environmental Releases | Manufacturing |
| 4-(N-Methyl-N-Nitrosamino)-1-(3-Pyridyl)-1-Butanone | Laboratory Supplies | Inhalation | **Nasal/Sinus**; **Lung**; **Liver**; **Bile-duct**; **Adrenal**; **Leukemia**; **Lymphoma**; **Larynx**; **Pancreas** | Lung | Smoking And Tobacco | |
| Dimethylarsinic Acid | Herbicides And Pesticides; Pharmaceuticals; Chemical Weapons; Wood And Lumber | Inhalation | Lung; Bladder; Kidney; Liver; Thyroid | | | Landscape/ Yard; Farming/ Agriculture; Pet Care; Processing |

Continued, next page...

**Table 3:** Exposure pathways and cancer types for chemicals with exposure disparities

| Chemical | Major Prod. Categories | Exp. route | Cancers: animal | Cancers: human | General exposure | Occupational exposure |
|---|---|---|---|---|---|---|
| Acrolein | Herbicides And Pesticides; Wood And Lumber; Leather Tanning And Processing; Plastics And Rubber; Disinfectants; Glass And Ceramics; Textiles; Inks And Dyes; Food And Food Production; Metals And Electronics; Waste Incineration And Treatment | Inhalation; Ingestion | Nasal/Sinus; Lung | Lung; Colorectal | Art/ Office Supplies; Smoking And Tobacco; Food/ Food Additives; Drinking Water | Farming/ Agriculture; Processing; Manufacturing; Cleaning Products |

**Notes:** Compiled information on exposure sources/types, product categories, and associated cancer types for the complete list of 28 carcinogens which presented the strongest evidence of exposure differences across demographic subgroups. Column (1) is the chemical name. Column (2) is the list of major product categories in which the chemical is used. Column (3) lists relevant exposure routes for the carcinogen. Column (4) lists cancer types linked with the chemical in animal testing. Column (5) lists cancer types linked with the chemical in human/epidemiological studies. Column (6) lists general population exposure sites. Column (7) lists occupational exposure sites. **Bold** text in columns (4) and (5) indicate that evidence supporting an animal-based or human-based link between carcinogen exposure and the cancer site is included in NTP's Report on Carcinogens dashboard (ROC, 2022) or the IARC's list of classifications by cancer sites with sufficient or limited evidence in humans (IARC, 2024). Other evidence sources include: CompTox (Williams et al., 2017), PubChem (Kim et al., 2023), and Haz-Map (Brown, 2024). See Section 3.4 and Appendix C for further details of literature and data review methods.
**Return to:** Section 3.4, Section 3.5.

# Appendices for "Identifying disparities in U.S. exposure to ubiquitous carcinogens"

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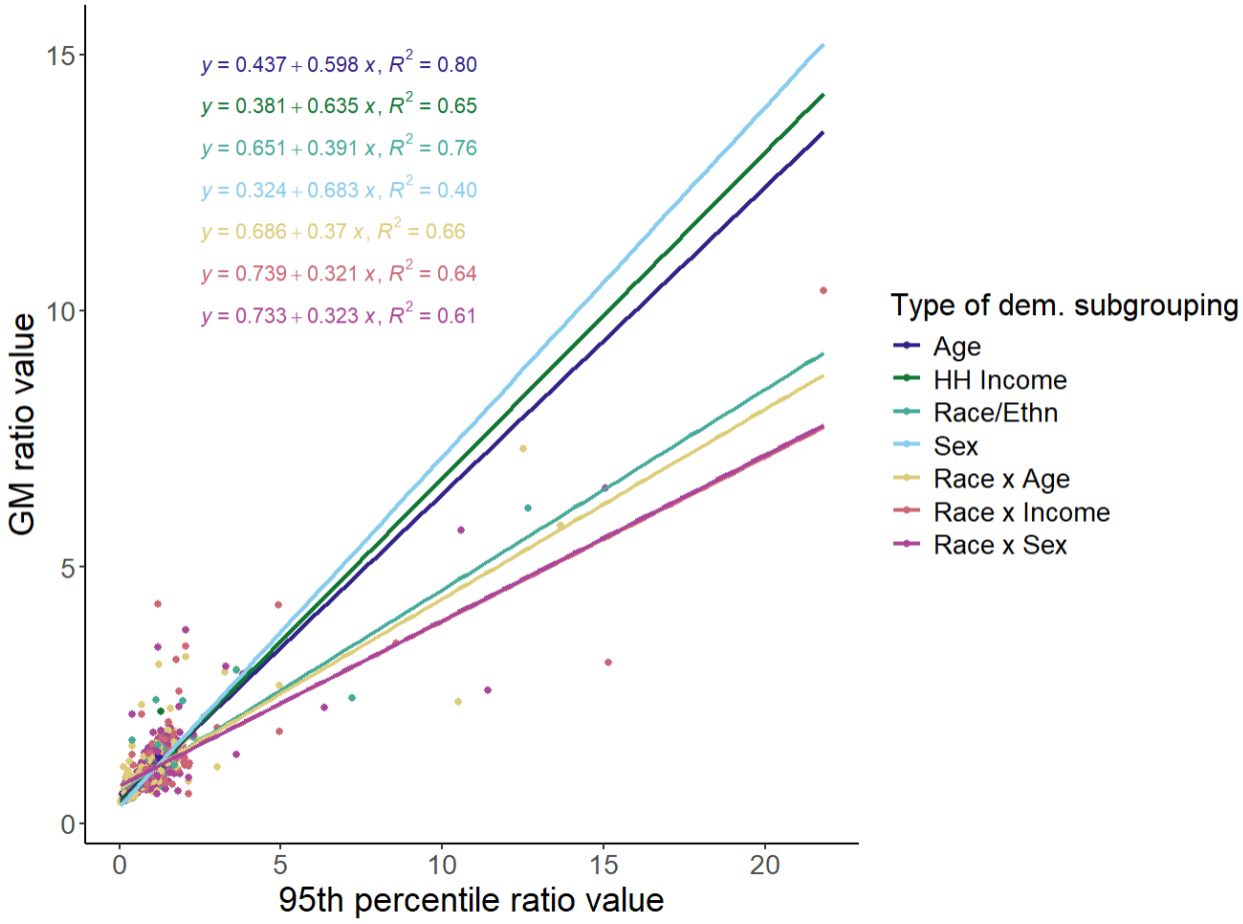
December 2024

## Appendices

# A Supplemental figures and tables

**Figure A1:** Correlations between NHANES GM ratio and P95 ratio values

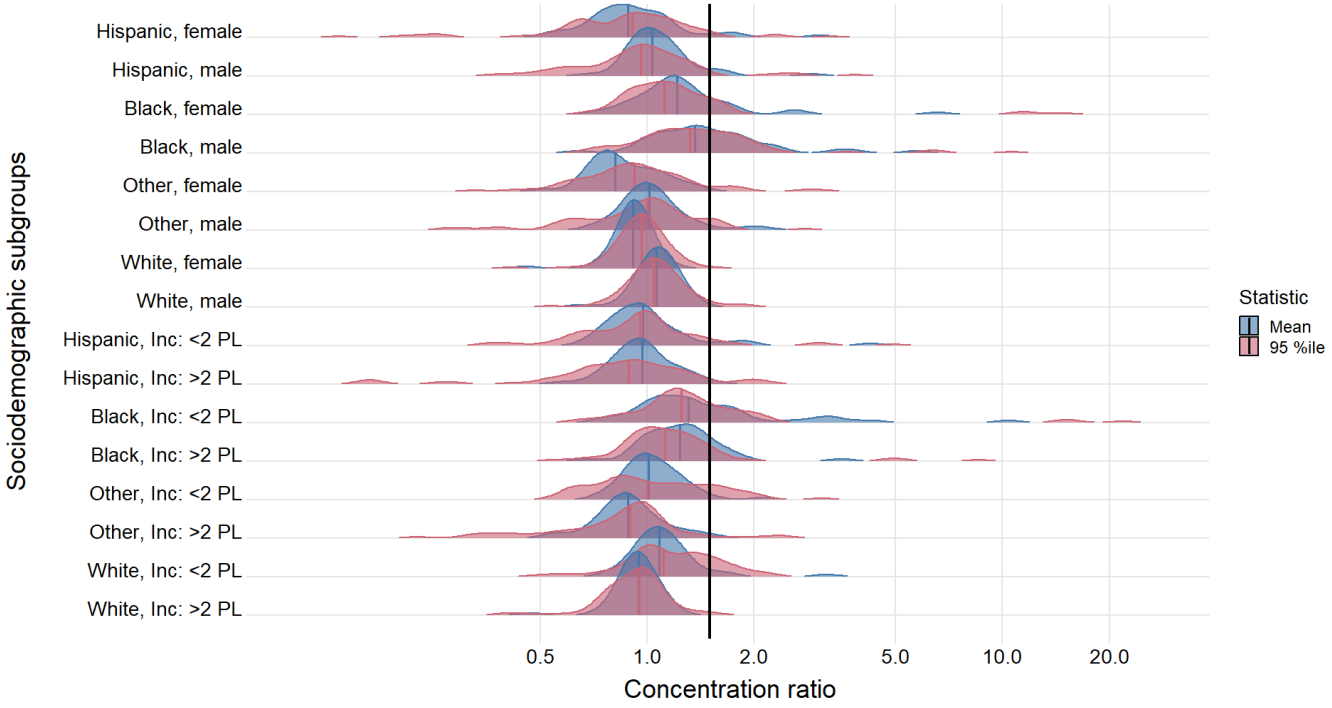



**Notes:** Correlation between calculated NHANES geometric mean ratio values and 95$^{th}$ percentile ratio values for different demographic subgroups. Each observation in these correlation regressions is a **complete** quartet of characteristics {Demographic subgroup, Chemical, GM ratio value, 95th %ile value}. If a subgroup-specific geometric mean concentration could not be calculated due to detection limits, the observation cannot be used in a correlation regression. Demographic subgroups include age (<19, 20+), HH income (<2x poverty line, >2x poverty line), Race/Ethnicity (Hispanic, non-Hispanic Black, non-Hispanic White, Other), Sex (Female, Male), and their interactions (denoted by $(\cdot) \times (\cdot)$). Correlation regressions fit on 94 observations for Age subgroups, 95 observations for HH Income subgroups, 190 observations for Race/Ethnicity subgroups, 95 observations for Sex subgroups, 371 observations for Race × Age subgroups, 378 observations for Race × Income subgroups, and 374 observations for Race × Sex subgroups.

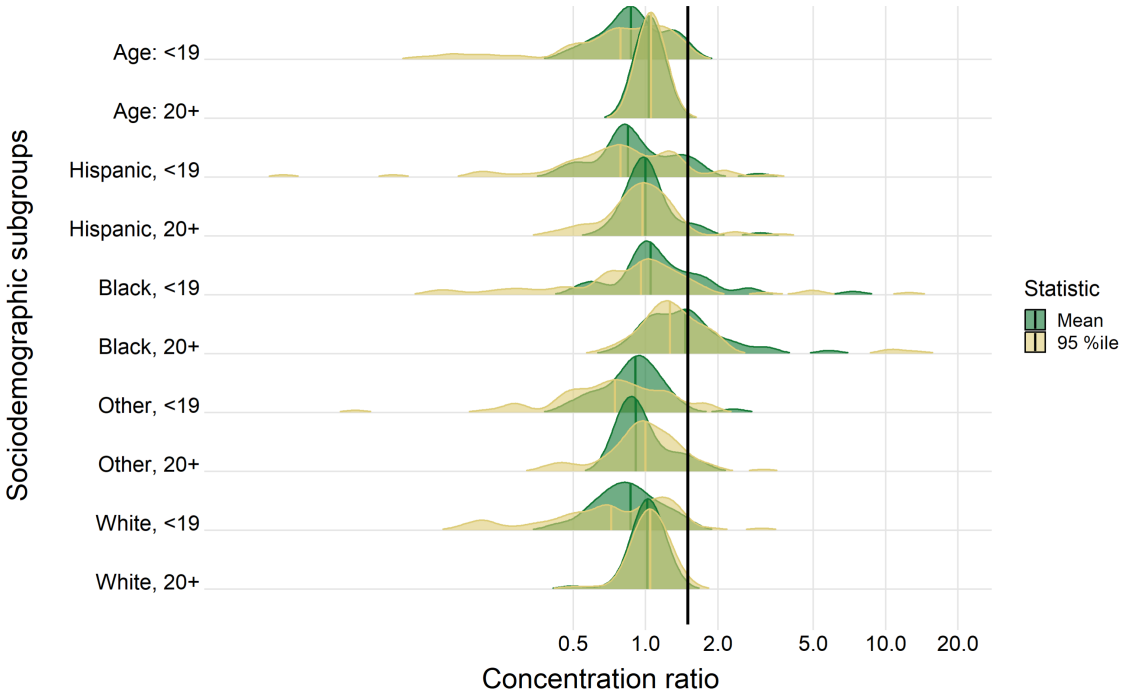
**Return to:** Section 3.1.3.

**Figure A2:** Cross-chemical summary of demographic heterogeneity analysis using individual-level NHANES data

**(a)** Distribution of geometric mean and 95th %ile ratios across (N = 39, 62) carcinogens, by demographic interactions

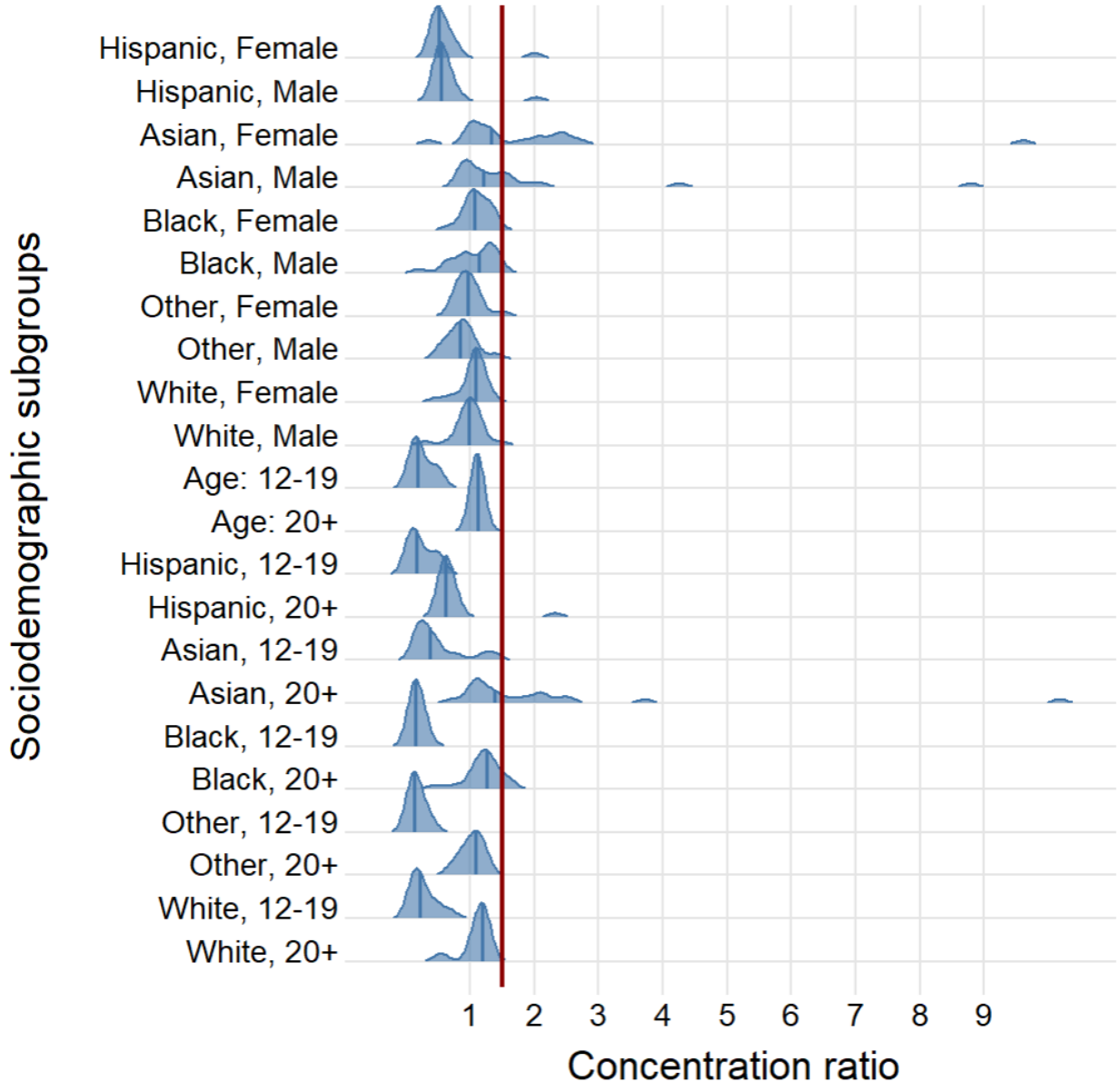



**(b)** Distribution of geometric mean and 95th %ile ratios across (N = 39, 62) carcinogens, by age-differentiated demographics



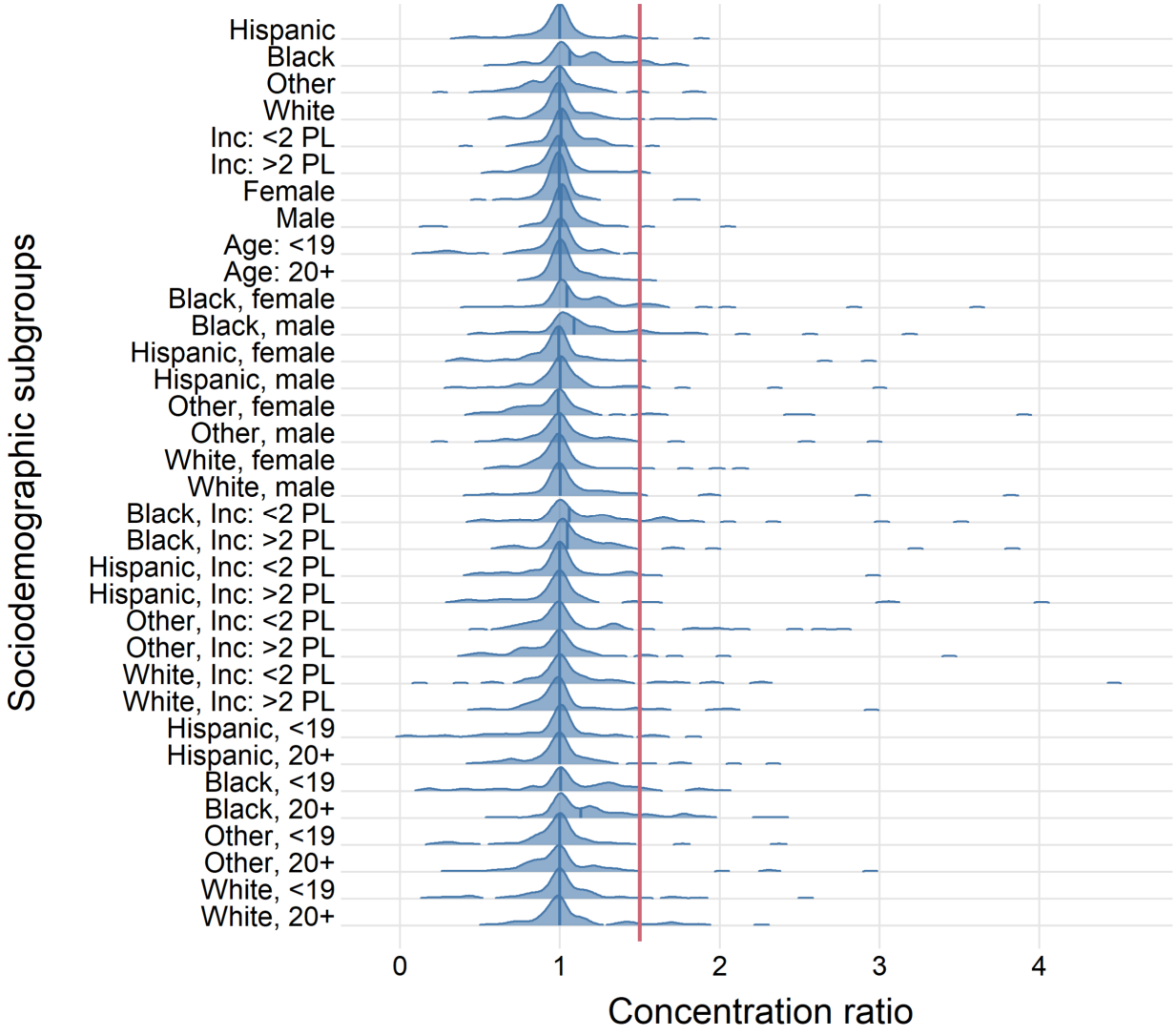

**Notes:** Panel (a) illustrates the full distribution of geometric mean (N = 39) and 95th percentile (N = 62) concentration ratios across matched carcinogens, differentiated by demographic subgroup. Subgroups in this panel include interactions of race/ethnicity and sex, and interactions of race/ethnicity and household income. The full, chemical-level results for these demographic subgroups are presented in Appendix Table A5 and Table A11. Panel (b) illustrates the full distribution of geometric mean (N = 39) and 95th percentile (N = 62) concentration ratios across matched carcinogens, presented by age subgroup, including age subgroups differentiated by race/ethnicity. The full, chemical-level results for these demographic subgroups are presented in Appendix Table A6 and Table A12. In both panels, subgroups' median GMR and $PR_{95}$ are marked on their respective density plot.
**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.
**Return to:** Section 3.1.

**Figure A3:** Distribution of arithmetic mean concentration ratios across (N = 22) carcinogens for *pooled* NHANES samples, by demographic subgroup



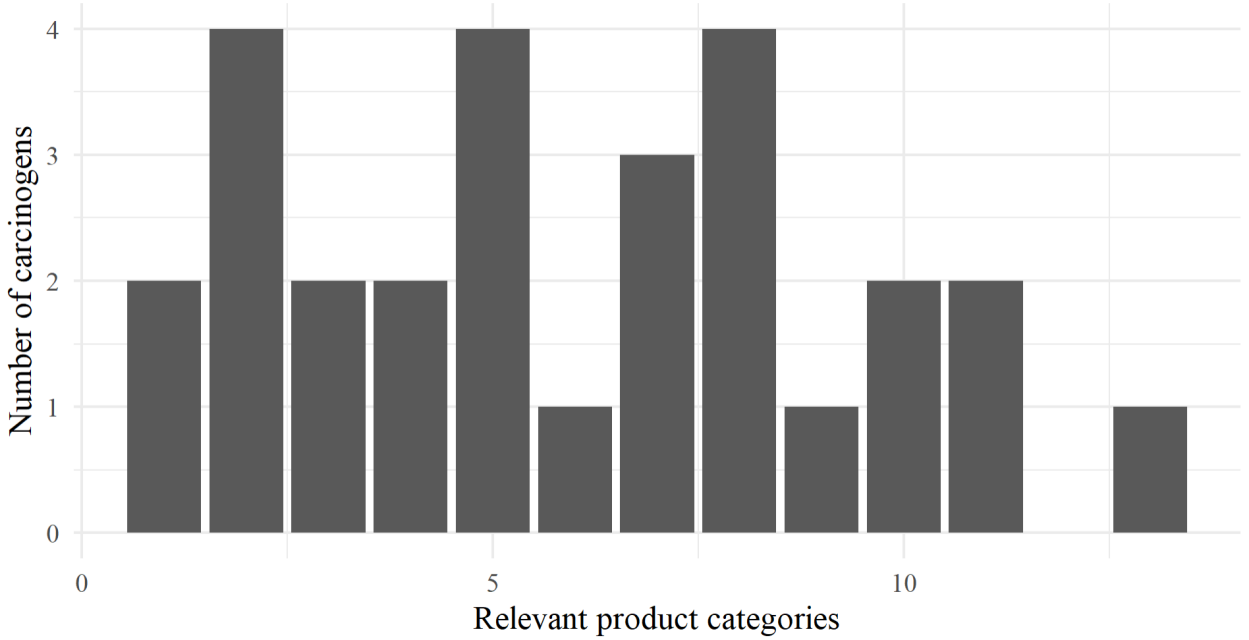

**Notes:** This figure illustrates the full distribution of arithmetic mean concentration ratios across the 22 matched carcinogens from pooled NHANES samples, differentiated by demographic subgroup. Subgroups in this figure include interactions of race/ethnicity and sex, and interactions of race/ethnicity and age. Each subgroup's median arithmetic mean ratio is marked on their respective density plot. The full set of arithmetic mean ratio results for these demographic subgroups are presented in Appendix Table A8 and Table A9.
**Demographic subgroups:** Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.
**Return to:** Section 3.1.2.

**Figure A4:** Distribution of sample detection ratios across (N = 82) carcinogens for individual NHANES samples, by demographic subgroup




**Notes:** This figure illustrates the full distribution of sample detection ratios across the 82 matched carcinogens, differentiated by demographic subgroup. The sample detection ratio for a given chemical and subgroup is given as the subgroup's survey-weighted fraction of samples with concentrations above the detection limit divided by the total population's survey-weighed fraction of samples with concentrations above the detection limit. Implicitly, for a chemical to be included in this analysis, at least one sample in the individual-level NHANES data must be detectable. The full set of sample detection ratio results for these demographic subgroups are presented in Appendix Table A13, Table A14, and Table A15. Each subgroup's median sample detection ratio is marked on their respective density plot.
**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.
**Return to:** Section 3.1.4.

**Figure A5:** Exposure sourcing: number of identified product categories in which each chemical is used




**Notes:** Histogram of the count of associated product categories for each of the (N = 28) carcinogens found to have likely exposure disparities. For example, two carcinogens are associated with a single product category, four carcinogens are associated with two different product categories, ..., and one carcinogen is associated with thirteen different product categories. See Section 3.4 for description of exposure pathway information collection and product categorization methods.

**Return to:** Section 2.4, Section 3.4.

**Table A1:** Summary of carcinogen list sourcing, classification, and data coverage

| **Panel A: Source List** | (1) All | (2) Cand. | (3a) Dir. BM | (3b) Metab. BM | (4) RSEI | (5) DW | (6) HHP | (7) Any Data |
|---|---|---|---|---|---|---|---|---|
| IARC | 41 | 30 | 5 | 4 | 6 | 2 | 5 | 12 |
| ROC | 47 | 28 | 1 | 0 | 5 | 1 | 1 | 7 |
| Prop65 | 173 | 141 | 12 | 5 | 38 | 14 | 4 | 45 |
| SVHC | 35 | 24 | 1 | 0 | 0 | 0 | 0 | 1 |
| IARC & ROC | 5 | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| IARC & Prop65 | 161 | 141 | 16 | 5 | 36 | 10 | 12 | 48 |
| IARC & SVHC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ROC & Prop65 | 49 | 45 | 2 | 1 | 9 | 4 | 2 | 12 |
| ROC & SVHC | 14 | 14 | 0 | 0 | 0 | 0 | 0 | 0 |
| Prop65 & SVHC | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| ROC, Prop65 & SVHC | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| IARC, ROC & Prop65 | 164 | 156 | 38 | 14 | 67 | 30 | 14 | 79 |
| IARC, Prop65 & SVHC | 7 | 7 | 0 | 0 | 2 | 0 | 0 | 2 |
| IARC, ROC & SVHC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Lists | 28 | 28 | 10 | 3 | 22 | 6 | 5 | 22 |
| **Total** | **727** | **622** | **85** | **32** | **186** | **67** | **44** | **230** |

| **Panel B: Classification** | (1) All | (2) Cand. | (3) Dir. BM | (4) Metab. BM | (5) RSEI | (6) DW | (7) HHP | (8) Any Data |
|---|---|---|---|---|---|---|---|---|
| Known Carcinogen | 112 | 96 | 16 | 6 | 22 | 18 | 9 | 30 |
| Probable Carcinogen | 234 | 218 | 37 | 16 | 90 | 25 | 16 | 103 |
| Possible Carcinogen | 172 | 142 | 19 | 5 | 35 | 10 | 15 | 50 |
| Other | 209 | 166 | 13 | 5 | 39 | 14 | 4 | 47 |
| **Total** | **727** | **622** | **85** | **32** | **186** | **67** | **44** | **230** |

**Notes:** Summary of carcinogen list sources (Panel A) and carcinogen classification (Panel B) for subsets of the 727 listed carcinogens and the 622 candidate carcinogens scoped into the analysis. All numeric values are applicable carcinogens counts. Column (1): all potential carcinogens. Column (2): all carcinogen candidates found to be ubiquitous. Column (3): set of carcinogens directly biomonitored by NHANES. Column (4): carcinogens indirectly biomonitored by metabolite. Column (5): carcinogens whose industrial releases are monitored in TRI/RSEI. Column (6) carcinogens monitored in drinking water by at least one PWS. Column (7): carcinogens matched as ingredients in purchased products for household product analysis. Column (8): set of carcinogens for which data was available (and detectable) in at least one analysis.

**Return to:** Section 2.1.2.

**Table A2:** Summary of carcinogen biomonitoring detection in NHANES

| Chemical | GM | AM | P95 | Detect |
|---|---|---|---|---|
| 1,1,1,2-Tetrachloroethane | | | | |
| 1,1,1-Trichloroethane | | | | T |
| 1,1,2,2-Tetrachloroethane | | | | T |
| 1,1,2-Trichloroethane | | | | |
| 1,1-Dichloroethane | | | | |
| 1,1-Dichloroethylene | | | | |
| 1,2,3,4,5,6-Hexachlorocyclohexane | | | T | T |
| 1,2,3-Trichloropropane | | | | |
| 1,2-Dibromo-3-chloropropane | | | | |
| 1,2-Dibromoethane | | | | |
| 1,2-Dichloropropane | | | | |
| 1,2-Propylene oxide | T | | T | T |
| 1,3-Butadiene | T | | T | T |
| 1,4-Dichlorobenzene | T | | T | T |
| 1,4-Dioxane | | | | |
| 1-Bromopropane | T | | T | T |
| 1-Naphthalenol, 1-(N-methylcarbamate) | T | | T | T |
| 1-Naphthylamine | T | | T | T |
| 2,3,4,7,8-Pentachlorodibenzofuran | | T | | T |
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin | | | | T |
| 2,4,6-Trichlorophenol | | | T | T |
| 2,4-Dichlorophenoxyacetic acid | T | | T | T |
| 2,6-Dimethylaniline | T | | T | T |
| 2-Amino-1-methyl-6-phenylimidazo [4,5-b]pyridine | | | T | T |
| 2-Amino-3-methyl-3H-imidazo[4,5-f]quinoline | | | | T |
| 2-Amino-alpha-carboline | | | T | T |
| 2-Anisidine | T | | T | T |
| 2-Methylaniline | T | | T | T |
| 2-Naphthylamine | T | | T | T |
| 2-Phenylphenol | | | T | T |
| 4,4'-Diaminobiphenyl methane | | | T | T |
| 4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone | T | | T | T |
| 4-Biphenylamine | T | | T | T |
| 4-Methyl-2-pentanone | | | | T |
| Acetochlor | | | | T |
| Acrolein | T | | T | T |
| Acrylamide | T | | T | T |
| Acrylonitrile | T | | T | T |
| Alachlor | | | | T |
| Arsenic | T | | T | T |
| Arsenic acid | | | T | T |
| Benzene | | | T | T |
| Beryllium | | | | |
| Bromodichloromethane | | | T | T |
| Bromoform | | | T | T |

Continued, next page...

**Table A2:** Summary of carcinogen biomonitoring detection in NHANES

| Chemical | GM | AM | P95 | Detect |
|---|---|---|---|---|
| Cadmium | T | | T | T |
| Carbon tetrachloride | | | | T |
| Chloroethane | | | | T |
| Chloroform | | | T | T |
| Cobalt | T | | T | T |
| Crotonaldehyde | T | | T | T |
| Cumene | | | | T |
| DDT | | T | | T |
| Di(2-ethylhexyl) phthalate | T | | T | T |
| Diazinon | | | T | T |
| Dichloromethane | | | | T |
| Dichlorvos | T | | T | T |
| Dieldrin | | | T | T |
| Diisononyl phthalate | | | T | T |
| Dimethylarsinic acid | T | | T | T |
| Ethylbenzene | T | | T | T |
| Ethylene oxide | T | | T | T |
| Ethylene thiourea | | | T | T |
| Formaldehyde | T | | T | T |
| Furan | | | T | T |
| Glu-P-1 | | | | T |
| Glu-P-2 | | | | T |
| Heptachlor epoxide B | | | T | T |
| Hexachlorobenzene | | | | |
| Hexachloroethane | | | | |
| Lead | T | | T | T |
| Lindane | | | | T |
| Malathion | T | | T | T |
| MeA-alpha-C | | | T | T |
| Melamine | T | | T | T |
| Methylarsonic acid | | | T | T |
| Mirex | | | | T |
| N'-Nitrosonornicotine | | | T | T |
| N,N-Dimethylformamide | T | | T | T |
| N-Nitroso-N-methylethylamine | | | | T |
| N-Nitrosodiethylamine | | | | T |
| N-Nitrosomorpholine | | | | T |
| N-Nitrosopiperidine | | | | T |
| N-Nitrosopyrrolidine | | | | T |
| Naphthalene | T | | T | T |
| Nickel | T | | T | T |
| Nitrobenzene | | | | |
| Nitrofen | T | | T | T |
| Nitromethane | T | | T | T |
| Pentachlorophenol | | | T | T |

Continued, next page...

**Table A2:** Summary of carcinogen biomonitoring detection in NHANES

| Chemical | GM | AM | P95 | Detect |
|---|---|---|---|---|
| Perfluorooctanesulfonic acid | T | | T | T |
| Perfluorooctanoic acid | T | | T | T |
| Polybrominated biphenyls (PBB) | | T | | T |
| Polychlorinated biphenyls | | T | | T |
| Propoxur | | | | |
| Styrene | T | | T | T |
| Tetrachloroethylene | | | T | T |
| Tetrahydrofuran | | | | T |
| Trichloroethylene | | | | T |
| Tris(2-chloroethyl) phosphate | T | | T | T |
| Trp-P-1 | | | | T |
| Vinyl bromide | | | | |
| Vinyl chloride | | | T | T |
| Z-Tetrachlorvinphos | T | | T | T |
| beta-Hexachlorocyclohexane | | T | | T |
| p,p'-DDE | | | | |

**Notes:** Summary of analyzability of the (N = 106) matched carcinogens with available NHANES biomonitoring data. A value of **T** in Columns (2-5) indicates that the chemical was measurable for that particular statistic. *GM* denotes the geometric mean ratio. *AM* denotes the arithmetic mean ratio. *P95* denotes the 95th percentile ratio. *Detect* denotes the detected sample ratio.

**Return to:** Section 2.2.1.

**Table A3:** Summary of carcinogens' product use categories and their data coverage

| **Product Uses** | (1) All | (2) Cand. | (3) Dir. BM | (4) Metab. BM | (5) RSEI | (6) DW | (7) HHP | (8) Any Data |
|---|---|---|---|---|---|---|---|---|
| Batteries | 69 | 68 | 17 | 6 | 31 | 11 | 18 | 40 |
| Cleaning and safety | 91 | 87 | 27 | 14 | 46 | 20 | 32 | 58 |
| Construction and building materials | 103 | 101 | 29 | 15 | 53 | 20 | 30 | 66 |
| Food and drug | 95 | 90 | 16 | 8 | 32 | 16 | 16 | 41 |
| Furniture and furnishings | 59 | 57 | 15 | 8 | 30 | 9 | 20 | 40 |
| Home maintenance | 128 | 124 | 33 | 17 | 68 | 27 | 33 | 83 |
| Industrial products | 112 | 110 | 31 | 15 | 59 | 24 | 33 | 75 |
| Laboratory supplies | 308 | 298 | 67 | 25 | 143 | 56 | 38 | 170 |
| Medical/dental | 55 | 54 | 17 | 6 | 31 | 11 | 23 | 37 |
| Personal care | 91 | 86 | 22 | 15 | 43 | 17 | 29 | 57 |
| Pesticides | 46 | 44 | 15 | 10 | 30 | 13 | 18 | 36 |
| Raw materials | 186 | 180 | 45 | 22 | 94 | 36 | 39 | 113 |
| Specialty occupational products | 118 | 114 | 28 | 13 | 60 | 23 | 29 | 71 |
| Vehicle | 75 | 73 | 24 | 14 | 42 | 18 | 29 | 54 |

**Notes:** Summary of carcinogens' product use categories and the corresponding exposure data coverage for subsets of the 727 listed carcinogens and the 622 candidate carcinogens scoped into the analysis. All numeric values are applicable carcinogens counts. Column (1): all potential carcinogens. Column (2): all carcinogen candidates found to be ubiquitous. Column (3): set of carcinogens directly biomonitored by NHANES. Column (4): carcinogens indirectly biomonitored by metabolite. Column (5): carcinogens whose industrial releases are monitored in TRI/RSEI. Column (6) carcinogens monitored in drinking water by at least one PWS. Column (7): carcinogens matched as ingredients in purchased products for household product analysis. Column (8): set of carcinogens for which data was available (and detectable) in at least one analysis.

**Return to:** Section 2.4, Section 3.4.

**Table A4:** NHANES GM biomarker concentration ratios: primary results

| **Chemical** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1-Naphthylamine | **1.45** | 0.82 | 0.77 | **1.93** | 0.98 | 0.79 | 0.92 | 1.08 |
| 1-naphthol** | 1.11 | 0.9 | 0.79 | **1.57** | 1.01 | 0.82 | 0.92 | 1.09 |
| 2,4-Dichlorophenoxyacetic acid | 0.97 | 1.02 | 0.89 | 1 | 1.04 | 0.9 | 0.89 | 1.13 |
| 2,4-dichlorophenol** | **1.36** | 0.82 | **1.67** | **2.44** | 0.76 | 0.74 | 0.97 | 1.03 |
| 2,5-dichlorophenol** | **2.08** | 0.63 | **2.98** | **6.15** | 0.54 | 0.77 | 0.91 | 1.1 |
| 2,6-Dimethylaniline | 1.05 | 0.98 | 0.96 | **1.26** | 1.01 | | 0.97 | 1.03 |
| 2-Anisidine | 0.98 | 1.02 | 0.88 | 1.01 | 1.06 | 0.83 | 0.89 | 1.12 |
| 2-Methylaniline | 1.12 | 0.94 | 0.98 | **1.53** | 0.95 | 0.85 | 0.92 | 1.09 |
| 2-Naphthylamine | 1.23 | 0.89 | 0.84 | **1.68** | 0.98 | 0.82 | 0.92 | 1.09 |
| 2-naphthol** | 1.21 | 0.87 | **1.47** | **1.69** | 0.85 | 0.73 | 0.96 | 1.05 |
| 4-Biphenylamine | 1.21 | 0.9 | 0.84 | **1.45** | 1 | 0.84 | 0.96 | 1.04 |
| Acrylamide | 1.06 | 0.97 | 0.95 | 1.13 | 1.01 | 0.92 | 0.94 | 1.07 |
| Arsenic | 0.96 | 1.01 | 1.07 | **1.32** | 0.87 | **1.56** | 0.92 | 1.1 |
| Bis(2-chloroethyl) phosphate** | 1.19 | 0.91 | 0.99 | 1.12 | 0.98 | 1.03 | 0.93 | 1.07 |
| Cadmium | 1.05 | 0.96 | 0.77 | 1.1 | 1.03 | 1.2 | 1.14 | 0.87 |
| Cobalt | 1 | 0.99 | 0.97 | 0.94 | 1.01 | 1 | 1.07 | 0.93 |
| Dimethyl phosphate** | 1.05 | 0.97 | 1.16 | 1.18 | 0.95 | 0.85 | 0.97 | 1.04 |
| Dimethyl thiophosphate** | 0.92 | 1.06 | 1 | 1.05 | 1.04 | 0.74 | 0.91 | 1.1 |
| Dimethylarsinic acid | 1.01 | 0.94 | 1.2 | 1.1 | 0.89 | **1.27** | 0.95 | 1.05 |
| Ethylene oxide | 1.23 | 0.87 | 0.92 | **1.46** | 0.95 | 1.04 | 0.92 | 1.09 |
| Formaldehyde | 0.98 | 1.01 | 1 | 0.94 | 1.01 | 0.99 | 1 | 1 |
| Lead | 1 | 0.99 | 0.83 | 1.01 | 1.03 | 1.17 | 0.88 | 1.15 |
| Mandelic acid** | 1.06 | 0.96 | 0.99 | **1.35** | 0.97 | 0.86 | 0.89 | 1.13 |
| Melamine | 1.05 | 0.99 | 0.71 | 0.73 | 1.1 | **1.62** | 0.92 | 1.09 |
| Mono-(2-ethyl-5-hydroxyhexyl) phthalate** | 1.15 | 0.92 | 1.06 | **1.32** | 0.94 | 0.93 | 0.9 | 1.11 |
| Mono-(2-ethyl-5-oxohexyl) phthalate** | 1.17 | 0.91 | 1.09 | **1.26** | 0.94 | 0.92 | 0.93 | 1.08 |
| Mono-2-ethyl-5-carboxypentyl phthalate** | 1.18 | 0.9 | 1.13 | 1.19 | 0.94 | 0.94 | 0.93 | 1.08 |
| N-Acetyl-S-(n-propyl)-L-cysteine** | 1.03 | 0.97 | 1.17 | **1.33** | 0.88 | 1.18 | 0.92 | 1.09 |
| N-acetyl-S-(2-Carboxyethyl)-L-cysteine** | 1.07 | 0.95 | 0.92 | **1.63** | 0.96 | 0.84 | 0.87 | 1.16 |
| N-acetyl-S-(2-carbamoylethyl)-L-cysteine** | 1.06 | 0.96 | 0.98 | **1.45** | 0.97 | 0.83 | 0.86 | 1.17 |
| N-acetyl-S-(2-cyanoethyl)-L-cysteine** | **1.38** | 0.82 | 0.7 | **2.39** | 0.99 | 0.69 | 0.77 | **1.32** |
| N-acetyl-S-(2-hydroxypropyl)-L-cysteine** | 1.05 | 0.96 | 0.92 | **1.27** | 1 | 0.85 | 0.88 | 1.15 |
| N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine** | 1.01 | 0.97 | 0.97 | 1.22 | 1 | 0.84 | 0.9 | 1.11 |
| N-acetyl-S-(3-Hydroxypropyl)-L-cysteine** | 1.12 | 0.93 | 0.92 | **1.43** | 0.95 | 1.06 | 0.82 | 1.22 |
| N-acetyl-S-(N-methylcarbamoyl)-L-cysteine** | 1.01 | 0.98 | 0.85 | 1.04 | 1.09 | 0.75 | 0.91 | 1.11 |
| **Dem. Subgroup:** | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | |
| Race/eth: | | | Hispanic | NH Black | NH White | NH Other | | |
| Sex: | | | | | | | Female | Male |

Continued, next page...

**Table A4:** NHANES GM biomarker concentration ratios: primary results

| **Chemical** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine** | 1.1 | 0.93 | 0.87 | **1.34** | 1.01 | 0.87 | 0.88 | 1.15 |
| NNAL** | **2.19** | | 0.62 | **2.41** | 1 | | | **1.33** |
| Nickel | 1.17 | 0.9 | 1.01 | 1.22 | 0.96 | 1 | 0.97 | 1.03 |
| Nitromethane | 0.99 | 1 | 1.02 | 1.1 | 0.96 | 1.14 | 1.02 | 0.98 |
| Perfluorooctanesulfonic acid | 0.88 | 1.09 | 0.75 | 1 | 1.1 | 0.93 | 0.8 | **1.26** |
| Perfluorooctanoic acid | 0.88 | 1.1 | 0.84 | 0.83 | 1.09 | 0.98 | 0.89 | 1.13 |
| Phenylglyoxylic acid** | 1.01 | 0.98 | 0.89 | **1.29** | 1 | 0.9 | 0.89 | 1.12 |
| **Dem. Subgroup:** | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | |
| Race/eth: | | | Hispanic | NH Black | NH White | NH Other | | |
| Sex: | | | | | | | Female | Male |

**Notes:** Presentation of the primary set of geometric mean ratios for the carcinogens and associated metabolites (N = 42) for which censoring by detection limits did not prevent statistical calculations. As summarized in Figure 1, after mapping metabolites to their parent chemicals, 39 separate carcinogens are represented by these results. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5. Statistics based on individual-level NHANES biomonitoring samples.

**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.

**Parent Chems:** {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol, 2-naphthol: *Naphthalene***} {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid***}; {2,4-dichlorophenol: *Nitrofen***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene***}; {2-naphthol: *Naphthalene***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {Dimethyl thiophosphate: *Malathion***}; {Mandelic acid: *Styrene***}; {Mandelic acid: *Ethylbenzene***}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide***}; {N-acetyl-S-(2-cyanoethyl)-L-cysteine: *Acrylonitrile***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine: *1,3-Butadiene***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Phenylglyoxylic acid: *Styrene***}; {Phenylglyoxylic acid: *Ethylbenzene***}

**Return to:** Section 3.1.1.

**Table A5:** NHANES GM biomarker concentration ratios: demographic interactions

| **Chemical** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-Naphthylamine | 0.68 | 0.88 | **1.65** | **2.28** | | 0.77 | 0.91 | 1.05 | 0.81 | 0.71 | **2.57** | 1.24 | 1.11 | | **1.63** | 0.81 |
| 1-naphthol** | 0.69 | 0.91 | **1.35** | **1.87** | 0.7 | 0.96 | 0.97 | 1.05 | 0.83 | 0.75 | **1.73** | **1.46** | 0.98 | 0.7 | 1.18 | 0.89 |
| 2,4-Dichlorophenoxyacetic acid | 0.8 | 0.98 | 0.93 | 1.1 | | 1.08 | 0.92 | 1.19 | 0.88 | 0.9 | 0.98 | 1.04 | 0.93 | 0.9 | 1.02 | 1.05 |
| 2,4-dichlorophenol** | **1.74** | **1.61** | **2.6** | **2.26** | 0.75 | 0.73 | 0.7 | 0.83 | **1.87** | 1.21 | **3.14** | **1.8** | 0.87 | 0.67 | 0.89 | 0.74 |
| 2,5-dichlorophenol** | **3.07** | **2.9** | **6.54** | **5.71** | 0.7 | 0.85 | 0.45 | 0.64 | **4.25** | **1.54** | **10.39** | **3.52** | 1.13 | 0.54 | 0.8 | 0.47 |
| 2,6-Dimethylaniline | | 1.02 | 1.19 | **1.34** | | | 0.99 | 1.03 | 0.88 | **1.26** | **1.32** | 1.07 | | | 1.09 | 0.98 |
| 2-Anisidine | 0.79 | 0.97 | 0.92 | 1.1 | 0.77 | 0.89 | 0.93 | 1.21 | 0.83 | 0.98 | 0.95 | 1.05 | 0.9 | 0.79 | 1.09 | 1.06 |
| 2-Methylaniline | 0.91 | 1.05 | **1.4** | **1.69** | 0.79 | 0.92 | 0.87 | 1.04 | 0.96 | 1.05 | **1.64** | **1.37** | 1.04 | 0.76 | 1.07 | 0.91 |
| 2-Naphthylamine | 0.76 | 0.92 | **1.56** | **1.81** | 0.79 | 0.86 | 0.9 | 1.07 | 0.85 | 0.83 | **1.98** | **1.28** | 0.89 | 0.8 | **1.31** | 0.88 |
| 2-naphthol** | **1.42** | **1.51** | **1.72** | **1.65** | 0.67 | 0.79 | 0.81 | 0.9 | **1.55** | **1.37** | **1.75** | **1.63** | 0.82 | 0.67 | 0.97 | 0.8 |
| 4-Biphenylamine | 0.76 | 0.92 | **1.35** | **1.56** | 0.96 | 0.71 | 0.95 | 1.05 | 0.83 | 0.84 | **1.65** | 1.18 | 0.88 | 0.83 | **1.35** | 0.89 |
| Acrylamide | 0.9 | 1 | 1 | **1.31** | 0.89 | 0.96 | 0.95 | 1.07 | 0.96 | 0.94 | **1.27** | 1 | 0.96 | 0.91 | 1.08 | 0.97 |
| Arsenic | 0.96 | 1.2 | **1.31** | **1.34** | **1.31** | **1.87** | 0.8 | 0.95 | 0.98 | 1.2 | 1.16 | **1.54** | **1.49** | **1.55** | 0.79 | 0.89 |
| Bis(2-chloroethyl) phosphate** | 0.92 | 1.07 | 1.12 | 1.11 | 0.97 | 1.09 | 0.9 | 1.06 | 0.99 | 1 | 1.21 | 1.01 | 1.2 | 0.96 | **1.33** | 0.88 |
| Cadmium | 0.87 | 0.68 | 1.17 | 1.02 | **1.42** | 1.02 | 1.18 | 0.89 | 0.74 | 0.83 | 1.1 | 1.02 | **1.37** | 1.08 | 1.18 | 0.96 |
| Cobalt | 1.09 | 0.86 | 0.99 | 0.87 | 1.11 | 0.91 | 1.07 | 0.96 | 1 | 0.93 | 0.96 | 0.95 | 0.96 | 1.05 | 1.02 | 1 |
| Dimethyl phosphate** | 1.12 | 1.21 | 1.05 | **1.36** | 0.81 | 0.91 | 0.94 | 0.96 | 1.23 | 1.02 | 1.07 | **1.36** | 0.96 | 0.81 | 0.98 | 0.95 |
| Dimethyl thiophosphate** | 1.03 | 0.98 | 0.91 | 1.23 | 0.68 | 0.81 | 0.93 | 1.17 | 1.01 | 0.89 | 0.91 | **1.28** | 0.76 | 0.78 | 0.92 | 1.12 |
| Dimethylarsinic acid | 1.13 | **1.27** | 1.14 | 1.05 | **1.27** | **1.26** | | 0.96 | 1.16 | 1.18 | 1.07 | 1.03 | 1.05 | **1.33** | 0.92 | 0.85 |
| Ethylene oxide | 0.87 | 0.98 | 1.23 | **1.79** | 1.08 | 1.01 | 0.86 | 1.05 | 0.98 | 0.84 | **1.78** | 1.18 | **1.25** | 0.92 | 1.24 | 0.85 |
| Formaldehyde | 1.01 | 1 | 0.95 | 0.94 | 0.98 | 0.99 | 1.01 | 1.01 | 0.99 | 1.02 | 0.95 | 0.93 | 1 | 0.98 | 0.99 | 1.02 |
| Lead | 0.71 | 0.96 | 0.92 | 1.13 | 1.06 | **1.29** | 0.89 | 1.19 | 0.85 | 0.79 | 1 | 0.95 | **1.29** | 1.08 | 1.04 | 1.02 |
| Mandelic acid** | 0.88 | 1.12 | 1.21 | **1.53** | 0.74 | 1 | 0.87 | 1.09 | 0.99 | 1 | **1.34** | **1.35** | 0.89 | 0.83 | 1.06 | 0.93 |
| Melamine | 0.57 | 0.88 | 0.81 | 0.64 | 1.1 | **2.13** | 1.03 | 1.19 | 0.81 | 0.57 | 0.76 | 0.68 | **2.13** | **1.35** | 1.24 | 1.08 |
| Mono-(2-ethyl-5-hydroxyhexyl) phthalate** | 0.98 | 1.15 | 1.23 | **1.42** | 0.86 | 1.02 | 0.84 | 1.06 | 1.15 | 0.85 | **1.36** | **1.32** | 1.13 | 0.86 | 1.1 | 0.9 |
| Mono-(2-ethyl-5-oxohexyl) phthalate** | 1.04 | 1.14 | 1.19 | **1.34** | 0.87 | 1 | 0.86 | 1.04 | 1.21 | 0.85 | **1.3** | **1.28** | 1.13 | 0.86 | 1.11 | 0.89 |
| Mono-2-ethyl-5-carboxypentyl phthalate** | 1.1 | 1.17 | 1.13 | **1.26** | 0.87 | 1.03 | 0.87 | 1.03 | **1.25** | 0.88 | **1.27** | 1.16 | 1.13 | 0.86 | 1.12 | 0.88 |
| N-Acetyl-S-(n-propyl)-L-cysteine** | 1.1 | 1.24 | **1.33** | **1.32** | 0.97 | **1.44** | 0.81 | 0.97 | 1.05 | **1.32** | **1.28** | **1.4** | 1.14 | 1.2 | 0.92 | 0.88 |
| N-acetyl-S-(2-Carboxyethyl)-L-cysteine** | 0.79 | 1.07 | **1.46** | **1.85** | 0.65 | 1.1 | 0.85 | 1.09 | 0.93 | 0.9 | **1.64** | **1.57** | 0.82 | 0.87 | 1.07 | 0.92 |
| N-acetyl-S-(2-carbamoylethyl)-L-cysteine** | 0.84 | 1.13 | 1.23 | **1.76** | 0.65 | 1.08 | 0.84 | 1.12 | 0.97 | 0.97 | **1.56** | **1.36** | 0.76 | 0.87 | 1.05 | 0.93 |
| N-acetyl-S-(2-cyanoethyl)-L-cysteine** | 0.53 | 0.94 | **1.62** | **3.78** | 0.51 | 0.95 | 0.78 | **1.26** | 0.71 | 0.72 | **3.46** | **1.6** | 1.02 | 0.55 | **1.63** | 0.82 |
| N-acetyl-S-(2-hydroxypropyl)-L-cysteine** | 0.81 | 1.03 | 1.13 | **1.47** | 0.67 | 1.09 | 0.89 | 1.14 | 0.95 | 0.88 | **1.31** | **1.26** | 0.78 | 0.9 | 1.12 | 0.95 |
| N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine** | 0.86 | 1.1 | 1.12 | **1.35** | 0.69 | 1.01 | 0.91 | 1.09 | 0.96 | 0.97 | 1.23 | 1.18 | 0.78 | 0.87 | 1.04 | 0.96 |
| N-acetyl-S-(3-Hydroxypropyl)-L-cysteine** | 0.76 | 1.11 | 1.18 | **1.76** | 0.83 | **1.37** | 0.78 | 1.15 | 0.93 | 0.92 | **1.49** | **1.3** | 1.21 | 0.98 | 1.1 | 0.89 |
| N-acetyl-S-(N-methylcarbamoyl)-L-cysteine** | 0.76 | 0.96 | 0.93 | 1.18 | 0.63 | 0.89 | 1.01 | 1.18 | 0.83 | 0.89 | 1.09 | 0.99 | 0.74 | 0.74 | 1.21 | 1.03 |
| **Dem. Subgroup:** | | | | | | | | | | | | | | | | |
| Inc/PL ratio: | | | | | | | | | <2 | >2 | <2 | >2 | <2 | >2 | <2 | >2 |
| Race/eth: | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht |
| Sex: | F | M | F | M | F | M | F | M | | | | | | | | |

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**Table A5:** NHANES GM biomarker concentration ratios: demographic interactions

| **Chemical** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine** | 0.76 | 0.99 | 1.14 | **1.62** | 0.72 | 1.06 | 0.89 | 1.14 | 0.89 | 0.86 | **1.41** | 1.2 | 0.99 | 0.79 | 1.17 | 0.93 |
| NNAL** | | 0.84 | **1.76** | **3.43** | | | | **1.31** | 0.76 | | **4.28** | 1.01 | **1.33** | | **3.19** | |
| Nickel | 0.95 | 1.09 | **1.28** | 1.14 | 1.05 | 0.96 | 0.91 | 1.01 | 1.09 | 0.94 | **1.27** | 1.13 | 1.17 | 0.86 | 1.19 | 0.87 |
| Nitromethane | 1.05 | 0.99 | 1.15 | 1.04 | 1.17 | 1.12 | 0.97 | 0.96 | 1 | 1.01 | 1.1 | 1.11 | 1.13 | 1.11 | 0.94 | 0.98 |
| Perfluorooctanesulfonic acid | 0.59 | 0.96 | 0.82 | **1.25** | 0.76 | 1.18 | 0.88 | **1.38** | 0.67 | 0.84 | 0.87 | 1.16 | 1.08 | 0.85 | 0.96 | 1.16 |
| Perfluorooctanoic acid | 0.72 | 0.97 | 0.7 | 1.01 | 0.86 | 1.16 | 0.99 | 1.2 | 0.77 | 0.93 | 0.76 | 0.93 | 1.04 | 0.93 | 0.94 | 1.17 |
| Phenylglyoxylic acid** | 0.79 | 1 | 1.17 | **1.45** | 0.75 | 1.08 | 0.9 | 1.12 | 0.85 | 0.95 | **1.3** | **1.27** | 0.87 | 0.91 | 1.06 | 0.97 |
| **Dem. Subgroup:** | | | | | | | | | | | | | | | | |
| Inc/PL ratio: | | | | | | | | | <2 | >2 | <2 | >2 | <2 | >2 | <2 | >2 |
| Race/eth: | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht |
| Sex: | F | M | F | M | F | M | F | M | | | | | | | | |

**Notes:** Demographic interaction analysis showing geometric mean ratios for the carcinogens and associated metabolites (N = 42) for which censoring by detection limits did not prevent statistical calculations. Subgroups in this table include interactions of race/ethnicity and sex, and interactions of race/ethnicity and household income. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5. Statistics based on individual-level NHANES biomonitoring samples.

**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.

**Parent Chems:** {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol, 2-naphthol: *Naphthalene***} {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid***}; {2,4-dichlorophenol: *Nitrofen***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene***}; {2-naphthol: *Naphthalene***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {Dimethyl thiophosphate: *Malathion***}; {Mandelic acid: *Styrene***}; {Mandelic acid: *Ethylbenzene***}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide***}; {N-acetyl-S-(2-cyanoethyl)-L-cysteine: *Acrylonitrile***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine: *1,3-Butadiene***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Phenylglyoxylic acid: *Styrene***}; {Phenylglyoxylic acid: *Ethylbenzene***}

**Return to:** Section 3.1.1.

**Table A6:** NHANES GM biomarker concentration ratios: age-differentiated results

| **Chemical** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1-Naphthylamine | 0.69 | 1.1 | 0.66 | 0.83 | 1.2 | **2.24** | 0.61 | | 0.63 | 1.07 |
| 1-naphthol** | 0.59 | 1.17 | 0.54 | 0.95 | 0.9 | **1.91** | 0.6 | 0.91 | 0.55 | 1.17 |
| 2,4-Dichlorophenoxyacetic acid | **1.28** | 0.94 | 1.14 | 0.81 | 1.13 | 0.97 | **1.29** | 0.8 | **1.4** | 0.98 |
| 2,4-dichlorophenol** | **1.26** | 0.94 | **1.68** | **1.67** | **2.68** | **2.36** | 0.92 | 0.71 | 0.96 | 0.72 |
| 2,5-dichlorophenol** | **1.49** | 0.9 | **2.94** | **3** | **7.31** | **5.81** | 0.8 | 0.76 | 0.79 | 0.49 |
| 2,6-Dimethylaniline | 0.96 | 1.01 | 0.85 | 1 | 0.92 | **1.39** | | | 1.09 | 0.99 |
| 2-Anisidine | 0.93 | 1.02 | 0.92 | 0.86 | 1.01 | 1.01 | 0.84 | 0.82 | 0.94 | 1.08 |
| 2-Methylaniline | 1.09 | 0.98 | 1.07 | 0.95 | **1.51** | **1.54** | 1.01 | 0.81 | 1.03 | 0.93 |
| 2-Naphthylamine | 0.85 | 1.04 | 0.78 | 0.86 | **1.31** | **1.82** | 0.76 | 0.84 | 0.8 | 1.02 |
| 2-naphthol** | 0.9 | 1.03 | **1.27** | **1.57** | **1.4** | **1.81** | 0.77 | 0.71 | 0.7 | 0.89 |
| 4-Biphenylamine | 0.92 | 1.02 | 0.84 | 0.84 | 1.11 | **1.58** | 0.9 | 0.82 | 0.91 | 1.02 |
| Acrylamide | 0.9 | 1.02 | 0.9 | 0.97 | 0.97 | 1.18 | 0.91 | 0.93 | 0.87 | 1.03 |
| Arsenic | 0.81 | 1.06 | 0.8 | 1.22 | 0.99 | **1.46** | 1.1 | **1.77** | 0.71 | 0.91 |
| Bis(2-chloroethyl) phosphate** | **1.44** | 0.9 | **1.27** | 0.88 | **1.44** | 1.01 | **1.41** | 0.94 | **1.54** | 0.87 |
| Cadmium | | **1.26** | | 1.01 | | **1.47** | 0.5 | **1.6** | | 1.24 |
| Cobalt | | 1 | | 0.97 | | 0.94 | | 1 | | 1.01 |
| Dimethyl phosphate** | **1.29** | 0.93 | **1.44** | 1.05 | **1.79** | 1.03 | 1.1 | 0.78 | 1.17 | 0.9 |
| Dimethyl thiophosphate** | **1.29** | 0.93 | **1.3** | 0.89 | **1.79** | 0.87 | 1.03 | 0.66 | **1.25** | 1 |
| Dimethylarsinic acid | 0.94 | 1.02 | 1.05 | **1.27** | 0.93 | 1.16 | 1.07 | **1.35** | 0.87 | 0.89 |
| Ethylene oxide | 0.79 | 1.05 | 0.77 | 0.98 | 1.02 | **1.61** | 0.89 | 1.1 | 0.74 | 0.99 |
| Formaldehyde | 1 | 1 | 0.98 | 1.01 | 0.95 | 0.94 | 1 | 0.99 | 1.01 | 1.01 |
| Lead | 0.57 | 1.13 | 0.52 | 0.97 | 0.6 | 1.15 | 0.64 | **1.36** | 0.58 | 1.13 |
| Mandelic acid** | 0.84 | 1.05 | 0.78 | 1.11 | 1 | **1.49** | 0.87 | 0.85 | 0.83 | 1 |
| Melamine | 0.68 | 1.11 | 0.82 | 0.67 | 0.64 | 0.76 | **2.32** | **1.51** | 0.6 | **1.27** |
| Mono-(2-ethyl-5-hydroxyhexyl) phthalate** | **1.34** | 0.92 | **1.4** | 0.93 | **1.73** | 1.2 | 1.12 | 0.87 | **1.28** | 0.88 |
| Mono-(2-ethyl-5-oxohexyl) phthalate** | **1.43** | 0.9 | **1.48** | 0.95 | **1.73** | 1.13 | 1.18 | 0.85 | **1.39** | 0.86 |
| Mono-2-ethyl-5-carboxypentyl phthalate** | **1.4** | 0.91 | **1.53** | 0.98 | **1.57** | 1.08 | 1.15 | 0.87 | **1.37** | 0.86 |
| N-Acetyl-S-(n-propyl)-L-cysteine** | 0.71 | 1.1 | 0.78 | **1.4** | 0.93 | **1.5** | 0.75 | **1.39** | 0.63 | 0.95 |
| N-acetyl-S-(2-Carboxyethyl)-L-cysteine** | 0.8 | 1.07 | 0.76 | 1 | 1.22 | **1.79** | 0.72 | 0.89 | 0.74 | 1.01 |
| N-acetyl-S-(2-carbamoylethyl)-L-cysteine** | 0.9 | 1.03 | 0.86 | 1.03 | 1.17 | **1.56** | 0.87 | 0.82 | 0.86 | 0.99 |
| N-acetyl-S-(2-cyanoethyl)-L-cysteine** | 0.49 | 1.22 | 0.44 | 0.87 | 0.97 | **3.24** | 0.55 | 0.75 | 0.41 | 1.2 |
| N-acetyl-S-(2-hydroxypropyl)-L-cysteine** | 0.76 | 1.08 | 0.79 | 0.98 | 1.01 | **1.38** | 0.71 | 0.91 | 0.71 | 1.08 |
| N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine** | 0.98 | 1.01 | 0.9 | 1 | 1.11 | **1.26** | 0.92 | 0.81 | 1 | 1 |
| N-acetyl-S-(3-Hydroxypropyl)-L-cysteine** | 0.82 | 1.06 | 0.79 | 0.98 | 1.06 | **1.58** | 0.9 | 1.12 | 0.77 | 0.99 |
| N-acetyl-S-(N-methylcarbamoyl)-L-cysteine** | 0.47 | 1.23 | 0.47 | 1.11 | 0.53 | **1.3** | 0.47 | 0.88 | 0.46 | **1.32** |
| N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine** | 0.75 | 1.08 | 0.69 | 0.97 | 0.89 | **1.54** | 0.82 | 0.89 | 0.74 | 1.08 |
| **Dem. Subgroup:** | | | | | | | | | | |
| Age: | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Black | NH Black | NH Other | NH Other | NH White | NH White |

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**Table A6:** NHANES GM biomarker concentration ratios: age-differentiated results

| **Chemical** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NNAL** | 0.58 | 1.14 | | 0.73 | 1.09 | **3.09** | | | 0.59 | 1.11 |
| Nickel | **1.26** | 0.94 | 1.19 | 0.94 | **1.48** | 1.14 | 1.23 | 0.94 | 1.24 | 0.9 |
| Nitromethane | 0.84 | 1.03 | 0.95 | 1.03 | 0.94 | 1.14 | 0.97 | 1.18 | 0.77 | 0.99 |
| Perfluorooctanesulfonic acid | 0.63 | 1.06 | 0.53 | 0.8 | 0.54 | 1.09 | 0.6 | 0.98 | 0.72 | 1.15 |
| Perfluorooctanoic acid | 0.83 | 1.02 | 0.79 | 0.85 | 0.67 | 0.86 | 0.89 | 0.99 | 0.89 | 1.11 |
| Phenylglyoxylic acid** | 0.87 | 1.04 | 0.76 | 0.95 | 1.05 | **1.38** | 0.95 | 0.88 | 0.87 | 1.03 |
| **Dem. Subgroup:** | | | | | | | | | | |
| Age: | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Black | NH Black | NH Other | NH Other | NH White | NH White |

**Notes:** Age-based analysis showing geometric mean ratios for the carcinogens and associated metabolites (N = 42) for which censoring by detection limits did not prevent statistical calculations. Demographic subgroups presented by age, including age subgroups differentiated by race/ethnicity. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5. Statistics based on individual-level NHANES biomonitoring samples.

**Demographic subgroups:** Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial.

**Parent Chems:** {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol, 2-naphthol: *Naphthalene***} {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid***}; {2,4-dichlorophenol: *Nitrofen***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene***}; {2-naphthol: *Naphthalene***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {Dimethyl thiophosphate: *Malathion***}; {Mandelic acid: *Styrene***}; {Mandelic acid: *Ethylbenzene***}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide***}; {N-acetyl-S-(2-cyanoethyl)-L-cysteine: *Acrylonitrile***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine: *1,3-Butadiene***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Phenylglyoxylic acid: *Styrene***}; {Phenylglyoxylic acid: *Ethylbenzene***}

**Return to:** Section 3.1.1.

**Table A7:** NHANES pooled biomarker mean concentration ratios: primary results

| **Chemical** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Beta-Hexachlorocyclohexane | 0.63 | **9.22** | | 0.49 | 0.66 | 1.2 | 0.79 |
| DDT | **2.01** | **3.42** | 0.98 | 0.55 | 1.12 | 0.94 | 1.07 |
| PBB153 | 0.63 | 0.64 | 0.97 | 1.13 | 1.12 | 0.75 | **1.27** |
| PCB074 | 0.51 | 1.05 | 1.05 | 1.13 | 0.8 | 1.21 | 0.78 |
| PCB105 | 0.61 | **1.73** | 1.12 | 1.04 | 0.65 | 1.11 | 0.88 |
| PCB126 | 0.74 | **2.02** | 0.9 | 1.01 | | 1.08 | 0.91 |
| PCB146 | 0.51 | **2.33** | **1.44** | 0.94 | 0.77 | 1.05 | 0.94 |
| PCB156 | 0.45 | 0.87 | 0.97 | 1.16 | 0.99 | 1.05 | 0.94 |
| PCB157 | | 0.94 | | 1.15 | 0.95 | | 0.94 |
| PCB167 | | **1.56** | 1.13 | 1.07 | | 1.14 | 0.86 |
| PCB169 | 0.64 | **1.4** | 0.89 | 1.08 | | 0.99 | 1.02 |
| PCB170 | 0.54 | 1.19 | 1.1 | 1.08 | 1.04 | 1.01 | 0.99 |
| PCB178 | 0.51 | **1.84** | 1.21 | 1.02 | 0.86 | 1.02 | 0.98 |
| PCB183 | 0.59 | **1.94** | **1.34** | 0.98 | 0.84 | 1.05 | 0.94 |
| PCB187 | 0.53 | **2.2** | **1.35** | 0.96 | 0.82 | 1.05 | 0.94 |
| PCB194 | 0.48 | 1.02 | 1.06 | 1.12 | 1.05 | 0.94 | 1.06 |
| PCB196 | 0.49 | 1.15 | 1.1 | 1.1 | 0.96 | 0.98 | 1.02 |
| PCB199 | 0.48 | **1.28** | 1.12 | 1.09 | 0.97 | 0.98 | 1.02 |
| PCB206 | 0.49 | 0.97 | 1.17 | 1.1 | 1 | 1.01 | 0.99 |
| PCB209 | 0.49 | 1 | **1.25** | 1.09 | 0.96 | 1.09 | 0.91 |
| PeCDF (furan) | 0.74 | 1.12 | 0.66 | 1.12 | | 0.94 | 1.06 |
| **Dem. Subgroup:** | | | | | | | |
| Race/eth: | Hispanic | NH Asian | NH Black | NH White | Other | | |
| Sex: | | | | | | Female | Male |

**Notes:** Presentation of the primary set of arithmetic mean ratios for the carcinogens and associated metabolites (N = 21) for which censoring by detection limits did not prevent statistical calculations. Statistics based on pooled NHANES biomonitoring samples. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5.
**Demographic subgroups:** Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.
**Return to:** Section 3.1.2.

**Table A8:** NHANES pooled biomarker mean concentration ratios: demographic interactions

| **Chemical** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Beta-Hexachlorocyclohexane | 0.77 | 0.49 | **9.61** | **8.79** | | 0.2 | 0.69 | 0.29 | 0.81 | |
| DDT | **2** | **2.03** | **2.72** | **4.25** | **1.26** | 0.66 | 0.46 | 0.66 | **1.52** | 0.64 |
| PBB153 | 0.52 | 0.74 | 0.36 | 0.95 | 1 | 0.94 | 0.79 | **1.48** | 0.84 | **1.41** |
| PCB074 | 0.56 | 0.46 | 1.2 | 0.9 | **1.37** | 0.64 | **1.36** | 0.89 | 1.07 | 0.53 |
| PCB105 | 0.66 | 0.57 | **2.05** | **1.39** | **1.29** | 0.91 | 1.13 | 0.94 | 0.76 | 0.53 |
| PCB126 | 0.78 | 0.7 | **2.36** | **1.64** | 0.91 | 0.89 | 1.09 | 0.92 | 0.7 | |
| PCB146 | 0.47 | 0.55 | **2.52** | **2.11** | **1.41** | **1.48** | 1.01 | 0.87 | 0.84 | 0.71 |
| PCB156 | 0.43 | 0.47 | 0.94 | 0.8 | 1.02 | 0.9 | 1.23 | 1.1 | 1.18 | 0.8 |
| PCB157 | | | 1.01 | 0.87 | 1.09 | | | 1.09 | 1.15 | |
| PCB167 | | 0.54 | **1.8** | **1.29** | 1.24 | | 1.23 | 0.91 | | |
| PCB169 | | 0.69 | **1.34** | **1.47** | | 0.99 | 1.1 | 1.06 | | |
| PCB170 | 0.51 | 0.57 | **1.27** | 1.11 | 1.06 | 1.15 | 1.1 | 1.06 | 1.06 | 1.02 |
| PCB178 | | 0.58 | **2.09** | **1.56** | 1.06 | **1.39** | 1.07 | 0.98 | 0.9 | |
| PCB183 | 0.56 | 0.61 | **2.32** | **1.55** | **1.36** | **1.31** | 1.02 | 0.93 | 0.88 | 0.8 |
| PCB187 | 0.47 | 0.6 | **2.47** | **1.91** | **1.27** | **1.46** | 1.04 | 0.87 | 0.84 | 0.8 |
| PCB194 | 0.43 | 0.53 | 1.05 | 0.99 | 0.89 | **1.26** | 1.08 | 1.17 | 0.98 | 1.13 |
| PCB196 | 0.45 | 0.53 | **1.26** | 1.02 | 1 | 1.23 | 1.09 | 1.12 | 0.95 | 0.96 |
| PCB199 | 0.44 | 0.53 | **1.4** | 1.16 | 1 | **1.26** | 1.08 | 1.09 | 0.97 | 0.97 |
| PCB206 | | 0.51 | 1.03 | 0.91 | 1.07 | **1.29** | 1.14 | 1.07 | 1.03 | 0.97 |
| PCB209 | | 0.48 | 1.08 | 0.9 | 1.14 | **1.39** | 1.23 | 0.95 | 1.07 | 0.85 |
| PeCDF (furan) | 0.65 | 0.83 | 1.01 | 1.21 | 0.67 | 0.65 | 1.07 | 1.18 | | 0.91 |
| **Dem. Subgroup:** | | | | | | | | | | |
| Race/eth: | Hispanic | Hispanic | NH Asian | NH Asian | NH Black | NH Black | NH White | NH White | Other | Other |
| Sex: | Female | Male | Female | Male | Female | Male | Female | Male | Female | Male |

**Notes:** Demographic interaction analysis showing arithmetic mean ratios for the carcinogens and associated metabolites (N = 21) for which censoring by detection limits did not prevent statistical calculations. Statistics based on pooled NHANES biomonitoring samples. Subgroups in this table include interactions of race/ethnicity and sex, and interactions of race/ethnicity and household income. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5.
**Demographic subgroups:** Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.
**Return to:** Section 3.1.2.

**Table A9:** NHANES pooled biomarker mean concentration ratios: age-differentiated results

| **Chemical** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beta-Hexachlorocyclohexane | | 1.11 | | 0.67 | **1.39** | **10.18** | | 0.44 | | 0.54 | | 0.73 |
| DDT | 0.5 | 1.07 | 0.54 | **2.32** | 1.21 | **3.72** | | 1.13 | 0.49 | 0.55 | 0.38 | 1.24 |
| PBB153 | | 1.13 | | 0.74 | | 0.7 | | 1.11 | | **1.25** | | **1.28** |
| PCB074 | 0.23 | 1.11 | 0.17 | 0.58 | 0.28 | 1.15 | 0.22 | 1.19 | 0.26 | 1.23 | 0.19 | 0.89 |
| PCB105 | 0.52 | 1.07 | 0.27 | 0.69 | 0.53 | **1.88** | 0.32 | **1.26** | 0.69 | 1.08 | 0.22 | 0.71 |
| PCB126 | | 1.08 | | 0.83 | | **2.16** | | 1 | | 1.06 | | |
| PCB146 | 0.2 | 1.11 | | 0.6 | 0.45 | **2.56** | 0.19 | **1.66** | 0.22 | 1.03 | 0.11 | 0.87 |
| PCB156 | 0.18 | 1.12 | | 0.53 | 0.19 | 0.96 | 0.11 | 1.11 | 0.25 | **1.28** | 0.1 | 1.12 |
| PCB157 | | 1.1 | | | | 1.03 | | 1.13 | | **1.25** | | 1.06 |
| PCB167 | | 1.1 | | 0.62 | | **1.7** | | **1.29** | | 1.14 | | |
| PCB169 | | 1.1 | | 0.71 | | **1.49** | | 0.99 | | 1.18 | | |
| PCB170 | 0.14 | 1.12 | 0.08 | 0.64 | 0.22 | **1.31** | 0.11 | **1.27** | 0.17 | 1.19 | 0.1 | 1.19 |
| PCB178 | | 1.12 | | 0.6 | | **2.03** | | **1.39** | | 1.13 | | 0.97 |
| PCB183 | | 1.11 | | 0.68 | 0.41 | **2.13** | | **1.54** | | 1.07 | 0.17 | 0.95 |
| PCB187 | 0.14 | 1.13 | 0.07 | 0.64 | 0.37 | **2.43** | 0.15 | **1.56** | 0.15 | 1.06 | 0.14 | 0.92 |
| PCB194 | 0.08 | 1.13 | | 0.57 | 0.16 | 1.13 | | 1.22 | 0.09 | **1.25** | | 1.2 |
| PCB196 | 0.1 | 1.13 | 0.07 | 0.58 | 0.2 | **1.26** | 0.11 | **1.27** | 0.11 | 1.22 | 0.09 | 1.08 |
| PCB199 | | 1.13 | | 0.58 | 0.22 | **1.39** | | **1.29** | 0.1 | 1.21 | 0.06 | 1.1 |
| PCB206 | | 1.12 | | 0.57 | | 1.06 | | **1.34** | | 1.22 | | 1.13 |
| PCB209 | | 1.13 | | 0.57 | | 1.08 | | **1.45** | | 1.21 | | 1.09 |
| PeCDF (furan) | 0.41 | 1.09 | 0.45 | 0.8 | 0.79 | 1.15 | | 0.74 | 0.42 | 1.21 | 0.37 | |
| **Dem. Subgroup:** | | | | | | | | | | | | |
| Age: | 12-19 | 20+ | 12-19 | 20+ | 12-19 | 20+ | 12-19 | 20+ | 12-19 | 20+ | 12-19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Asian | NH Asian | NH Black | NH Black | NH White | NH White | NH Other | NH Other |

**Notes:** Age-based analysis showing arithmetic mean ratios for the carcinogens and associated metabolites (N = 21) for which censoring by detection limits did not prevent statistical calculations. Statistics based on pooled NHANES biomonitoring samples. Demographic subgroups presented by age, including age subgroups differentiated by race/ethnicity. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5.
**Demographic subgroups:** Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Other race including multi-racial
**Return to:** Section 3.1.2.

**Table A10:** NHANES P95 biomarker concentration ratios: primary results

| **Chemical** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1,4-Dichlorobenzene | 1.17 | 0.61 | **1.34** | **3.4** | 0.6 | 0.69 | 0.9 | 1.02 |
| 1-Naphthylamine | **1.41** | 0.72 | 0.41 | **1.51** | 1.03 | 0.55 | 0.9 | 1.04 |
| 1-naphthol** | **1.32** | 0.8 | 0.75 | **1.43** | 1.06 | 0.67 | 1.01 | 1 |
| 2,4,5-trichlorophenol** | 1 | 1 | 0.67 | 0.67 | 1 | 1 | 1 | 1 |
| 2,4,6-Trichlorophenol | 1.18 | 0.91 | 1.18 | **1.36** | 0.91 | 0.91 | 1 | 1 |
| 2,4-Dichlorophenoxyacetic acid | 0.98 | 1 | 0.92 | 0.83 | 1.04 | 0.9 | 0.88 | 1.08 |
| 2,4-dichlorophenol** | **1.71** | 0.62 | **2.3** | **7.21** | 0.55 | 0.7 | 1.05 | 1 |
| 2,5-dichlorophenol** | **2.61** | 0.33 | **3.62** | **12.67** | 0.22 | 0.32 | 1.14 | 0.91 |
| 2,6-Dimethylaniline | 1.01 | 1.04 | 0.76 | 0.89 | 1.18 | 0.68 | 1.14 | 0.89 |
| 2-Amino-1-methyl-6-phenylimidazo [4,5-b]pyridine | 0.58 | 1.21 | 0.92 | 1.1 | 1.06 | 0.86 | 0.91 | 1.09 |
| 2-Amino-alpha-carboline | **1.37** | 0.72 | 0.41 | **1.37** | 1.04 | 0.45 | 0.94 | 1.05 |
| 2-Anisidine | 0.91 | 1.06 | 0.86 | 0.81 | 1.06 | 0.85 | 0.93 | 1.05 |
| 2-Methylaniline | 1.08 | 0.8 | 0.88 | 1.2 | 0.94 | 0.93 | 0.93 | 1.04 |
| 2-Naphthylamine | 1.22 | 0.83 | 0.55 | **1.42** | 1.05 | 0.74 | 0.94 | 1.05 |
| 2-Phenylphenol | 1 | 1 | 1 | **1.4** | 1 | 0.6 | 1 | 1 |
| 2-naphthol** | 1.21 | 0.87 | 1.07 | **1.44** | 0.94 | 0.85 | 1.03 | 1 |
| 4,4'-Diaminobiphenyl methane | 1.02 | 1.02 | 1.07 | 1.11 | 0.99 | 1.03 | 0.99 | 1.02 |
| 4-Biphenylamine | **1.26** | 0.84 | 0.61 | **1.35** | 1.09 | 0.78 | 1.06 | 0.95 |
| Acrylamide | **1.27** | 0.88 | 0.86 | **1.68** | 0.99 | 0.74 | 0.84 | **1.27** |
| Arsenic | 0.85 | 0.97 | 0.91 | **1.4** | 0.81 | **1.64** | 0.96 | 1.12 |
| Arsenic acid | 1.01 | 1.01 | 1.16 | | 0.94 | 0.93 | 1 | 0.99 |
| Benzene | **1.45** | 0.54 | 0.42 | **1.27** | 1.06 | 1.22 | 0.93 | 1.06 |
| Bis(2-chloroethyl) phosphate** | **1.34** | 0.82 | 0.88 | 0.91 | 1.04 | 1.22 | 0.83 | **1.26** |
| Bromodichloromethane | 1 | 1 | 1 | 1 | 0.91 | 1.09 | 1 | 1 |
| Bromoform | **1.3** | 1 | 1.2 | 0.8 | 1 | 1 | 1 | 1.1 |
| Cadmium | 1.21 | 0.81 | 0.62 | 1.05 | 1.05 | 1.12 | 1.14 | 0.89 |
| Chloroform | 1.03 | 1 | 0.91 | 1.15 | 1 | **1.26** | 0.94 | 1.03 |
| Cobalt | 1.02 | 1 | 0.95 | 0.86 | 1.05 | 0.86 | 1.09 | 0.88 |
| Crotonaldehyde | 1.07 | 0.99 | **1.44** | 1 | 0.9 | 1.22 | 0.99 | 1.07 |
| Dieldrin | 0.89 | 1.13 | 0.77 | 0.84 | 1.03 | **1.37** | 0.89 | 1.15 |
| Diisononyl phthalate | 1 | 1 | **1.33** | 1.06 | 0.94 | 0.78 | 0.94 | 1.06 |
| Dimethyl dithiophosphate** | 0.67 | **1.3** | 0.63 | 0.89 | **1.3** | 0.5 | 0.87 | **1.32** |
| Dimethyl phosphate** | **1.25** | 0.95 | **1.25** | **1.32** | 0.98 | 0.59 | 0.94 | 1.07 |
| Dimethyl thiophosphate** | 1 | 1 | 0.73 | 1.13 | 1.06 | 0.5 | 0.74 | 1.07 |
| Dimethylarsinic acid | 0.95 | 0.9 | 1.15 | 1.11 | 0.79 | **1.66** | 1.06 | 0.9 |
| **Dem. Subgroup:** | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | |
| Race/eth: | | | Hispanic | NH Black | NH White | NH Other | | |
| Sex: | | | | | | | Female | Male |

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**Table A10:** NHANES P95 biomarker concentration ratios: primary results

| **Chemical** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ethylbenzene | 1.23 | 0.73 | 0.58 | 1.08 | 1.09 | 1.19 | 0.92 | 1.08 |
| Ethylene oxide | 1.12 | 0.94 | 0.55 | **1.25** | 1.1 | 0.68 | 0.9 | 1.05 |
| Ethylene thiourea | **1.4** | 0.79 | 1.14 | **1.47** | 0.7 | **2.77** | 0.95 | 1 |
| Formaldehyde | 1 | 1.01 | 1.03 | 0.99 | 1 | 0.98 | 1 | 1 |
| Furan | **1.51** | 0.57 | 0.43 | 1.09 | 1.05 | **1.38** | 0.93 | 1.08 |
| Heptachlor epoxide B | 1.04 | 1 | 0.8 | 0.98 | 1.08 | 0.88 | 1.04 | 0.98 |
| Lead | 1.09 | 0.96 | 0.87 | 1.13 | 0.96 | 1.13 | 0.87 | 1.15 |
| Malathion dicarboxylic acid** | 0.88 | 1.01 | 0.65 | 0.65 | 1.14 | 0.8 | 1.07 | 0.9 |
| Mandelic acid** | 1.23 | 0.85 | 0.97 | **1.35** | 0.93 | 0.88 | 0.98 | 1.02 |
| MeA-alpha-C | **1.42** | 0.61 | 0.32 | **1.49** | 1.1 | 0.5 | 0.78 | 1.22 |
| Melamine | 1.11 | 1 | **1.35** | 1 | 0.96 | 0.39 | 1 | 1.11 |
| Methylarsonic acid | 0.97 | 0.97 | 1.12 | 0.99 | 0.93 | 1.11 | 0.99 | 1.01 |
| Mono-(2-ethyl-5-hydroxyhexyl) phthalate** | 1.08 | 0.91 | 1.02 | 1.23 | 1 | 1.07 | 0.92 | 1.11 |
| Mono-(2-ethyl-5-oxohexyl) phthalate** | 1.13 | 0.9 | 1.07 | 1.15 | 0.95 | 1.02 | 0.91 | 1.09 |
| Mono-(2-ethylhexyl) phthalate** | 1.04 | 0.9 | **1.3** | **1.32** | 0.84 | 1.18 | 0.84 | 1.14 |
| Mono-2-ethyl-5-carboxypentyl phthalate** | 1.09 | 0.8 | 1.12 | 1.18 | 0.88 | 1.18 | 0.9 | 1.12 |
| N'-Nitrosonornicotine | **1.38** | 0.73 | 0.29 | 1.1 | 1.12 | 0.86 | 0.73 | **1.26** |
| N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA)** | **1.48** | 0.7 | 0.57 | **1.67** | 0.98 | 0.63 | 0.87 | 1.13 |
| N-Acetyl-S-(n-propyl)-L-cysteine** | 0.9 | 1.01 | 1.19 | 1.04 | 0.95 | **1.28** | 1.09 | 0.96 |
| N-Acetyl-S-(phenyl)-L-cysteine** | 0.94 | 1.03 | 1.23 | 0.82 | 0.98 | 1.1 | 0.93 | 1.05 |
| N-acetyl-S-(2-Carboxyethyl)-L-cysteine** | 1.05 | 0.97 | 0.75 | **1.45** | 1.02 | 0.66 | 0.94 | 1.11 |
| N-acetyl-S-(2-Hydroxyethyl)-L-cysteine** | **1.42** | 0.8 | 0.85 | **1.6** | 0.82 | 1.1 | 1.05 | 0.96 |
| N-acetyl-S-(2-carbamoylethyl)-L-cysteine** | 1.2 | 0.86 | 0.93 | **1.46** | 0.9 | 0.95 | 0.8 | 1.17 |
| N-acetyl-S-(2-cyanoethyl)-L-cysteine** | **1.34** | 0.82 | 0.61 | **1.96** | 0.95 | 0.68 | 0.76 | **1.34** |
| N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine** | **1.3** | 0.67 | 0.85 | **1.44** | 1.02 | 0.59 | 0.91 | 1.14 |
| N-acetyl-S-(2-hydroxypropyl)-L-cysteine** | 1.01 | 0.84 | 0.75 | 0.89 | 1.16 | 0.84 | 1.04 | 0.95 |
| N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine** | 1.05 | 0.94 | 0.9 | 1.05 | 1.03 | 0.91 | 1.01 | 1 |
| N-acetyl-S-(3-Hydroxypropyl)-L-cysteine** | 1.09 | 0.96 | 0.69 | **1.45** | 1.07 | 0.79 | 1.05 | 1 |
| N-acetyl-S-(N-methylcarbamoyl)-L-cysteine** | 1.16 | 0.9 | 0.67 | 1.21 | 1.13 | 0.78 | 0.86 | 1.1 |
| N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine** | 1.2 | 0.87 | 0.65 | **1.31** | 1.11 | 0.83 | 0.93 | 1.09 |
| NNAL** | **1.29** | 0.7 | 0.34 | 1.13 | 1.14 | 0.76 | 0.74 | 1.22 |
| Nickel | 1.1 | 0.84 | 0.94 | 1.1 | 0.99 | 0.97 | 0.98 | 1.02 |
| Nitromethane | 1.04 | 0.95 | 0.95 | 1.24 | 0.94 | 1.06 | 1.02 | 0.96 |
| Oxypyrimidine** | **1.42** | 0.86 | 0.96 | **1.91** | 0.84 | 0.86 | 1 | 1.02 |
| Pentachlorophenol | 0.94 | 1.02 | 0.8 | 1.12 | 1.02 | 0.77 | 0.88 | **1.26** |
| **Dem. Subgroup:** | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | |
| Race/eth: | | | Hispanic | NH Black | NH White | NH Other | | |
| Sex: | | | | | | | Female | Male |

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**Table A10:** NHANES P95 biomarker concentration ratios: primary results

| **Chemical** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Perfluorooctanesulfonic acid | 0.96 | 1.03 | 0.68 | **1.5** | 0.95 | **1.36** | 0.9 | 1.08 |
| Perfluorooctanoic acid | 0.97 | 1.11 | 0.79 | 0.89 | 1 | **1.46** | 1 | 1 |
| Phenylglyoxylic acid** | 1 | 0.96 | 0.84 | **1.27** | 1.03 | 0.82 | 0.94 | 1.04 |
| Styrene | 1.15 | 0.97 | 0.64 | **1.27** | 1.14 | 0.7 | 0.83 | 1.15 |
| Tetrachloroethylene | | 1.21 | 0.78 | 1.03 | 1.07 | | 0.74 | 1.18 |
| **Dem. Subgroup:** | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | |
| Race/eth: | | | Hispanic | NH Black | NH White | NH Other | | |
| Sex: | | | | | | | Female | Male |

**Notes:** Presentation of the primary set of 95th percentile ratios for the carcinogens and associated metabolites (N = 75) for which censoring by detection limits did not prevent statistical calculations. As summarized in Figure 3, after mapping metabolites to their parent chemicals, 62 separate carcinogens are represented by these results. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5. Statistics based on individual-level NHANES biomonitoring samples.

**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.

**Parent Chems:** {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol, 2-naphthol: *Naphthalene***} {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid***}; {2,4-dichlorophenol: *Nitrofen***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene***}; {2-naphthol: *Naphthalene***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {Dimethyl dithiophosphate: *Malathion***}; {Dimethyl thiophosphate: *Malathion***}; {Malathion dicarboxylic acid: *Malathion***}; {Mandelic acid: *Styrene***}; {Mandelic acid: *Ethylbenzene***}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-(2-ethylhexyl) phthalate Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA), N-acetyl-S-(2-Hydroxyethyl)-L-cysteine, N-acetyl-S-(2-cyanoethyl)-L-cysteine: *Acrylonitrile***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-Acetyl-S-(phenyl)-L-cysteine: *Benzene***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Vinyl Chloride***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Ethylene Oxide***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine, N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine: *1,3-Butadiene***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Oxypyrimidine: *Diazonon***}; {Phenylglyoxylic acid: *Styrene***}; {Phenylglyoxylic acid: *Ethylbenzene***}

**Return to:** Section 3.1.3.

**Table A11:** NHANES P95 biomarker concentration ratios: demographic interactions

| **Chemical** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,4-Dichlorobenzene | 1.17 | **1.34** | **3.87** | **3.13** | 0.86 | 0.66 | 0.41 | 0.74 | **1.34** | 0.73 | **4.07** | **2.12** | 1.01 | 0.47 | 0.74 | 0.44 |
| 1-Naphthylamine | 0.27 | 0.55 | 1.19 | **1.86** | 0.55 | 0.57 | 0.91 | 1.21 | 0.67 | 0.26 | **1.86** | 1.13 | 0.63 | 0.6 | **1.62** | 0.74 |
| 1-naphthol** | 0.63 | 0.75 | 1.17 | **1.54** | 0.67 | 0.83 | 1.24 | 1.04 | 0.85 | 0.51 | **1.31** | **1.52** | 0.71 | 0.52 | **2.16** | 0.8 |
| 2,4,5-trichlorophenol** | 0.67 | 0.67 | 1 | 0.67 | 0.67 | 1 | 1 | 1 | 0.67 | 0.67 | 0.67 | 0.67 | **1.67** | 0.33 | 1 | 1 |
| 2,4,6-Trichlorophenol | 1.09 | 1.18 | **1.45** | 1.18 | 0.82 | 0.91 | 1 | 0.91 | 1 | **1.45** | **1.73** | 0.91 | 0.82 | 0.91 | 1.09 | 0.82 |
| 2,4-Dichlorophenoxyacetic acid | 0.8 | 1.13 | 0.83 | 0.86 | 0.9 | 0.89 | 0.95 | 1.15 | 0.83 | 1.05 | 0.83 | 0.94 | 0.75 | 0.99 | 1.06 | 1 |
| 2,4-dichlorophenol** | **2.29** | **2.57** | **11.42** | **6.36** | 0.82 | 0.38 | 0.58 | 0.53 | **3.04** | **1.36** | **15.14** | **4.95** | 0.82 | 0.31 | 0.6 | 0.53 |
| 2,5-dichlorophenol** | **3.29** | **3.84** | **15.05** | **10.59** | 0.25 | 0.32 | 0.22 | 0.21 | **4.94** | **1.98** | **21.81** | **8.58** | 0.43 | 0.18 | 0.57 | 0.18 |
| 2,6-Dimethylaniline | 0.66 | 0.88 | 0.69 | **3.62** | 0.72 | 0.68 | **1.55** | 0.89 | 0.61 | **1.79** | 1.19 | 0.69 | 0.87 | 0.56 | 1.18 | **1.25** |
| 2-Amino-1-methyl-6-phenylimidazo [4,5-b]pyridine | 0.92 | 0.92 | 0.7 | 1.23 | 0.94 | 0.6 | 0.9 | 1.2 | 0.87 | 0.9 | 0.63 | **1.28** | 0.91 | 0.71 | 0.49 | **1.27** |
| 2-Amino-alpha-carboline | 0.26 | 0.49 | **1.26** | **1.53** | 0.47 | 0.3 | 1.01 | 1.12 | 0.54 | 0.16 | **1.38** | 1.1 | 0.9 | 0.43 | **1.53** | 0.81 |
| 2-Anisidine | 0.61 | 1.04 | 0.82 | 0.8 | 0.79 | 0.86 | 1.05 | 1.09 | 0.82 | 1.04 | 0.75 | 0.9 | 0.84 | 0.86 | 1.05 | 1.07 |
| 2-Methylaniline | 0.88 | 0.95 | 1.2 | **1.45** | 0.88 | 1.15 | 0.92 | 1.02 | 0.95 | 0.82 | **1.4** | 0.9 | 0.81 | 0.88 | 1.08 | 0.75 |
| 2-Naphthylamine | 0.5 | 0.56 | **1.52** | **1.27** | 0.73 | 0.77 | 0.94 | 1.21 | 0.62 | 0.54 | **1.52** | 1.24 | 0.65 | 0.91 | **1.47** | 0.85 |
| 2-Phenylphenol | 1 | 1 | 1.2 | **1.4** | 0.6 | 0.6 | 1 | 1 | 1 | 1 | 1.2 | **1.4** | 0.6 | 0.4 | 1 | 1 |
| 2-naphthol** | 1.06 | 1.2 | **1.47** | **1.39** | 0.96 | 0.74 | 0.94 | 0.9 | 1.03 | 0.96 | **1.66** | **1.32** | 0.87 | 0.8 | 1.23 | 0.82 |
| 4,4'-Diaminobiphenyl methane | 1.14 | 1.01 | 1.11 | 1.11 | 0.89 | 1.24 | 0.97 | 0.99 | 1.07 | 1.04 | 1.22 | 1.02 | 1.21 | 1.02 | 0.87 | 1 |
| 4-Biphenylamine | 0.65 | 0.59 | **1.61** | **1.32** | 1.02 | 0.61 | 1.09 | 1.07 | 0.71 | 0.54 | **1.46** | 1.21 | 0.64 | 0.79 | **1.55** | 0.84 |
| Acrylamide | 0.62 | 0.98 | 1.07 | **1.78** | 0.77 | 0.73 | 0.85 | **1.27** | 0.86 | 0.8 | **2.01** | 1 | 0.95 | 0.59 | **1.27** | 0.92 |
| Arsenic | 0.91 | 0.98 | **1.4** | **1.67** | **1.64** | **1.58** | 0.77 | 0.83 | 0.73 | 1.06 | **1.3** | **1.43** | **1.82** | **1.47** | 0.57 | 0.85 |
| Arsenic acid | 1.09 | 1.23 | | | 0.93 | 0.95 | 1 | 0.91 | 1.14 | 1.23 | | 0.94 | | 1.07 | 1.05 | 1 |
| Benzene | 0.35 | 0.51 | 1.09 | **1.41** | 1.1 | **1.38** | 1.07 | 1.05 | 0.44 | 0.39 | 1.13 | 1.07 | **1.45** | 0.87 | **1.73** | 0.43 |
| Bis(2-chloroethyl) phosphate** | 0.75 | 0.98 | 0.86 | **1.26** | **1.87** | 1.07 | 0.71 | **1.34** | 1 | 0.72 | **1.26** | 0.55 | **1.98** | 0.75 | **1.34** | 0.92 |
| Bromodichloromethane | 1.18 | 1 | 1 | 1 | 0.82 | 1.09 | 0.91 | 1 | 1 | 1.18 | 1.09 | 1 | 0.73 | 1.09 | 1.09 | 0.91 |
| Bromoform | 1 | **1.4** | | 1.1 | 1.2 | 1 | 1 | 1 | **1.5** | 1.2 | | 1.1 | 1.2 | 0.8 | **1.5** | 0.9 |
| Cadmium | 0.64 | 0.61 | 1.04 | 1.05 | 1.2 | 1.12 | **1.27** | 0.93 | 0.64 | 0.64 | 1.05 | 0.95 | 1.2 | 0.87 | **1.38** | 0.8 |
| Chloroform | 0.85 | 0.97 | 1.15 | 1.24 | **1.26** | 0.97 | 0.88 | 1.12 | 0.94 | 0.94 | 1.12 | 1.24 | **1.26** | 1.06 | 0.91 | 1 |
| Cobalt | 1.16 | 0.65 | 0.88 | 0.74 | 1.12 | 0.65 | 1.09 | 1 | 0.95 | 0.81 | 0.86 | 0.91 | 0.81 | 0.91 | 1.09 | 1.02 |
| Crotonaldehyde | **1.48** | **1.4** | 0.85 | 1.11 | 0.82 | 1.22 | 0.98 | 0.89 | **1.65** | 1.22 | 1.14 | 0.92 | **1.36** | 0.87 | 0.86 | 0.99 |
| Dieldrin | 0.89 | 0.77 | 0.84 | 0.75 | **2.73** | 0.78 | 0.86 | 1.23 | 0.66 | 1.13 | 0.84 | 0.83 | 0.82 | **2.43** | 0.95 | 1.16 |
| Diisononyl phthalate | **1.28** | **1.33** | 1.06 | 1.11 | 0.67 | 1 | 0.89 | 1.06 | **1.72** | 1.22 | **1.39** | 0.89 | 0.56 | 0.72 | 0.94 | 1.06 |
| Dimethyl dithiophosphate** | 0.74 | 0.59 | 0.86 | 0.98 | 0.4 | 0.73 | 0.94 | **1.82** | 0.58 | 1 | 0.71 | 0.89 | 0.47 | 0.73 | 0.8 | **1.52** |
| Dimethyl phosphate** | **1.45** | 0.91 | 0.85 | **1.72** | 0.61 | 0.56 | 0.99 | 0.98 | **1.32** | 0.89 | 1.14 | **1.36** | 0.61 | 0.63 | **1.33** | 0.95 |
| Dimethyl thiophosphate** | 0.76 | 0.66 | 0.88 | **1.38** | 0.36 | 0.61 | 0.84 | 1.07 | 0.64 | 0.73 | 0.86 | 1.13 | 0.48 | 0.58 | 1.07 | 1.03 |
| Dimethylarsinic acid | **1.27** | 1.09 | **1.28** | 0.93 | **1.76** | **1.56** | 0.86 | 0.72 | 1.06 | **1.37** | 1.06 | 0.89 | 1.17 | **1.86** | 0.74 | 0.75 |
| **Dem. Subgroup:** | | | | | | | | | | | | | | | | |
| Inc/PL ratio: | | | | | | | | | <2 | >2 | <2 | >2 | <2 | >2 | <2 | >2 |
| Race/eth: | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht |
| Sex: | F | M | F | M | F | M | F | M | | | | | | | | |

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**Table A11:** NHANES P95 biomarker concentration ratios: demographic interactions

| **Chemical** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ethylbenzene | 0.47 | 0.73 | 0.91 | **1.29** | 0.91 | **1.27** | 1.08 | 1.12 | 0.6 | 0.6 | 1.02 | 1.01 | **1.25** | 0.97 | **1.31** | 0.61 |
| Ethylene oxide | 0.45 | 0.71 | 1.04 | **1.52** | 0.84 | 0.57 | 0.91 | 1.12 | 0.64 | 0.6 | **1.37** | 1.19 | **1.28** | 0.27 | **1.26** | 1.1 |
| Ethylene thiourea | 1.05 | 1.16 | 1.19 | **1.93** | **3.09** | **2.77** | | 0.84 | **1.35** | 0.74 | **1.53** | 1.19 | **3.09** | 0.88 | | 0.79 |
| Formaldehyde | 1.03 | 1.03 | 0.99 | 0.99 | 0.99 | 0.98 | 1 | 1 | 1.03 | 1.05 | 0.99 | 0.99 | 0.99 | 0.97 | 0.95 | 1 |
| Furan | 0.43 | 0.5 | 0.97 | **1.31** | 1 | **1.49** | 1.15 | 0.97 | 0.43 | 0.42 | 1.06 | 1.2 | **1.49** | **1.27** | **1.84** | 0.4 |
| Heptachlor epoxide B | 1.04 | 0.67 | 1.11 | 0.76 | **1.26** | 0.88 | 1.04 | 1.1 | 0.82 | 0.79 | 1.12 | 1 | 0.84 | 0.95 | 1.18 | 1.04 |
| Lead | 0.68 | 1.1 | 1.05 | **1.29** | 0.99 | 1.16 | 0.83 | 1.14 | 1.02 | 0.76 | 1.22 | 0.92 | **1.44** | 1.04 | 1.04 | 0.96 |
| Malathion dicarboxylic acid** | 0.63 | 0.71 | 0.72 | 0.54 | 0.8 | 0.4 | **1.26** | 1.09 | 0.73 | 0.54 | 0.73 | 0.45 | 0.35 | **2.28** | **1.4** | 1.11 |
| Mandelic acid** | 0.91 | 1.09 | **1.26** | **1.51** | 0.92 | 0.83 | 0.95 | 0.92 | 1.05 | 0.91 | **1.4** | 1.14 | 0.92 | 0.78 | 1.19 | 0.82 |
| MeA-alpha-C | 0.23 | 0.58 | **1.29** | **2.1** | 0.6 | 0.27 | 0.86 | 1.22 | 0.56 | 0.29 | **1.76** | 1.06 | 0.73 | 0.23 | **1.55** | 0.64 |
| Melamine | 1.17 | **2.15** | 0.92 | **1.83** | 0.69 | 0.39 | 0.96 | 0.84 | 1.17 | **2.15** | 1.24 | 1 | 0.69 | 0.39 | 1 | 0.96 |
| Methylarsonic acid | 1.12 | 1.23 | 0.94 | 1.02 | 1.1 | 1.11 | 0.93 | 0.96 | 1.12 | 0.96 | 0.96 | 1.02 | 1.01 | 1.07 | 0.96 | 0.93 |
| Mono-(2-ethyl-5-hydroxyhexyl) phthalate** | 0.96 | 1.21 | 1.14 | **1.31** | 1.08 | 1.04 | 0.71 | 1.11 | 1.21 | 0.85 | 1.23 | 1.11 | **2.13** | 0.87 | 1 | 0.81 |
| Mono-(2-ethyl-5-oxohexyl) phthalate** | 1.04 | 1.07 | 1.07 | **1.26** | 1.16 | 0.96 | 0.72 | 1.09 | 1.15 | 0.8 | 1.23 | 0.93 | **2.01** | 0.87 | 1.01 | 0.9 |
| Mono-(2-ethylhexyl) phthalate** | **1.26** | **1.4** | **1.4** | 1.04 | 1.18 | 1.1 | 0.66 | 1 | **1.38** | 0.84 | **1.32** | **1.26** | 1.24 | 1 | 0.7 | 0.84 |
| Mono-2-ethyl-5-carboxypentyl phthalate** | 1.15 | 1.03 | 1.06 | **1.28** | 1.04 | 1.21 | 0.78 | 1.04 | 1.13 | 0.81 | 1.18 | 0.94 | **1.73** | 0.93 | 0.99 | 0.67 |
| N'-Nitrosonornicotine | 0.2 | 0.37 | 0.97 | 1.22 | 0.42 | **1.43** | 0.87 | **1.51** | 0.38 | 0.17 | **1.31** | 0.76 | 0.95 | 0.7 | **1.95** | 0.78 |
| N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA)** | 0.35 | 0.92 | **1.31** | **2.17** | 0.39 | 0.78 | 0.89 | 1.04 | 0.75 | 0.5 | **1.68** | 1.2 | **1.94** | 0.14 | **1.54** | 0.74 |
| N-Acetyl-S-(n-propyl)-L-cysteine** | 1.17 | **1.32** | 1.1 | 1.03 | **1.69** | 1.19 | 1.01 | 0.95 | 1 | **1.99** | 0.87 | 1.14 | 1.2 | **1.28** | 0.77 | 0.98 |
| N-Acetyl-S-(phenyl)-L-cysteine** | 0.92 | **1.33** | 0.82 | 0.83 | 0.94 | **1.41** | 0.93 | 1.03 | **1.35** | 0.92 | 0.81 | 0.82 | 1.05 | **1.31** | 0.88 | 1.03 |
| N-acetyl-S-(2-Carboxyethyl)-L-cysteine** | 0.56 | 0.86 | 1.21 | **1.57** | 0.59 | 0.88 | 1 | 1.11 | 0.81 | 0.62 | **1.45** | **1.33** | 0.83 | 0.58 | 1.18 | 0.99 |
| N-acetyl-S-(2-Hydroxyethyl)-L-cysteine** | 0.85 | 0.9 | **1.6** | **1.58** | **1.28** | 1.01 | 0.94 | 0.81 | 0.95 | 0.69 | **2.08** | **1.33** | **1.51** | 1.01 | 1.05 | 0.73 |
| N-acetyl-S-(2-carbamoylethyl)-L-cysteine** | 0.68 | 1.19 | 1.07 | **1.89** | 0.83 | 1.09 | 0.77 | 1.07 | 0.85 | 0.99 | **1.77** | **1.27** | **1.64** | 0.95 | **1.27** | 0.86 |
| N-acetyl-S-(2-cyanoethyl)-L-cysteine** | 0.36 | 0.92 | **1.47** | **2.06** | 0.42 | 0.77 | 0.84 | 1.22 | 0.62 | 0.47 | **2.06** | **1.52** | 1.22 | 0.12 | **1.66** | 0.82 |
| N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine** | 0.37 | 1.16 | 0.7 | **2.26** | 0.47 | 0.59 | 0.99 | 1.02 | 0.94 | 0.51 | **1.6** | 1.15 | 1.09 | | **1.46** | 0.75 |
| N-acetyl-S-(2-hydroxypropyl)-L-cysteine** | 0.66 | 0.8 | 0.89 | 0.89 | **1.43** | 0.69 | 1.16 | 1.14 | 0.89 | 0.57 | 0.89 | 1.04 | **1.43** | 0.79 | **1.31** | 0.88 |
| N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine** | 0.83 | 0.99 | 0.91 | 1.07 | 0.79 | 0.99 | 1.06 | 1 | 0.96 | 0.85 | **1.26** | 0.88 | 0.91 | 0.99 | 1.08 | 0.99 |
| N-acetyl-S-(3-Hydroxypropyl)-L-cysteine** | 0.56 | 0.74 | 1.17 | **1.75** | 0.79 | 0.79 | 1.12 | 1 | 0.72 | 0.68 | **1.67** | 1.17 | 0.98 | 0.67 | **1.28** | 1.05 |
| N-acetyl-S-(N-methylcarbamoyl)-L-cysteine** | 0.64 | 0.81 | 1.16 | **1.35** | 0.57 | 1.14 | 1.01 | 1.16 | 0.71 | 0.64 | 1.21 | 1 | 0.78 | 0.89 | **1.32** | 0.93 |
| N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine** | 0.5 | 0.72 | 1.02 | **1.79** | 0.93 | 0.83 | 1.11 | 1.16 | 0.79 | 0.47 | **1.7** | 0.87 | 1 | 0.59 | **1.43** | 0.93 |
| NNAL** | 0.13 | 0.42 | 1.06 | 1.18 | 0.32 | 1.07 | 0.81 | **1.39** | 0.36 | 0.16 | 1.18 | 0.99 | 1 | 0.54 | **1.75** | 0.76 |
| Nickel | 0.83 | 0.94 | 1.13 | 1.03 | 0.97 | 1.08 | 0.96 | 1.04 | 1.03 | 0.78 | 1.19 | 1 | 1.1 | 0.97 | 1.13 | 0.8 |
| Nitromethane | 0.95 | 0.95 | **1.29** | 1.12 | 1.08 | 1.04 | 0.95 | 0.93 | 1.01 | 0.87 | **1.25** | 1.13 | 1.21 | 0.96 | 0.96 | 0.94 |
| Oxypyrimidine** | 0.96 | 1.06 | **1.67** | **1.91** | 0.86 | 0.94 | 0.82 | 0.89 | 0.96 | 1.16 | **1.98** | **1.55** | 0.88 | 0.86 | 0.9 | 0.79 |
| Pentachlorophenol | 0.64 | 0.81 | 1.23 | 1.07 | 0.77 | **1.54** | 0.89 | **1.36** | 0.81 | 0.68 | 1.15 | 1.12 | 0.73 | 0.34 | 0.97 | 1.04 |
| **Dem. Subgroup:** | | | | | | | | | | | | | | | | |
| Inc/PL ratio: | | | | | | | | | <2 | >2 | <2 | >2 | <2 | >2 | <2 | >2 |
| Race/eth: | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht |
| Sex: | F | M | F | M | F | M | F | M | | | | | | | | |

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**Table A11:** NHANES P95 biomarker concentration ratios: demographic interactions

| **Chemical** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Perfluorooctanesulfonic acid | 0.58 | 0.78 | **1.51** | **1.43** | 1.1 | **1.58** | 0.9 | 1.03 | 0.71 | 0.61 | **1.39** | **1.62** | **1.58** | 1.03 | 0.88 | 1.01 |
| Perfluorooctanoic acid | 0.71 | 0.79 | 0.89 | 0.92 | 1.01 | **1.58** | 1.03 | 1 | 0.63 | 0.74 | 0.79 | 0.89 | **1.82** | 0.98 | 1 | 1.16 |
| Phenylglyoxylic acid** | 0.73 | 0.93 | **1.28** | **1.27** | 0.8 | 0.82 | 0.96 | 1.05 | 0.85 | 0.81 | **1.35** | 1.09 | 0.87 | 0.81 | 1 | 0.98 |
| Styrene | 0.57 | 0.71 | **1.33** | **1.27** | 0.6 | 0.95 | 0.87 | **1.39** | 0.64 | 0.61 | **1.27** | **1.28** | 0.95 | 0.6 | **1.67** | 1.02 |
| Tetrachloroethylene | | 1.07 | 0.89 | 1.14 | | | 0.78 | **1.85** | | **1.26** | | **1.93** | | | | **1.46** |
| **Dem. Subgroup:** | | | | | | | | | | | | | | | | |
| Inc/PL ratio: | | | | | | | | | <2 | >2 | <2 | >2 | <2 | >2 | <2 | >2 |
| Race/eth: | Hsp | Hsp | Blk | Blk | Wht | Wht | Oth | Oth | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht |
| Sex: | F | M | F | M | F | M | F | M | | | | | | | | |

**Notes:** Demographic interaction analysis showing 95th percentile ratios for the carcinogens and associated metabolites (N = 75) for which censoring by detection limits did not prevent statistical calculations. Subgroups in this table include interactions of race/ethnicity and sex, and interactions of race/ethnicity and household income. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5. Statistics based on individual-level NHANES biomonitoring samples.

**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex.

**Parent Chems:** {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol, 2-naphthol: *Naphthalene***} {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid***}; {2,4-dichlorophenol: *Nitrofen***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene***}; {2-naphthol: *Naphthalene***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {Dimethyl dithiophosphate: *Malathion***}; {Dimethyl thiophosphate: *Malathion***}; {Malathion dicarboxylic acid: *Malathion***}; {Mandelic acid: *Styrene***}; {Mandelic acid: *Ethylbenzene***}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-(2-ethylhexyl) phthalate Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA), N-acetyl-S-(2-Hydroxyethyl)-L-cysteine, N-acetyl-S-(2-cyanoethyl)-L-cysteine: *Acrylonitrile***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-Acetyl-S-(phenyl)-L-cysteine: *Benzene***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Vinyl Chloride***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Ethylene Oxide***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine, N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine: *1,3-Butadiene***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Oxypyrimidine: *Diazonon***}; {Phenylglyoxylic acid: *Styrene***}; {Phenylglyoxylic acid: *Ethylbenzene***}

**Return to:** Section 3.1.3.

**Table A12:** NHANES P95 biomarker concentration ratios: age-differentiated results

| **Chemical** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1,4-Dichlorobenzene | 1.13 | 1 | **1.56** | **1.29** | **1.63** | **3.86** | 0.28 | 0.72 | 0.45 | 0.6 |
| 1-Naphthylamine | 0.22 | 1.09 | 0.2 | 0.52 | 0.31 | **1.57** | 0.45 | 0.66 | 0.22 | 1.14 |
| 1-naphthol** | 0.32 | 1.24 | 0.37 | 0.85 | 0.71 | **1.54** | 0.52 | 0.67 | 0.22 | **1.49** |
| 2,4,5-trichlorophenol** | 0.67 | 1 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 1 | 1 | 1 |
| 2,4,6-Trichlorophenol | 1.18 | 1 | 1.18 | 1.09 | **1.27** | **1.36** | 0.73 | 0.91 | **1.27** | 0.82 |
| 2,4-Dichlorophenoxyacetic acid | 1.19 | 0.92 | 1.21 | 0.8 | 0.94 | 0.78 | 0.99 | 0.82 | **1.25** | 0.97 |
| 2,4-dichlorophenol** | **1.26** | 0.96 | **2.1** | **2.36** | **4.95** | **10.51** | 0.58 | 0.73 | 0.7 | 0.48 |
| 2,5-dichlorophenol** | **1.43** | 0.94 | **3.28** | **3.62** | **12.5** | **13.67** | 0.22 | 0.39 | 0.5 | 0.18 |
| 2,6-Dimethylaniline | 0.78 | 1.04 | 0.3 | 1 | 0.28 | 1.14 | 0.21 | 0.83 | **3.04** | 1.12 |
| 2-Amino-1-methyl-6-phenylimidazo [4,5-b]pyridine | 0.49 | 1.09 | 0.52 | 0.99 | 0.72 | 1.23 | 0.49 | 0.91 | 0.39 | 1.16 |
| 2-Amino-alpha-carboline | 0.14 | 1.12 | 0.09 | 0.55 | 0.14 | **1.51** | 0.52 | 0.45 | 0.34 | 1.12 |
| 2-Anisidine | 0.72 | 1.05 | 0.65 | 0.99 | 0.64 | 0.84 | 0.66 | 1.04 | 0.89 | 1.07 |
| 2-Methylaniline | 1.08 | 0.93 | 0.83 | 0.88 | **1.26** | 1.2 | 0.88 | 0.93 | **1.29** | 0.87 |
| 2-Naphthylamine | 0.56 | 1.14 | 0.52 | 0.56 | 0.75 | **1.52** | 0.46 | 0.9 | 0.51 | 1.21 |
| 2-Phenylphenol | 1.2 | 1 | 1 | 1 | **1.6** | 1.2 | 0.6 | 0.4 | 1.2 | 1 |
| 2-naphthol** | 0.9 | 1.04 | 0.99 | 1.15 | 1.12 | **1.47** | 0.93 | 0.68 | 0.72 | 0.96 |
| 4,4'-Diaminobiphenyl methane | 1.17 | 0.97 | **1.25** | 0.9 | **1.45** | 0.98 | **1.26** | 0.89 | 0.99 | 0.97 |
| 4-Biphenylamine | 0.52 | 1.09 | 0.47 | 0.65 | 0.68 | **1.7** | 0.55 | 1 | 0.41 | 1.16 |
| Acrylamide | 0.49 | 1.08 | 0.5 | 0.93 | 0.67 | **1.73** | 0.53 | 0.79 | 0.43 | 1.05 |
| Arsenic | 0.64 | 1.12 | 0.56 | 1.24 | **1.3** | **1.43** | **1.27** | **1.82** | 0.45 | 0.85 |
| Arsenic acid | 1.12 | 0.99 | 1.24 | 1.06 | | | | 0.95 | 1.05 | 0.94 |
| Benzene | 0.18 | 1.07 | 0.17 | 0.51 | 0.22 | **1.38** | 0.14 | **1.45** | 0.18 | 1.12 |
| Bis(2-chloroethyl) phosphate** | **1.35** | 0.92 | **1.27** | 0.75 | 1.23 | 0.73 | **1.25** | 1.16 | **1.88** | 0.97 |
| Bromodichloromethane | 1 | 1 | 0.73 | 1.09 | 0.91 | 1.09 | 1 | 1.09 | **1.27** | 0.91 |
| Bromoform | 1 | 1 | 0.9 | **1.3** | | 0.8 | | 1 | 1 | 1 |
| Cadmium | 0.21 | 1.12 | 0.2 | 0.73 | 0.22 | **1.29** | 0.29 | **1.3** | 0.2 | 1.16 |
| Chloroform | 0.94 | 1 | 0.71 | 0.94 | 1.06 | 1.24 | 1 | **1.26** | **1.26** | 1 |
| Cobalt | | 1 | | 0.95 | | 0.86 | | 0.86 | | 1.05 |
| Crotonaldehyde | 0.84 | 1.02 | 1.19 | **1.46** | 0.76 | 1.04 | **1.27** | 1.22 | 0.8 | 0.98 |
| Dieldrin | 0.48 | 1.03 | 0.47 | 0.89 | 0.42 | 0.84 | 0.45 | **1.37** | 0.54 | 1.05 |
| Diisononyl phthalate | 1 | 1 | **1.33** | **1.33** | 1.22 | 1.06 | 0.78 | 0.72 | 1 | 0.94 |
| Dimethyl dithiophosphate** | 1.24 | 0.88 | 0.89 | 0.58 | **3.11** | 0.62 | 1.19 | 0.43 | **1.42** | **1.27** |
| Dimethyl phosphate** | **1.45** | 0.93 | **1.32** | 0.89 | **1.72** | 1.14 | **1.77** | 0.47 | **1.33** | 0.96 |
| Dimethyl thiophosphate** | **1.28** | 0.81 | 0.85 | 0.73 | **1.86** | 0.67 | 1.15 | 0.44 | 1.19 | 1.03 |
| Dimethylarsinic acid | 0.9 | 1.05 | 0.96 | 1.16 | 0.69 | **1.28** | 1.16 | **1.76** | 0.77 | 0.79 |
| Ethylbenzene | 0.31 | 1.08 | 0.2 | 0.63 | 0.3 | 1.14 | 0.38 | **1.25** | 0.33 | 1.1 |
| **Dem. Subgroup:** | | | | | | | | | | |
| Age: | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Black | NH Black | NH Other | NH Other | NH White | NH White |

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**Table A12:** NHANES P95 biomarker concentration ratios: age-differentiated results

| **Chemical** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ethylene oxide | 0.17 | 1.12 | 0.17 | 0.71 | 0.27 | **1.36** | 0.18 | 0.84 | 0.14 | 1.12 |
| Ethylene thiourea | 1.02 | 0.95 | 0.88 | 1.16 | **1.42** | **1.81** | | **3.09** | 1.02 | |
| Formaldehyde | 0.99 | 1.01 | 1.01 | 1.03 | 0.99 | 0.99 | 0.97 | 0.99 | 0.99 | 1 |
| Furan | | 1.13 | | 0.51 | | 1.2 | 0.29 | **1.49** | | 1.15 |
| Heptachlor epoxide B | | 1.09 | | 0.84 | | 1.01 | | 0.88 | | 1.13 |
| Lead | 0.47 | 1.07 | 0.47 | 1 | 0.49 | 1.24 | 0.56 | **1.28** | 0.46 | 1.02 |
| Malathion dicarboxylic acid** | 0.83 | 1.07 | 0.62 | 0.67 | 0.65 | 0.65 | **1.64** | 0.8 | 0.9 | 1.14 |
| Mandelic acid** | 0.71 | 1.06 | 0.64 | **1.26** | 1 | **1.42** | 0.81 | 0.92 | 0.68 | 1.01 |
| MeA-alpha-C | 0.17 | 1.13 | | 0.55 | 0.25 | **1.76** | 0.48 | 0.55 | 0.19 | 1.15 |
| Melamine | 1.11 | 0.97 | **2.15** | 1.17 | 1 | **1.39** | 0.69 | 0.39 | 1.11 | 0.96 |
| Methylarsonic acid | 1.01 | 0.99 | 0.9 | 1.14 | 0.96 | 0.99 | 1.07 | 1.17 | 1.1 | 0.93 |
| Mono-(2-ethyl-5-hydroxyhexyl) phthalate** | 1.24 | 0.94 | **1.43** | 0.95 | **1.39** | 1.11 | **1.55** | 0.88 | 1.15 | 0.81 |
| Mono-(2-ethyl-5-oxohexyl) phthalate** | **1.34** | 0.91 | **1.44** | 1.04 | 1.23 | 1.07 | **1.64** | 0.9 | **1.28** | 0.8 |
| Mono-(2-ethylhexyl) phthalate** | 1.04 | 0.98 | **1.3** | **1.3** | **1.42** | **1.26** | **1.42** | 1.1 | 0.82 | 0.84 |
| Mono-2-ethyl-5-carboxypentyl phthalate** | **1.3** | 0.85 | **1.34** | 0.97 | 1.21 | 1.15 | **1.72** | 1.01 | 1.23 | 0.63 |
| N'-Nitrosonornicotine | 0.16 | 1.13 | | 0.4 | 0.16 | **1.27** | | 1.14 | 0.22 | **1.26** |
| N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA)** | | 1.23 | | 0.94 | 0.35 | **1.98** | | 0.78 | | 1.16 |
| N-Acetyl-S-(n-propyl)-L-cysteine** | 0.66 | 1.12 | 0.78 | **1.41** | 0.7 | 1.14 | 0.85 | **1.87** | 0.55 | 0.98 |
| N-Acetyl-S-(phenyl)-L-cysteine** | 1.21 | 0.93 | **1.3** | 1.2 | 0.96 | 0.81 | 1.21 | 1.05 | **1.25** | 0.91 |
| N-acetyl-S-(2-Carboxyethyl)-L-cysteine** | 0.58 | 1.07 | 0.52 | 0.85 | 0.95 | **1.58** | 0.6 | 0.73 | 0.5 | 1.11 |
| N-acetyl-S-(2-Hydroxyethyl)-L-cysteine** | 0.78 | 1.11 | 0.78 | 0.92 | 0.94 | **1.9** | 0.66 | **1.28** | 0.69 | 0.94 |
| N-acetyl-S-(2-carbamoylethyl)-L-cysteine** | 0.76 | 1.05 | 0.64 | 1.04 | 1.07 | **1.65** | 0.75 | 1.09 | 0.67 | 0.98 |
| N-acetyl-S-(2-cyanoethyl)-L-cysteine** | 0.07 | 1.23 | 0.05 | 0.93 | 0.24 | **2.06** | 0.07 | 0.94 | 0.03 | 1.19 |
| N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine** | | **1.28** | | 1.16 | | **1.98** | | 0.73 | | **1.28** |
| N-acetyl-S-(2-hydroxypropyl)-L-cysteine** | 0.47 | 1.16 | 0.63 | 0.8 | 0.73 | 1.01 | 0.44 | 1.19 | 0.33 | **1.29** |
| N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine** | 0.93 | 1.01 | 0.83 | 0.93 | 1.11 | 1 | 0.87 | 0.92 | 0.92 | 1.05 |
| N-acetyl-S-(3-Hydroxypropyl)-L-cysteine** | 0.55 | 1.13 | 0.47 | 0.74 | 0.64 | **1.96** | 0.78 | 0.92 | 0.49 | 1.24 |
| N-acetyl-S-(N-methylcarbamoyl)-L-cysteine** | 0.27 | 1.18 | 0.24 | 0.81 | 0.34 | **1.33** | 0.29 | 0.89 | 0.27 | **1.26** |
| N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine** | 0.35 | 1.16 | 0.33 | 0.8 | 0.39 | **1.8** | 1.21 | 0.83 | 0.3 | **1.27** |
| NNAL** | 0.11 | 1.15 | 0.03 | 0.43 | 0.13 | 1.23 | 0.06 | 1.02 | 0.17 | **1.31** |
| Nickel | 1.17 | 0.93 | 1.22 | 0.78 | **1.41** | 1.06 | 1.24 | 0.95 | 1.11 | 0.95 |
| Nitromethane | 0.7 | 1.02 | 0.77 | 1.01 | 0.76 | **1.26** | 0.72 | 1.07 | 0.6 | 0.95 |
| Oxypyrimidine** | 0.71 | 1.06 | 0.6 | 1.17 | 1.12 | **1.97** | 0.86 | 0.86 | 0.51 | 0.89 |
| Pentachlorophenol | 1.23 | 0.94 | 0.81 | 0.8 | 1.14 | 1.12 | **1.28** | 0.77 | **1.42** | 0.95 |
| Perfluorooctanesulfonic acid | 0.5 | 1.03 | 0.42 | 0.71 | 0.49 | **1.54** | 0.5 | **1.42** | 0.65 | 0.98 |
| Perfluorooctanoic acid | 0.63 | 1.03 | 0.76 | 0.79 | 0.44 | 0.93 | 0.76 | **1.53** | 0.63 | 1.05 |
| Phenylglyoxylic acid** | 0.75 | 1.08 | 0.65 | 0.93 | 0.94 | **1.35** | 0.8 | 0.82 | 0.7 | 1.08 |
| **Dem. Subgroup:** | | | | | | | | | | |
| Age: | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Black | NH Black | NH Other | NH Other | NH White | NH White |

Continued, next page...

**Table A12:** NHANES P95 biomarker concentration ratios: age-differentiated results

| **Chemical** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Styrene | 0.61 | 1.02 | 0.49 | 0.65 | 0.36 | **1.33** | 0.41 | 0.73 | 0.72 | 1.16 |
| Tetrachloroethylene | 0.78 | 1.03 | | 1.07 | | 1.13 | | | 1.15 | 1.07 |
| **Dem. Subgroup:** | | | | | | | | | | |
| Age: | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Black | NH Black | NH Other | NH Other | NH White | NH White |

**Notes:** Age-based analysis showing 95th percentile ratios for the carcinogens and associated metabolites (N = 42) for which censoring by detection limits did not prevent statistical calculations. Demographic subgroups presented by age, including age subgroups differentiated by race/ethnicity. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5. Statistics based on individual-level NHANES biomonitoring samples.

**Demographic subgroups:** Hispanic, non-Hispanic Black, non-Hispanic White, Other race including multi-racial

**Parent Chems:** {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol, 2-naphthol: *Naphthalene***}; {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid***}; {2,4-dichlorophenol: *Nitrofen***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {Dimethyl dithiophosphate: *Malathion***}; {Dimethyl thiophosphate: *Malathion***}; {Malathion dicarboxylic acid: *Malathion***}; {Mandelic acid: *Styrene***}; {Mandelic acid: *Ethylbenzene***}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-(2-ethylhexyl) phthalate Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA), N-acetyl-S-(2-Hydroxyethyl)-L-cysteine, N-acetyl-S-(2-cyanoethyl)-L-cysteine: *Acrylonitrile***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-Acetyl-S-(phenyl)-L-cysteine: *Benzene***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Vinyl Chloride***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Ethylene Oxide***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine, N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine: *1,3-Butadiene***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Oxypyrimidine: *Diazonon***}; {Phenylglyoxylic acid: *Styrene***}; {Phenylglyoxylic acid: *Ethylbenzene***}

**Return to:** Section 3.1.3.

**Table A13:** NHANES detected sample ratios: primary results

| **Chemical** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | 0.41 | **1.26** | 0.37 | | 1.16 | **1.27** | 1.12 | 1.18 | 0.81 |
| 1,1,2,2-Tetrachloroethane | 0.72 | **1.49** | 0 | | 1.24 | 0.98 | **1.87** | 0.67 | **1.33** |
| 1,4-Dichlorobenzene | 1.1 | 0.87 | 1 | | **1.53** | 0.74 | 0.85 | 0.99 | 1.01 |
| 1-Naphthylamine | 1.11 | 0.89 | 0.95 | | 1.22 | 0.98 | 0.84 | 0.96 | 1.04 |
| 1-naphthol** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| 2,4,5-trichlorophenol** | 0.99 | 0.96 | 0.74 | | 1.24 | 1.06 | 1.16 | 1 | 1 |
| 2,4,6-Trichlorophenol | 1.1 | 0.83 | 1.02 | | **1.41** | 0.83 | 0.83 | 1 | 1 |
| 2,4-Dichlorophenoxyacetic acid | 1 | 1.01 | 0.98 | | 1.06 | 1.02 | 0.9 | 0.95 | 1.05 |
| 2,4-dichlorophenol** | 1.01 | 0.99 | 1.02 | | 1.05 | 0.96 | 0.95 | 1 | 1 |
| 2,5-dichlorophenol** | 1.01 | 0.99 | 1.01 | | 1.02 | 0.99 | 0.97 | 0.99 | 1.01 |
| 2,6-Dimethylaniline | 1.03 | 0.97 | 1 | | 1.1 | 1 | 0.84 | 0.96 | 1.05 |
| PhIP | 0.99 | 1.02 | 1.1 | | 1.21 | 0.89 | 0.79 | 0.96 | 1.04 |
| IQ (heterocyclic amine) | 1.05 | 0.85 | 0.99 | | 0.96 | 1.03 | 1 | 1.02 | 0.98 |
| 2-Amino-alpha-carboline | 1.06 | 0.93 | 0.98 | | 1.04 | 1.06 | 0.84 | 0.91 | 1.09 |
| 2-Anisidine | 1 | 1.01 | 1 | | 1 | 1 | 1 | 1 | 1 |
| 2-Methylaniline | 1.02 | 0.98 | 1 | | 1.08 | 0.98 | 0.93 | 0.97 | 1.03 |
| 2-Naphthylamine | 1.05 | 0.95 | 0.95 | | 1.18 | 0.98 | 0.89 | 0.96 | 1.04 |
| 2-Phenylphenol | 1.08 | 0.92 | 0.94 | | 1.17 | 1.01 | 0.68 | 1.01 | 0.99 |
| 2-naphthol** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| 4,4'-Diaminobiphenyl methane | 1.02 | 0.96 | 1.04 | | 1.12 | 0.99 | 0.78 | 0.97 | 1.03 |
| 4-Biphenylamine | 1.03 | 0.97 | 0.95 | | 1.07 | 1.02 | 0.93 | 0.98 | 1.02 |
| 4-Methyl-2-pentanone | 0.96 | 1.22 | 0.84 | | 0.9 | **1.62** | 0.25 | 0.88 | 1.13 |
| Acetochlor mercapturate** | 1.01 | 0.94 | 0.86 | | **1.71** | 0.64 | **1.5** | 1.04 | 0.95 |
| Acrylamide | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Alachlor mercapturate** | 1.03 | **1.34** | 0.73 | | 0.79 | **1.7** | 0 | 1.17 | 0.82 |
| Arsenic | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Arsenic acid | 1.02 | 1.07 | **1.38** | | 0.67 | 1.01 | 0.91 | 1 | 1 |
| Benzene | 1.18 | 0.82 | 0.81 | | **1.31** | 1.04 | 0.8 | 0.89 | 1.12 |
| Beta-Hexachlorocyclohexane† | | | 1.09 | **1.42** | 0.82 | 0.97 | 0.97 | 1 | 1 |
| **Dem. Subgroup:** | | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | | |
| Race/eth: | | | Hispanic | NH Asian | NH Black | NH White | Other | | |
| Sex: | | | | | | | | Female | Male |

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**Table A13:** NHANES detected sample ratios: primary results

| **Chemical** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bis(2-chloroethyl) phosphate** | 1.02 | 0.98 | 1 | | 1.04 | 0.99 | 0.96 | 0.99 | 1.01 |
| Bromodichloromethane | 0.9 | 1.11 | 0.89 | | 1.13 | 0.92 | 1.13 | 1 | 0.99 |
| Bromoform | 1.1 | 0.93 | **1.43** | | 0.57 | 1.02 | 0.93 | 0.95 | 1.06 |
| Cadmium | 0.95 | 1.04 | 0.94 | | 1 | 1 | 1.08 | 1.02 | 0.97 |
| Carbon tetrachloride | 0.8 | **1.48** | **1.4** | | **1.51** | 0.98 | 0 | 0.65 | **1.38** |
| Chloroethane | **1.58** | 0.74 | 0 | | **1.51** | **1.93** | 0 | 0 | **2.05** |
| Chloroform | 0.94 | 1.04 | 0.9 | | 1.21 | 0.89 | 1.06 | 1.03 | 0.97 |
| Cobalt | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Crotonaldehyde | 1.07 | 0.9 | 1.13 | | 1.05 | 0.85 | 1.15 | 1 | 1 |
| Cumene | 0.89 | 0.84 | 1.03 | | 0 | **1.83** | 0.64 | 0.49 | **1.55** |
| DDT† | | | 0.92 | 0.99 | 0.87 | 1.05 | 0.98 | 1.02 | 0.98 |
| Dichloromethane | 0.8 | **1.48** | **1.4** | | 0 | **1.47** | 0.84 | 0.97 | 1.03 |
| Dieldrin | 0.85 | 1.13 | 0.85 | | 0.8 | 1.19 | 1.16 | 0.95 | 1.05 |
| Diisononyl phthalate | 1.05 | 0.83 | 1.15 | | 1.2 | 0.86 | 0.82 | 1 | 1 |
| Dimethyl dithiophosphate** | 0.99 | 1.04 | 1.04 | | 0.98 | 1.03 | 0.93 | 0.98 | 1.02 |
| Dimethyl phosphate** | 0.99 | 1.01 | 1.01 | | 1 | 0.99 | 1.01 | 1 | 1 |
| Dimethyl thiophosphate** | 0.99 | 1.01 | 1 | | 1 | 1.01 | 0.99 | 0.99 | 1.01 |
| Dimethylarsinic acid | 0.99 | 0.99 | 1.07 | | 1.02 | 0.89 | 1.07 | 0.96 | 1.04 |
| Ethylbenzene | 1.19 | 0.85 | 0.61 | | **1.4** | 1.11 | 0.84 | 0.83 | 1.18 |
| Ethylene oxide | 1.03 | 0.95 | 1 | | 1.06 | 0.93 | 1.07 | 0.99 | 1.01 |
| Ethylene thiourea | 1.1 | 0.9 | 1.22 | | 1.17 | 0.69 | **1.48** | 0.96 | 1.04 |
| Formaldehyde | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Furan | **1.41** | 0.61 | 0.44 | | **1.56** | 1.2 | 0.71 | 0.87 | 1.14 |
| Glu-P-1 | 1.13 | 0.98 | 1.03 | | **1.35** | 0.99 | 0.48 | 1.09 | 0.91 |
| Glu-P-2 | **1.29** | 0.56 | **1.88** | | **1.74** | 0 | 0.83 | **1.75** | 0.25 |
| Heptachlor epoxide B | 0.95 | 1.03 | 0.92 | | 0.77 | 1.2 | 0.79 | 1.04 | 0.96 |
| Lead | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Malathion dicarboxylic acid** | 0.94 | 1.1 | 0.92 | | 0.84 | 1.16 | 0.68 | 0.97 | 1.03 |
| Mandelic acid** | 1 | 1 | 0.99 | | 1 | 1 | 1.01 | 1 | 1 |
| **Dem. Subgroup:** | | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | | |
| Race/eth: | | | Hispanic | NH Asian | NH Black | NH White | Other | | |
| Sex: | | | | | | | | Female | Male |

Continued, next page...

**Table A13:** NHANES detected sample ratios: primary results

| **Chemical** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MeA-alpha-C | 1.2 | 0.78 | 0.58 | | **1.35** | 1.24 | 0.64 | 0.84 | 1.16 |
| Melamine | 1.01 | 1.01 | 0.93 | | 0.92 | 1.08 | **1.25** | 0.99 | 1.01 |
| Methylarsonic acid | 0.99 | 1 | 1.11 | | 0.92 | 0.85 | 1.19 | 0.92 | 1.09 |
| Mirex† | | | 0.82 | 0.94 | 1.05 | 1.05 | 0.97 | 0.99 | 1.01 |
| Mono-(2-ethyl-5-hydroxyhexyl) phthalate** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Mono-(2-ethyl-5-oxohexyl) phthalate** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Mono-(2-ethylhexyl) phthalate** | 1.05 | 0.95 | 1.05 | | 1.13 | 0.83 | 1.07 | 0.94 | 1.07 |
| Mono-2-ethyl-5-carboxypentyl phthalate** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Mono-n-octyl phthalate** | 0.9 | 0.86 | 1.12 | | 1.24 | 0.84 | 0.82 | 0.95 | 1.05 |
| N'-Nitrosonornicotine | **1.26** | 0.73 | 0.47 | | **1.26** | **1.33** | 0.71 | 0.81 | 1.19 |
| NAS-(1-cyano-2-hydroxyethyl)-LC (CYHA)** | 1.23 | 0.77 | 0.58 | | **1.7** | 1.13 | 0.63 | 0.78 | 1.22 |
| NAS-(n-propyl)-LC** | 0.99 | 1.01 | 1.02 | | 1.05 | 0.94 | 1.01 | 0.97 | 1.03 |
| NAS-(phenyl)-LC** | 0.97 | 1.03 | 1.03 | | 1.05 | 1.03 | 0.8 | 0.91 | 1.09 |
| N-Nitroso-N-methylethylamine | **1.27** | 0.62 | 1.03 | | 1.03 | 0.61 | **1.81** | 0.78 | 1.21 |
| N-Nitrosodiethylamine | 0.84 | 0.89 | 1.09 | | 0.95 | 0.83 | **1.29** | 1 | 1 |
| N-Nitrosomorpholine | **1.25** | 0.77 | 0.6 | | **1.54** | 0.98 | 1 | 1.13 | 0.87 |
| N-Nitrosopiperidine | 1.24 | 0.79 | **1.27** | | **1.25** | 0.66 | 1 | 0.92 | 1.08 |
| N-Nitrosopyrrolidine | 0.86 | 1.12 | **1.56** | | 0.77 | 0.91 | 0.55 | **1.83** | 0.17 |
| NAS-(2-Carboxyethyl)-LC** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| NAS-(2-Hydroxyethyl)-LC** | 1.03 | 0.96 | 0.96 | | **1.25** | 0.96 | 0.81 | 1 | 1 |
| NAS-(2-carbamoylethyl)-LC** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| NAS-(2-cyanoethyl)-LC** | 0.99 | 1.01 | 0.96 | | 1.13 | 0.98 | 0.94 | 0.94 | 1.06 |
| NAS-(2-hydroxy-3-butenyl)-LC** | 1.21 | 0.79 | 0.71 | | **1.43** | 1.21 | 0.59 | 0.81 | 1.19 |
| NAS-(2-hydroxypropyl)-LC** | 1 | 1.01 | 1 | | 1.02 | 1 | 0.97 | 0.98 | 1.02 |
| NAS-(3,4-dihydroxybutyl)-LC** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| NAS-(3-Hydroxypropyl)-LC** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| NAS-(N-methylcarbamoyl)-LC** | 1 | 1 | 1 | | 1 | 1 | 0.99 | 1 | 1 |
| NAS-(3-hydroxypropyl-1-methyl)-LC** | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| NNAL** | 1.17 | 0.81 | 0.95 | | 1.21 | 0.96 | 0.86 | 0.94 | 1.06 |
| **Dem. Subgroup:** | | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | | |
| Race/eth: | | | Hispanic | NH Asian | NH Black | NH White | Other | | |
| Sex: | | | | | | | | Female | Male |

Continued, next page...

**Table A13:** NHANES detected sample ratios: primary results

| **Chemical** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Nickel | 1 | 1 | 1 | | 1.02 | 1 | 0.98 | 0.99 | 1.01 |
| Nitromethane | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Oxypyrimidine** | 1.03 | 0.92 | 0.85 | | **1.56** | 0.83 | 0.85 | 0.98 | 1.02 |
| PBB153† | | | 0.97 | 0.82 | 1.01 | 1.03 | 0.93 | 1 | 1 |
| PCB028† | | | 0.78 | **1.33** | 0.7 | 1.1 | 0.78 | 1.13 | 0.86 |
| PCB066† | | | 0.49 | **2.11** | 0.9 | 1.06 | 0.93 | 1 | 1 |
| PCB074† | | | 0.96 | 1.04 | 0.99 | 1.01 | 0.98 | 0.98 | 1.02 |
| PCB081† | | | 1.08 | **3.99** | 0 | 0.97 | 0 | **1.66** | 0.3 |
| PCB105† | | | 0.97 | 1.03 | 0.97 | 1.01 | 0.93 | 0.99 | 1.01 |
| PCB114† | | | 0.68 | 1.06 | 0.9 | 1.09 | 1.16 | 0.97 | 1.03 |
| PCB126† | | | 1 | **1.28** | 0.89 | 1.02 | 0.68 | 1 | 1 |
| PCB146† | | | 0.87 | 1.06 | 1.03 | 1.02 | 1.06 | 0.98 | 1.02 |
| PCB156† | | | 0.93 | 1.04 | 1 | 1.01 | 1.04 | 0.97 | 1.03 |
| PCB157† | | | 0.7 | 1.21 | 0.9 | 1.07 | 1.05 | 0.92 | 1.08 |
| PCB167† | | | 0.87 | **1.41** | 0.92 | 1.03 | 0.75 | 0.98 | 1.02 |
| PCB169† | | | 0.82 | 1.21 | 0.84 | 1.08 | 0.65 | 0.94 | 1.06 |
| PCB170† | | | 1 | 1.01 | 0.99 | 1.01 | 0.96 | 1 | 1 |
| PCB178† | | | 0.79 | 1.18 | 0.95 | 1.05 | 0.92 | 0.94 | 1.06 |
| PCB183† | | | 0.94 | 1.04 | 0.99 | 1.02 | 0.89 | 0.98 | 1.02 |
| PCB187† | | | 0.98 | 1.04 | 1.04 | 0.99 | 1.04 | 0.98 | 1.02 |
| PCB189† | | | 0.54 | 1.04 | 0.9 | 1.12 | 1.24 | 1.05 | 0.94 |
| PCB194† | | | 0.95 | 1.05 | 0.98 | 1.02 | 0.95 | 0.98 | 1.02 |
| PCB196† | | | 0.96 | 1.03 | 0.99 | 1.01 | 1.03 | 0.97 | 1.03 |
| PCB199† | | | 0.88 | 1.04 | 0.97 | 1.03 | 1.06 | 0.99 | 1.02 |
| PCB206† | | | 0.82 | 1.15 | 1.03 | 1.03 | 1.02 | 0.92 | 1.08 |
| PCB209† | | | 0.89 | **1.27** | 1.01 | 1 | 1.03 | 0.87 | 1.14 |
| PeCDF (furan)† | | | 0.99 | 1 | 0.86 | 1.05 | 0.72 | 0.92 | 1.08 |
| Pentachlorophenol | 1.03 | 0.97 | 0.75 | | 1.22 | 1.04 | 0.85 | 0.98 | 1.02 |
| Perfluorooctanesulfonic acid | 1 | 1 | 1 | | 0.99 | 1 | 1 | 1 | 1 |
| **Dem. Subgroup:** | | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | | |
| Race/eth: | | | Hispanic | NH Asian | NH Black | NH White | Other | | |
| Sex: | | | | | | | | Female | Male |

Continued, next page...

**Table A13:** NHANES detected sample ratios: primary results

| **Chemical** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Perfluorooctanoic acid | 1 | 1 | 1 | | 0.99 | 1 | 1 | 1 | 1 |
| Phenylglyoxylic acid** | 1 | 1 | 1 | | 1.01 | 1 | 1 | 1 | 1 |
| Styrene | 1 | 1.01 | 0.89 | | 1.01 | 1.15 | 0.79 | 0.91 | 1.09 |
| TCDD (dioxin)† | | | 0.89 | **1.31** | 0.83 | 1.05 | 0.79 | 1.1 | 0.89 |
| Tetrachloroethylene | 0.76 | **1.34** | 0.87 | | 1.18 | 1.12 | 0.74 | 0.88 | 1.13 |
| Tetrahydrofuran | 1 | 1.11 | 0.7 | | 0.75 | 1.23 | **1.26** | 1.14 | 0.86 |
| Trichloroethylene | 1.2 | 0.86 | 0.47 | | **1.5** | 0.98 | 1.12 | 0.97 | 1.03 |
| Trp-P-1 | 1.06 | 0.94 | 0.79 | | 1.18 | 0.95 | 1.23 | 1.07 | 0.93 |
| **Dem. Subgroup:** | | | | | | | | | |
| Inc/PL ratio: | <2x P.L. | >2x P.L. | | | | | | | |
| Race/eth: | | | Hispanic | NH Asian | NH Black | NH White | Other | | |
| Sex: | | | | | | | | Female | Male |

**Notes:** Presentation of the primary set of sample detection ratios for (N = 125) matched carcinogens and carcinogen-associated metabolites. Statistics based on both individual-level (N = 96) and pooled (N = 29) NHANES samples. The sample detection ratio for a given chemical and subgroup is given as the subgroup's survey-weighted fraction of samples with concentrations above the detection limit divided by the total population's survey-weighed fraction of samples with concentrations above the detection limit. Implicitly, for a chemical to be included in this analysis, at least one sample in the data must be detectable. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5. **: Carcinogen metabolite. †: Result based on pooled sampling data.

**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex. Non-Hispanic Asian results presented separately only for chemicals with pooled biomonitoring sampling.

**Parent Chems:** {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol, 2-naphthol: *Naphthalene***}; {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid***}; {2,4-dichlorophenol: *Nitrofen***}; {2,4,5-trichlorophenol: *beta-Hexachlorocyclohexane***}; {2,4,5-trichlorophenol: *Lindane***}; {2,4,5-trichlorophenol: *1,2,3,4,5,6-Hexachlorocyclohexane***}; {2,4,5-trichlorophenol: *Pentachlorophenol***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {Dimethyl dithiophosphate: *Malathion***}; {Dimethyl thiophosphate: *Malathion***}; {Malathion dicarboxylic acid: *Malathion***}; {Mandelic acid: *Styrene***}; {Mandelic acid: *Ethylbenzene***}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-(2-ethylhexyl) phthalate Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA), N-acetyl-S-(2-Hydroxyethyl)-L-cysteine, N-acetyl-S-(2-cyanoethyl)-L-cysteine: *Acrylonitrile***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-Acetyl-S-(phenyl)-L-cysteine: *Benzene***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Vinyl Chloride***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Ethylene Oxide***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine, N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine: *1,3-Butadiene***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Oxypyrimidine: *Diazonon***}; {Phenylglyoxylic acid: *Styrene***}; {Phenylglyoxylic acid: *Ethylbenzene***}

**Return to:** Section 3.1.4.

**Table A14:** NHANES detected sample ratios: demographic interactions

| **Chemical** | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | 0.69 | 0 | | | **1.46** | 0.81 | 0.85 | **1.4** | **1.55** | 1.01 | 0 | 0.53 | 0 | **1.95** | **1.36** | 0 | 0.59 | **2.05** |
| 1,1,2,2-Tetrachloroethane | 0 | 0 | | | 0 | **2.57** | **3.9** | 0 | 0 | **1.93** | 0 | 0 | 0 | **3.23** | 0 | **3.44** | **2.25** | 0 |
| 1,4-Dichlorobenzene | 0.95 | 1.05 | | | **1.57** | **1.49** | 0.87 | 0.83 | 0.71 | 0.78 | 1.16 | 0.75 | **1.68** | **1.35** | 0.91 | 0.8 | 0.76 | 0.71 |
| 1-Naphthylamine | 0.93 | 0.96 | | | 1.22 | 1.22 | 0.82 | 0.87 | 0.91 | 1.04 | 0.96 | 0.89 | **1.29** | 1.1 | 1.03 | 0.76 | 1.14 | 0.86 |
| 1-naphthol** | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2,4,5-trichlorophenol** | 0.8 | 0.69 | | | 1.23 | **1.25** | 0.97 | **1.3** | 1.04 | 1.08 | 0.7 | 0.64 | **1.25** | 1.22 | **1.34** | 0.76 | 1.07 | 1.01 |
| 2,4,6-Trichlorophenol | 0.97 | 1.07 | | | **1.49** | **1.34** | 0.7 | 0.93 | 0.86 | 0.81 | 1 | 0.91 | **1.61** | 1.11 | 0.97 | 0.51 | 0.93 | 0.75 |
| 2,4-Dichlorophenoxyacetic acid | 0.94 | 1.01 | | | 1.02 | 1.09 | 0.79 | 1.01 | 0.97 | 1.07 | 0.98 | 0.98 | 1.05 | 1.06 | 0.92 | 0.89 | 1 | 1.05 |
| 2,4-dichlorophenol** | 1.02 | 1.02 | | | 1.04 | 1.06 | 0.95 | 0.96 | 0.95 | 0.98 | 1.03 | 0.99 | 1.06 | 1.03 | 0.94 | 1 | 0.97 | 0.96 |
| 2,5-dichlorophenol** | 1 | 1.02 | | | 1.02 | 1.02 | 0.98 | 0.97 | 0.97 | 1 | 1.02 | 0.99 | 1.03 | 1.02 | 0.99 | 0.96 | 1 | 0.98 |
| 2,6-Dimethylaniline | 0.92 | 1.1 | | | 1.09 | 1.11 | 0.89 | 0.79 | 0.94 | 1.07 | 0.98 | 1.1 | 1.11 | 1.06 | 0.84 | 0.82 | 1.07 | 0.96 |
| PhIP | 1.07 | 1.13 | | | 1.23 | 1.19 | 0.79 | 0.79 | 0.81 | 0.98 | 1.1 | 1.12 | 1.15 | **1.31** | 0.86 | 0.76 | 0.81 | 0.98 |
| IQ (heterocyclic amine) | 1.2 | 0.76 | | | **1.27** | 0.67 | 0.74 | **1.28** | 0.85 | 1.19 | 1.1 | 0.46 | 1.06 | 0.71 | 0.84 | 1.19 | 1.05 | 0.89 |
| 2-Amino-alpha-carboline | 0.83 | 1.14 | | | 0.94 | 1.14 | 0.78 | 0.91 | 1.01 | 1.1 | 0.97 | 0.94 | 1.07 | 0.99 | 1.02 | 0.77 | 1.16 | 0.97 |
| 2-Anisidine | 1 | 1 | | | 1 | 1 | 1.01 | 0.98 | 1 | 1.01 | 1 | 1 | 0.99 | 1.01 | 0.99 | 1 | 1 | 1.01 |
| 2-Methylaniline | 0.97 | 1.03 | | | 1.07 | 1.1 | 0.93 | 0.93 | 0.95 | 1.02 | 0.98 | 1.01 | 1.1 | 1.05 | 1.01 | 0.87 | 1 | 0.98 |
| 2-Naphthylamine | 0.93 | 0.96 | | | 1.14 | 1.21 | 0.84 | 0.95 | 0.93 | 1.02 | 0.95 | 0.93 | 1.23 | 1.1 | 0.9 | 0.89 | 1.06 | 0.92 |
| 2-Phenylphenol | 1 | 0.9 | | | 1.17 | 1.16 | 0.48 | 0.82 | 1.01 | 1.02 | 0.95 | 0.96 | **1.32** | 1.06 | 0.75 | 0.47 | 1.13 | 0.9 |
| 2-naphthol** | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 4,4'-Diaminobiphenyl methane | 1 | 1.09 | | | 1.12 | 1.11 | 0.73 | 0.83 | 0.94 | 1.03 | 1.03 | 1.03 | 1.17 | 1.07 | 0.82 | 0.72 | 0.96 | 1 |
| 4-Biphenylamine | 0.93 | 0.97 | | | 1.05 | 1.09 | 0.96 | 0.9 | 0.99 | 1.05 | 0.93 | 0.96 | 1.11 | 1.04 | 0.91 | 0.95 | 1.1 | 0.96 |
| 4-Methyl-2-pentanone | 0.8 | 0.89 | | | 0.43 | **1.43** | 0 | 0.52 | **1.78** | **1.45** | **1.33** | 0.6 | 0.52 | **1.7** | 0.79 | 0 | 1.03 | **2.07** |
| Acetochlor mercapturate** | 0.83 | 0.88 | | | **2.05** | **1.37** | 0.67 | **2.54** | 0.67 | 0.61 | 0.8 | 1.12 | **1.85** | 1.13 | **2.14** | 0.9 | 0.12 | 0.82 |
| Acrylamide | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Alachlor mercapturate** | 0.48 | 1.01 | | | **1.48** | 0 | 0 | 0 | **2.13** | **1.3** | 0.82 | 1.06 | 0.77 | **1.34** | 0 | 0 | **2.27** | **1.62** |
| Arsenic | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Arsenic acid | **1.27** | **1.51** | | | 0.64 | 0.7 | 0.99 | 0.82 | 1.03 | 0.98 | **1.59** | 1.13 | 0.7 | 0.76 | 0.77 | 1.07 | 0.89 | 1.19 |
| Benzene | 0.74 | 0.89 | | | 1.12 | **1.53** | 0.68 | 0.93 | 0.96 | 1.12 | 0.87 | 0.74 | **1.41** | 1.14 | 1.11 | 0.62 | **1.29** | 0.82 |
| Beta-Hexachlorocyclohexane† | 1.16 | 1.02 | **1.42** | **1.42** | 0.79 | 0.86 | 1.14 | 0.8 | 0.95 | 1 | | | | | | | | |
| Bis(2-chloroethyl) phosphate** | 0.99 | 1.01 | | | 1.04 | 1.05 | 0.91 | 1.02 | 0.99 | 0.98 | 1.01 | 0.98 | 1.03 | 1.07 | 0.99 | 0.97 | 1.04 | 0.96 |
| Bromodichloromethane | 0.85 | 0.92 | | | 1.2 | 1.06 | 1.15 | 1.11 | 0.89 | 0.94 | 0.88 | 1.04 | 0.98 | **1.4** | 0.91 | 1.19 | 0.86 | 0.93 |
| Bromoform | **1.48** | **1.37** | | | 0.52 | 0.63 | 0.78 | 1.09 | 0.94 | 1.1 | **1.46** | **1.59** | 0.51 | 0.65 | 0.91 | 0.81 | **1.29** | 0.83 |
| Cadmium | 0.96 | 0.91 | | | 1.03 | 0.97 | 1.12 | 1.04 | 1.01 | 0.99 | 0.9 | 0.99 | 0.94 | 1.05 | 1.05 | 1.09 | 0.96 | 1.03 |
| Carbon tetrachloride | 0 | **3** | | | **2.84** | 0 | 0 | 0 | 0 | **1.94** | 0 | **4.02** | **3.51** | 0 | 0 | 0 | 0 | **1.96** |
| Chloroethane | 0 | 0 | | | 0 | **3.19** | 0 | 0 | 0 | **3.82** | 0 | 0 | 0 | **3.83** | 0 | 0 | **4.47** | 0 |
| **Dem. Subgroup:** | | | | | | | | | | | | | | | | | | |
| Inc/PL ratio: | | | | | | | | | | | <2 | >2 | <2 | >2 | <2 | >2 | <2 | >2 |
| Race/eth: | Hsp | Hsp | Asn | Asn | Blk | Blk | Oth | Oth | Wht | Wht | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht |
| Sex: | F | M | F | M | F | M | F | M | F | M | | | | | | | | |

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**Table A14:** NHANES detected sample ratios: demographic interactions

| **Chemical** | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chloroform | 0.89 | 0.92 | | | **1.3** | 1.12 | 1.07 | 1.06 | 0.91 | 0.87 | 0.87 | 0.93 | **1.25** | 1.2 | 0.96 | 1.13 | 0.8 | 0.96 |
| Cobalt | 1.01 | 1 | | | 1 | 1 | 1.01 | 1 | 1 | 0.99 | 1.01 | 1 | 1.01 | 0.99 | 1 | 1 | 0.99 | 1 |
| Crotonaldehyde | 1.15 | 1.11 | | | 0.99 | 1.1 | 1.11 | 1.2 | 0.87 | 0.84 | 1.19 | 1.03 | 1.1 | 0.95 | **1.37** | 1.07 | 0.93 | 0.77 |
| Cumene | 0.97 | 1.09 | | | 0 | 0 | 0 | **1.33** | 0.74 | **2.89** | 0 | **1.46** | 0 | 0 | **1.97** | 0 | **1.71** | **1.47** |
| DDT† | 0.89 | 0.96 | 1.03 | 0.95 | 0.84 | 0.9 | 1.03 | 0.94 | 1.09 | 1 | | | | | | | | |
| Dichloromethane | **1.33** | **1.48** | | | 0 | 0 | 0 | **1.72** | **1.98** | 0.97 | **2.96** | 0 | 0 | 0 | 0 | **1.53** | 0 | **2.95** |
| Dieldrin | 0.81 | 0.89 | | | 0.86 | 0.74 | 1.16 | 1.15 | 1.07 | **1.32** | 0.83 | 0.93 | 0.58 | 1.05 | 0.64 | **1.37** | 1.11 | 1.2 |
| Diisononyl phthalate | 1.19 | 1.09 | | | **1.29** | 1.12 | 0.69 | 0.96 | 0.84 | 0.88 | 1.23 | 0.71 | 1.22 | 0.97 | 0.71 | 0.87 | 0.94 | 0.77 |
| Dimethyl dithiophosphate** | 1.07 | 1 | | | 1.03 | 0.94 | 0.87 | 0.99 | 0.93 | 1.11 | 1.03 | 1.01 | 0.99 | 1.02 | 0.97 | 0.95 | 0.95 | 1.12 |
| Dimethyl phosphate** | 1 | 1.01 | | | 1 | 0.99 | 1.02 | 1.01 | 0.99 | 0.99 | 1.01 | 1.02 | 0.98 | 1.01 | 1.01 | 1.01 | 0.97 | 1.01 |
| Dimethyl thiophosphate** | 1 | 1.01 | | | 0.98 | 1.02 | 0.98 | 0.99 | 0.98 | 1.03 | 1 | 0.99 | 0.98 | 1.01 | 0.98 | 1 | 1 | 1.02 |
| Dimethylarsinic acid | 1.03 | 1.12 | | | 1.01 | 1.03 | 1.04 | 1.1 | 0.82 | 0.97 | 1.06 | 1.06 | 1.02 | 0.99 | 0.98 | 1.1 | 0.9 | 0.88 |
| Ethylbenzene | 0.54 | 0.68 | | | 1.12 | **1.71** | 0.68 | 1 | 0.95 | **1.27** | 0.68 | 0.53 | **1.44** | **1.34** | **1.27** | 0.63 | **1.37** | 0.88 |
| Ethylene oxide | 1 | 0.99 | | | 1.05 | 1.08 | 1.06 | 1.07 | 0.9 | 0.95 | 1.03 | 0.92 | 1.09 | 1.04 | 1.07 | 1.07 | 0.98 | 0.88 |
| Ethylene thiourea | 1.06 | **1.38** | | | **1.27** | 1.08 | **1.56** | **1.4** | 0.65 | 0.73 | **1.43** | 0.82 | 1.24 | 1.15 | **1.84** | 1.1 | 0.56 | 0.81 |
| Formaldehyde | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Furan | 0.37 | 0.51 | | | **1.3** | **1.86** | 0.52 | 0.9 | 1.16 | 1.24 | 0.45 | 0.4 | **1.81** | 1.11 | **1.34** | 0.41 | **1.93** | 0.58 |
| Glu-P-1 | 1.16 | 0.88 | | | **1.4** | **1.3** | 0.71 | 0.25 | 1.02 | 0.96 | **1.42** | 0.45 | **1.61** | 1.15 | 0 | 0.76 | 0.79 | **1.25** |
| Glu-P-2 | **2.66** | 1 | | | **3.61** | 0 | **1.62** | 0 | 0 | 0 | 0.81 | **3.08** | **3.01** | 0 | **2.77** | 0 | 0 | 0 |
| Heptachlor epoxide B | 0.96 | 0.87 | | | 1.04 | 0.5 | 0.87 | 0.69 | 1.09 | **1.31** | 0.97 | 0.85 | 0.48 | 1.03 | 0.49 | 0.93 | **1.35** | 1.09 |
| Lead | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Lindane† | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2.99** | 0 | | | | | | | | |
| Malathion dicarboxylic acid** | 0.89 | 0.96 | | | 0.9 | 0.77 | 0.86 | 0.47 | 1.08 | **1.25** | 1.03 | 0.85 | 0.99 | 0.64 | 0.48 | 0.89 | 0.9 | **1.32** |
| Mandelic acid** | 0.99 | 1 | | | 1 | 1.01 | 1.01 | 1.01 | 1 | 1 | 0.99 | 0.99 | 1 | 1.01 | 1.01 | 1.01 | 1 | 1 |
| MeA-alpha-C | 0.41 | 0.77 | | | 1.13 | **1.56** | 0.59 | 0.69 | 1.12 | **1.36** | 0.64 | 0.41 | **1.55** | 1.02 | 0.67 | 0.59 | **1.63** | 0.94 |
| Melamine | 0.89 | 0.96 | | | 0.98 | 0.87 | 1.19 | **1.32** | 1.05 | 1.11 | 0.94 | 0.93 | 0.94 | 0.92 | **1.32** | 1.17 | 1.1 | 1.06 |
| Methylarsonic acid | 0.98 | **1.26** | | | 0.81 | 1.03 | 1.15 | 1.24 | 0.79 | 0.91 | 1.08 | 1.15 | 0.95 | 0.91 | 1.1 | 1.21 | 0.9 | 0.82 |
| Mirex† | 0.83 | 0.81 | 0.94 | 0.95 | 0.92 | 1.2 | 1.1 | 0.83 | 1.04 | 1.06 | | | | | | | | |
| Mono-(2-ethyl-5-hydroxyhexyl) phthalate** | 1 | 1 | | | 1 | 1 | 0.99 | 1 | 1 | 1 | 1 | 0.99 | 1 | 1.01 | 1 | 0.99 | 1 | 1 |
| Mono-(2-ethyl-5-oxohexyl) phthalate** | 1 | 0.99 | | | 1 | 1 | 0.99 | 1 | 1 | 1 | 1 | 0.99 | 0.99 | 1.01 | 1 | 0.99 | 1 | 1 |
| Mono-(2-ethylhexyl) phthalate** | 0.99 | 1.12 | | | 1.08 | 1.19 | 1 | 1.15 | 0.75 | 0.9 | 1.08 | 0.94 | 1.2 | 1.07 | 1.11 | 1.06 | 0.88 | 0.81 |
| Mono-2-ethyl-5-carboxypentyl phthalate** | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mono-n-octyl phthalate** | **1.43** | 0.83 | | | 0.71 | **1.77** | 0 | **1.43** | 0.83 | 0.84 | 0.92 | 0.79 | 0.83 | **1.42** | 0.46 | 0.82 | 1.01 | 0.72 |
| N'-Nitrosonornicotine | 0.35 | 0.6 | | | 1.03 | **1.48** | 0.47 | 0.98 | 1.18 | **1.49** | 0.49 | 0.33 | **1.43** | 1.01 | 0.96 | 0.6 | **1.97** | 0.83 |
| NAS-(1-cyano-2-hydroxyethyl)-LC** | 0.43 | 0.76 | | | **1.26** | **2.15** | 0.38 | 0.87 | 1.08 | 1.19 | 0.61 | 0.54 | **2.05** | **1.29** | 0.92 | 0.36 | **1.6** | 0.86 |
| **Dem. Subgroup:** | | | | | | | | | | | | | | | | | | |
| Inc/PL ratio: | | | | | | | | | | | <2 | >2 | <2 | >2 | <2 | >2 | <2 | >2 |
| Race/eth: | Hsp | Hsp | Asn | Asn | Blk | Blk | Oth | Oth | Wht | Wht | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht |
| Sex: | F | M | F | M | F | M | F | M | F | M | | | | | | | | |

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**Table A14:** NHANES detected sample ratios: demographic interactions

| **Chemical** | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NAS-(n-propyl)-LC** | 1 | 1.05 | | | 1.03 | 1.07 | 0.92 | 1.09 | 0.9 | 0.97 | 1.01 | 1.05 | 1.02 | 1.12 | 0.99 | 1.02 | 0.92 | 0.94 |
| NAS-(phenyl)-LC** | 0.97 | 1.1 | | | 0.96 | 1.15 | 0.64 | 0.96 | 0.95 | 1.11 | 1 | 1.07 | 1.01 | 1.14 | 0.76 | 0.86 | 1 | 1.05 |
| N-Nitroso-N-methylethylamine | 0.39 | **1.76** | | | **1.63** | 0.49 | 0.71 | **2.97** | 0.64 | 0.59 | **1.43** | 0.67 | 0.9 | 0.7 | **2.47** | **1.71** | 1.05 | 0 |
| N-Nitrosodiethylamine | 0 | **2.34** | | | 1 | 0.9 | **2.55** | 0 | 1.15 | 0.54 | 0.63 | 1.18 | 0.83 | 0 | 0 | **2.02** | **1.3** | 0.53 |
| N-Nitrosomorpholine | 0.84 | 0.33 | | | **1.57** | **1.51** | **1.35** | 0.64 | 1.01 | 0.95 | 0.57 | 0.66 | **1.64** | **1.31** | **1.99** | 0.5 | **1.4** | 0.73 |
| N-Nitrosopiperidine | 1.1 | **1.46** | | | **1.33** | 1.17 | 0.84 | 1.17 | 0.57 | 0.74 | **1.36** | 1.13 | **1.69** | 0.74 | 0.79 | 1.14 | 0.9 | 0.47 |
| N-Nitrosopyrrolidine | **2.93** | 0 | | | **1.6** | 0 | 1.08 | 0 | **1.41** | 0.44 | 0.54 | **3.03** | 0.67 | 1.05 | **1.84** | 0 | 1.03 | 0.89 |
| NAS-(2-Carboxyethyl)-LC** | 0.99 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| NAS-(2-Hydroxyethyl)-LC** | 0.99 | 0.93 | | | 1.23 | **1.26** | 0.76 | 0.86 | 0.97 | 0.95 | 0.98 | 0.92 | **1.3** | 1.2 | 0.73 | 0.85 | 1 | 0.92 |
| NAS-(2-carbamoylethyl)-LC** | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.99 | 1 |
| NAS-(2-cyanoethyl)-LC** | 0.91 | 1.02 | | | 1.09 | 1.17 | 0.84 | 1.03 | 0.91 | 1.04 | 0.93 | 1.02 | 1.13 | 1.14 | 0.94 | 0.94 | 0.97 | 0.98 |
| NAS-(2-hydroxy-3-butenyl)-LC** | 0.51 | 0.96 | | | 1.02 | **1.84** | 0.28 | 0.88 | **1.32** | 1.11 | 0.72 | 0.85 | **1.63** | 1.19 | 0.97 | 0.22 | **1.76** | 0.86 |
| NAS-(2-hydroxypropyl)-LC** | 0.98 | 1.02 | | | 1.01 | 1.03 | 0.93 | 1.02 | 0.99 | 1.01 | 1 | 1 | 1.02 | 1.03 | 0.94 | 0.99 | 1 | 1.01 |
| NAS-(3,4-dihydroxybutyl)-LC** | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| NAS-(3-Hydroxypropyl)-LC** | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| NAS-(N-methylcarbamoyl)-LC** | 1 | 1 | | | 1 | 1.01 | 0.99 | 1 | 1 | 1 | 1 | 1 | 1.01 | 1 | 0.98 | 1 | 1 | 1.01 |
| NAS-(3-hydroxypropyl-1-methyl)-LC** | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| NNAL** | 0.9 | 1.01 | | | 1.18 | 1.24 | 0.8 | 0.93 | 0.88 | 1.04 | 1.02 | 0.83 | **1.36** | 0.97 | 1.09 | 0.72 | 1.2 | 0.78 |
| Nickel | 0.98 | 1.02 | | | 1.02 | 1.02 | 0.98 | 0.99 | 0.97 | 1.02 | 1.01 | 1 | 1 | 1.02 | 0.98 | 0.98 | 1.01 | 0.99 |
| Nitromethane | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Oxypyrimidine** | 0.95 | 0.74 | | | **1.51** | **1.61** | 0.58 | 1.11 | 0.84 | 0.83 | 0.81 | 0.75 | **1.69** | **1.29** | 0.84 | 0.85 | 0.81 | 0.86 |
| PBB153† | 0.97 | 0.97 | 0.88 | 0.75 | 1.01 | 1 | 0.92 | 0.95 | 1.02 | 1.03 | | | | | | | | |
| PCB028† | 0.89 | 0.67 | **1.33** | **1.32** | 0.84 | 0.53 | 1.03 | 0.53 | **1.25** | 0.95 | | | | | | | | |
| PCB066† | 0.38 | 0.6 | **2.34** | **1.86** | 0.95 | 0.84 | 1.13 | 0.72 | 1.04 | 1.07 | | | | | | | | |
| PCB074† | 0.91 | 1.01 | 1.04 | 1.04 | 1 | 0.98 | 1.04 | 0.93 | 0.99 | 1.04 | | | | | | | | |
| PCB081† | **2.16** | 0 | **6.16** | **1.61** | 0 | 0 | 0 | 0 | **1.57** | 0.33 | | | | | | | | |
| PCB105† | 0.97 | 0.98 | 1.03 | 1.03 | 1 | 0.95 | 1.03 | 0.83 | 0.99 | 1.03 | | | | | | | | |
| PCB114† | 0.75 | 0.61 | 0.98 | 1.15 | 0.93 | 0.86 | **1.33** | 0.99 | 1.01 | 1.17 | | | | | | | | |
| PCB126† | 1.02 | 0.97 | 1.23 | **1.33** | 0.94 | 0.83 | 0.84 | 0.53 | 1 | 1.03 | | | | | | | | |
| PCB146† | 0.87 | 0.86 | 1.06 | 1.06 | 1.02 | 1.06 | 1.06 | 1.06 | 0.99 | 1.05 | | | | | | | | |
| PCB156† | 0.9 | 0.97 | 1.04 | 1.04 | 0.96 | 1.04 | 1.04 | 1.04 | 0.99 | 1.04 | | | | | | | | |
| PCB157† | 0.7 | 0.71 | 1.07 | **1.36** | 0.98 | 0.8 | **1.3** | 0.8 | 0.93 | 1.22 | | | | | | | | |
| PCB167† | 0.76 | 0.97 | **1.37** | **1.45** | 0.94 | 0.9 | 0.75 | 0.75 | 1.03 | 1.03 | | | | | | | | |
| PCB169† | 0.76 | 0.89 | 1.22 | 1.21 | 0.75 | 0.95 | 0.68 | 0.62 | 1.02 | 1.15 | | | | | | | | |
| PCB170† | 0.99 | 1.01 | 1.01 | 1.01 | 0.97 | 1.01 | 1.01 | 0.9 | 1.01 | 1.01 | | | | | | | | |
| **Dem. Subgroup:** | | | | | | | | | | | | | | | | | | |
| Inc/PL ratio: | | | | | | | | | | | <2 | >2 | <2 | >2 | <2 | >2 | <2 | >2 |
| Race/eth: | Hsp | Hsp | Asn | Asn | Blk | Blk | Oth | Oth | Wht | Wht | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht |
| Sex: | F | M | F | M | F | M | F | M | F | M | | | | | | | | |

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**Table A14:** NHANES detected sample ratios: demographic interactions

| **Chemical** | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB178† | 0.66 | 0.92 | 1.12 | 1.24 | 0.83 | 1.09 | 1.13 | 0.7 | 1 | 1.11 | | | | | | | | |
| PCB183† | 0.94 | 0.95 | 0.99 | 1.08 | 0.95 | 1.03 | 1.08 | 0.69 | 0.99 | 1.05 | | | | | | | | |
| PCB187† | 0.97 | 0.99 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 0.97 | 1.02 | | | | | | | | |
| PCB189† | 0.46 | 0.62 | 1.2 | 0.87 | 0.95 | 0.84 | **1.42** | 1.07 | 1.19 | 1.04 | | | | | | | | |
| PCB194† | 0.94 | 0.96 | 1.05 | 1.05 | 0.93 | 1.05 | 0.96 | 0.95 | 0.99 | 1.04 | | | | | | | | |
| PCB196† | 0.93 | 1 | 1.03 | 1.03 | 0.95 | 1.03 | 1.03 | 1.03 | 0.98 | 1.03 | | | | | | | | |
| PCB199† | 0.89 | 0.86 | 1.02 | 1.06 | 0.97 | 0.98 | 1.06 | 1.06 | 1 | 1.06 | | | | | | | | |
| PCB206† | 0.7 | 0.95 | 1.24 | 1.06 | 0.97 | 1.11 | 1.04 | 0.99 | 0.93 | 1.12 | | | | | | | | |
| PCB209† | 0.72 | 1.05 | 1.24 | **1.29** | 0.93 | 1.12 | 1.05 | 1 | 0.84 | 1.17 | | | | | | | | |
| PeCDF (furan)† | 0.99 | 1 | 0.91 | 1.09 | 0.78 | 0.95 | 0.58 | 0.87 | 0.96 | 1.14 | | | | | | | | |
| Pentachlorophenol | 0.74 | 0.75 | | | **1.27** | 1.16 | 0.96 | 0.75 | 0.95 | 1.15 | 0.71 | 0.76 | **1.28** | 1.15 | 0.94 | 0.69 | 1.16 | 0.99 |
| Perfluorooctanesulfonic acid | 1 | 1 | | | 1 | 0.99 | 1 | 1 | 1 | 1 | 1 | 1 | 0.99 | 1 | 1 | 1 | 1 | 1 |
| Perfluorooctanoic acid | 1.01 | 1 | | | 0.99 | 0.99 | 1 | 1.01 | 1.01 | 1 | 1.01 | 1.01 | 0.99 | 1 | 1.01 | 1 | 1 | 1.01 |
| Phenylglyoxylic acid** | 1 | 1 | | | 1.01 | 1.01 | 0.99 | 1.01 | 1 | 1 | 1 | 1 | 1.01 | 1.01 | 1 | 1 | 0.99 | 1 |
| Styrene | 0.83 | 0.95 | | | 0.89 | 1.14 | 0.61 | 0.97 | 1.08 | 1.22 | 0.88 | 0.81 | 1.07 | 0.94 | 0.79 | 0.91 | 1.22 | 1.14 |
| TCDD (dioxin)† | 0.91 | 0.86 | 1 | **1.64** | 0.88 | 0.76 | 1.19 | 0.38 | 1.19 | 0.9 | | | | | | | | |
| Tetrachloroethylene | 0.62 | 1.15 | | | 1.23 | 1.12 | 0.83 | 0.63 | 0.86 | **1.38** | 0.65 | **1.45** | 0.76 | **1.71** | 0.84 | 0.74 | 0.8 | **1.46** |
| Tetrahydrofuran | 0.66 | 0.74 | | | 0.71 | 0.79 | **2.44** | 0 | 1 | **1.46** | **1.47** | 0 | 0 | 0.94 | **1.32** | **1.54** | 1.14 | **1.49** |
| Trichloroethylene | 0 | 0.99 | | | **1.9** | 1.06 | 1.09 | 1.15 | 0.99 | 0.97 | 0.49 | 0 | **2.33** | 0.63 | **2.62** | 0.51 | 0.38 | **1.63** |
| Trp-P-1 | 1.16 | 0.37 | | | 0.9 | **1.45** | **1.51** | 0.94 | 0.92 | 0.98 | 1.06 | 0.57 | 0.93 | 1.17 | **1.55** | 0.98 | 1.01 | 0.98 |
| **Dem. Subgroup:** | | | | | | | | | | | | | | | | | | |
| Inc/PL ratio: | | | | | | | | | | | <2 | >2 | <2 | >2 | <2 | >2 | <2 | >2 |
| Race/eth: | Hsp | Hsp | Asn | Asn | Blk | Blk | Oth | Oth | Wht | Wht | Hsp | Hsp | Blk | Blk | Oth | Oth | Wht | Wht |
| Sex: | F | M | F | M | F | M | F | M | F | M | | | | | | | | |

**Notes:** Demographic interaction analysis of sample detection ratios for (N = 125) matched carcinogens and carcinogen-associated metabolites. Subgroups in this table include interactions of race/ethnicity and sex, and interactions of race/ethnicity and household income. Statistics based on both individual-level (N = 96) and pooled (N = 29) NHANES samples. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5. **: Carcinogen metabolite. †: Result based on pooled sampling data.

**Demographic subgroups:** Household income below 2 times the poverty line, Household income above 2 times the poverty line, Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Other race including multi-racial, Female sex, Male sex. Non-Hispanic Asian results presented separately only for chemicals with pooled sampling.

**Parent Chems:** {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol, 2-naphthol: *Naphthalene***}; {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid***}; {2,4-dichlorophenol: *Nitrofen***}; {2,4,5-trichlorophenol: *beta-Hexachlorocyclohexane***}; {2,4,5-trichlorophenol: *Lindane***}; {2,4,5-trichlorophenol: *1,2,3,4,5,6-Hexachlorocyclohexane***}; {2,4,5-trichlorophenol: *Pentachlorophenol***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {Dimethyl dithiophosphate: *Malathion***}; {Dimethyl thiophosphate: *Malathion***}; {Malathion dicarboxylic acid: *Malathion***}; {Mandelic acid: *Styrene***}; {Mandelic acid: *Ethylbenzene***}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-(2-ethylhexyl) phthalate Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA), N-acetyl-S-(2-Hydroxyethyl)-L-cysteine, N-acetyl-S-(2-cyanoethyl)-L-cysteine: *Acrylonitrile***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-Acetyl-S-(phenyl)-L-cysteine: *Benzene***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Vinyl Chloride***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Ethylene Oxide***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine, N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine: *1,3-Butadiene***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Oxypyrimidine: *Diazonon***}; {Phenylglyoxylic acid: *Styrene***}; {Phenylglyoxylic acid: *Ethylbenzene***}

**Return to:** Section 3.1.4.

**Table A15:** NHANES detected sample ratios: age-differentiated results

| **Chemical** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | 0.27 | 1.14 | 0 | 0.46 | | | **1.34** | 1.12 | 0 | **1.35** | 0 | **1.48** |
| 1,1,2,2-Tetrachloroethane | 0 | 1.23 | 0 | 0 | | | 0 | **1.59** | 0 | **2.33** | 0 | 1.12 |
| 1,4-Dichlorobenzene | 0.88 | 1.02 | 0.88 | 1.03 | | | **1.45** | **1.55** | 0.72 | 0.88 | 0.63 | 0.76 |
| 1-Naphthylamine | 1.01 | 0.99 | 0.97 | 0.93 | | | 1.24 | 1.21 | 0.89 | 0.82 | 0.93 | 0.99 |
| 1-naphthol** | 1 | 1 | 1 | 1 | | | 1 | 1 | 0.99 | 1 | 1 | 1 |
| 2,4,5-trichlorophenol** | 0.99 | 1 | 0.81 | 0.7 | | | **1.33** | 1.19 | 1.02 | 1.24 | 1 | 1.08 |
| 2,4,6-Trichlorophenol | 1.09 | 0.96 | 1.07 | 0.99 | | | **1.4** | **1.42** | 0.94 | 0.77 | 0.94 | 0.8 |
| 2,4-Dichlorophenoxyacetic acid | 1.08 | 0.96 | 1.04 | 0.93 | | | 1.09 | 1.03 | 1.08 | 0.82 | 1.13 | 0.99 |
| 2,4-dichlorophenol** | 1.02 | 0.99 | 1.02 | 1.02 | | | 1.07 | 1.04 | 0.99 | 0.93 | 1 | 0.95 |
| 2,5-dichlorophenol** | 1 | 1 | 1.01 | 1.01 | | | 1.02 | 1.02 | 0.97 | 0.97 | 0.99 | 0.99 |
| 2,6-Dimethylaniline | 0.97 | 1.01 | 0.98 | 1.02 | | | 1.03 | 1.14 | 0.89 | 0.81 | 0.94 | 1.02 |
| PhIP | 0.97 | 1.01 | 1.05 | 1.13 | | | 1.1 | **1.27** | 0.77 | 0.8 | 0.84 | 0.91 |
| IQ (heterocyclic amine) | 0.89 | 1.05 | 0.54 | **1.29** | | | 0.92 | 0.99 | 0.69 | 1.18 | **1.52** | 0.9 |
| 2-Amino-alpha-carboline | 0.84 | 1.07 | 0.86 | 1.05 | | | 0.83 | 1.18 | 0.83 | 0.85 | 0.86 | 1.11 |
| 2-Anisidine | 1 | 1 | 1.01 | 0.99 | | | 1 | 1.01 | 1 | 0.99 | 1 | 1 |
| 2-Methylaniline | 1.02 | 0.99 | 1.02 | 0.98 | | | 1.06 | 1.09 | 1 | 0.88 | 0.97 | 0.99 |
| 2-Naphthylamine | 0.99 | 1 | 0.95 | 0.94 | | | 1.15 | 1.19 | 0.93 | 0.87 | 0.93 | 0.99 |
| 2-Phenylphenol | **1.26** | 0.89 | 1.06 | 0.87 | | | **1.51** | 0.99 | 1.07 | 0.45 | **1.38** | 0.91 |
| 2-naphthol** | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| 4,4'-Diaminobiphenyl methane | 1.15 | 0.9 | 1.19 | 0.94 | | | **1.3** | 0.97 | 0.92 | 0.69 | 1.12 | 0.92 |
| 4-Biphenylamine | 1.03 | 0.99 | 0.99 | 0.92 | | | 1.07 | 1.07 | 0.98 | 0.91 | 1.08 | 1.01 |
| 4-Methyl-2-pentanone | 0 | 1.2 | 0 | 1.05 | | | 0 | 1.05 | 0 | 0.31 | 0 | **1.89** |
| Acetochlor mercapturate** | 0.93 | 1.06 | 0.55 | 1.22 | | | **1.91** | **1.41** | 0 | **2.94** | 0.44 | 0.73 |
| Acrylamide | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Alachlor mercapturate** | 0.86 | 1.19 | 0.75 | 0.7 | | | 0.59 | 1.2 | 0 | 0 | **1.69** | **1.7** |
| Arsenic | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Arsenic acid | 1.06 | 0.96 | **1.57** | 1.24 | | | 0.65 | 0.68 | 0.93 | 0.89 | 1.01 | 1 |
| Benzene | 0.6 | 1.08 | 0.58 | 0.87 | | | 0.74 | **1.41** | 0.4 | 0.89 | 0.68 | 1.1 |
| Beta-Hexachlorocyclohexane† | 0.3 | 1.1 | 0.4 | 1.23 | **1.42** | **1.42** | 0.2 | 0.93 | 0.39 | 1.06 | 0.18 | 1.07 |
| Bis(2-chloroethyl) phosphate** | 1.04 | 0.97 | 1.04 | 0.97 | | | 1.06 | 1.03 | 1.03 | 0.92 | 1.04 | 0.96 |
| Bromodichloromethane | 0.94 | 1.01 | 0.61 | 0.95 | | | 0.83 | 1.19 | 1.16 | 1.13 | 1.17 | 0.87 |
| Bromoform | 0.82 | 1.04 | 0.93 | **1.56** | | | 0.54 | 0.58 | 0.61 | 1 | 1.06 | 1.01 |
| Cadmium | 0.7 | 1.15 | 0.66 | 1.1 | | | 0.67 | 1.16 | 0.87 | 1.19 | 0.66 | 1.15 |
| Carbon tetrachloride | 0 | 1.2 | 0 | **1.76** | | | 0 | **1.76** | 0 | 0 | 0 | 1.14 |
| Chloroethane | 0 | 1.2 | 0 | 0 | | | 0 | **1.77** | 0 | 0 | 0 | **2.26** |
| Chloroform | 0.89 | 1.02 | 0.69 | 0.96 | | | 1.2 | 1.21 | 1.05 | 1.07 | 0.78 | 0.91 |
| **Dem. Subgroup:** | | | | | | | | | | | | |
| Age: | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Asian | NH Asian | NH Black | NH Black | NH Other | NH Other | NH White | NH White |

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**Table A15:** NHANES detected sample ratios: age-differentiated results

| **Chemical** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cobalt | | 1 | | 1 | | | | 1 | | 1 | | 1 |
| Crotonaldehyde | 0.93 | 1.01 | 1.17 | 1.12 | | | 0.73 | 1.13 | 0.97 | 1.2 | 0.74 | 0.87 |
| Cumene | 0.76 | 1.05 | 0 | **1.28** | | | 0 | 0 | 0 | 0.78 | **2.54** | **1.71** |
| DDT† | 0.79 | 1.03 | 0.74 | 0.96 | 1.07 | 0.98 | 0.41 | 0.95 | 0.74 | 1.02 | 0.89 | 1.07 |
| Dichloromethane | 0 | 1.2 | 0 | **1.75** | | | 0 | 0 | 0 | 1.02 | 0 | **1.72** |
| Dieldrin | 0.26 | **1.32** | 0.28 | 1.2 | | | 0.17 | **1.32** | 0.44 | **1.32** | 0.33 | **1.37** |
| Diisononyl phthalate | **1.28** | 0.82 | **1.34** | 1.01 | | | **1.58** | 0.97 | 1.09 | 0.62 | 1.14 | 0.71 |
| Dimethyl dithiophosphate** | 1.16 | 0.89 | 1.11 | 0.98 | | | 1.19 | 0.85 | 1.13 | 0.78 | 1.21 | 0.92 |
| Dimethyl phosphate** | 1.01 | 1 | 1.01 | 1 | | | 1 | 0.99 | 1.01 | 1.01 | 1 | 0.99 |
| Dimethyl thiophosphate** | 1.03 | 0.98 | 1.03 | 0.98 | | | 1.05 | 0.97 | 1 | 0.97 | 1.03 | 0.99 |
| Dimethylarsinic acid | 0.96 | 1.02 | 1.01 | 1.11 | | | 0.98 | 1.04 | 1.04 | 1.09 | 0.86 | 0.91 |
| Ethylbenzene | 0.44 | 1.11 | 0.21 | 0.71 | | | 0.54 | **1.54** | 0.35 | 0.94 | 0.66 | 1.19 |
| Ethylene oxide | 1.04 | 0.98 | 1.02 | 0.99 | | | 1.11 | 1.05 | 1.08 | 1.06 | 1 | 0.9 |
| Ethylene thiourea | **1.27** | 0.88 | **1.34** | 1.15 | | | **1.47** | 1.02 | 0 | **2.02** | 1.2 | 0.54 |
| Formaldehyde | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Furan | 0.2 | 1.16 | 0.05 | 0.54 | | | 0.21 | **1.79** | 0.32 | 0.79 | 0.27 | **1.36** |
| Glu-P-1 | 1.15 | 0.93 | **1.39** | 0.79 | | | **1.32** | **1.36** | 0.33 | 0.57 | 1.22 | 0.93 |
| Glu-P-2 | 0.79 | 1.1 | 1.19 | **2.34** | | | **1.52** | **1.87** | 0 | **1.3** | 0 | 0 |
| Heptachlor epoxide B | 0.12 | **1.38** | 0.04 | **1.46** | | | 0.16 | **1.28** | 0 | 0.99 | 0.18 | **1.41** |
| Lead | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Malathion dicarboxylic acid** | 0.96 | 1.02 | 0.84 | 0.97 | | | 0.98 | 0.78 | 0.78 | 0.64 | 1.14 | 1.17 |
| Mandelic acid** | 0.99 | 1 | 0.99 | 1 | | | 0.99 | 1.01 | 1.01 | 1.01 | 1 | 1 |
| MeA-alpha-C | 0.36 | **1.3** | 0.29 | 0.77 | | | 0.43 | **1.93** | 0.28 | 0.84 | 0.44 | **1.45** |
| Melamine | 0.92 | 1.04 | 0.99 | 0.87 | | | 0.82 | 1.01 | **1.32** | 1.22 | 0.9 | 1.11 |
| Methylarsonic acid | 0.97 | 1.02 | 1.02 | 1.17 | | | 0.81 | 0.99 | 1.17 | 1.21 | 0.9 | 0.82 |
| Mirex† | 0.06 | 1.13 | 0 | 0.99 | 0 | 1.06 | 0 | 1.23 | 0 | 1.11 | 0.11 | 1.16 |
| Mono-(2-ethyl-5-hydroxyhexyl) phthalate** | 1.01 | 1 | 1.01 | 0.99 | | | 1.01 | 1 | 1.01 | 0.99 | 1.01 | 1 |
| Mono-(2-ethyl-5-oxohexyl) phthalate** | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 0.99 | 1.01 | 1 |
| Mono-(2-ethylhexyl) phthalate** | 1.13 | 0.92 | 1.13 | 0.99 | | | **1.33** | 1.01 | 1.19 | 0.99 | 0.93 | 0.77 |
| Mono-2-ethyl-5-carboxypentyl phthalate** | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Mono-n-octyl phthalate** | **1.26** | 0.89 | 1.24 | 1.04 | | | 0.78 | **1.48** | 0.75 | 0.86 | **1.72** | 0.58 |
| N'-Nitrosonornicotine | 0.31 | **1.33** | 0.19 | 0.66 | | | 0.4 | **1.78** | 0.22 | 0.96 | 0.42 | **1.59** |
| NAS-(1-cyano-2-hydroxyethyl)-LC (CYHA)** | 0.33 | **1.46** | 0.15 | 0.9 | | | 0.85 | **2.38** | 0.17 | 0.96 | 0.19 | **1.65** |
| NAS-(n-propyl)-LC** | 0.9 | 1.07 | 0.92 | 1.1 | | | 0.94 | 1.13 | 0.9 | 1.09 | 0.82 | 1 |
| NAS-(phenyl)-LC** | 1 | 1 | 1.06 | 1 | | | 0.98 | 1.11 | 0.83 | 0.78 | 1.04 | 1.03 |
| N-Nitroso-N-methylethylamine | 1.05 | 0.98 | **1.55** | 0.69 | | | **1.37** | 0.83 | 0.99 | **2.29** | 0 | 0.77 |
| N-Nitrosodiethylamine | **1.26** | 0.88 | **1.84** | 0.6 | | | 0 | **1.52** | **1.76** | 1.02 | **1.37** | 0.7 |
| **Dem. Subgroup:** | | | | | | | | | | | | |
| Age: | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Asian | NH Asian | NH Black | NH Black | NH Other | NH Other | NH White | NH White |

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**Table A15:** NHANES detected sample ratios: age-differentiated results

| **Chemical** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N-Nitrosomorpholine | 1.04 | 0.98 | 0.45 | 0.7 | | | **1.86** | **1.34** | **1.29** | 0.84 | 0.8 | 1.02 |
| N-Nitrosopiperidine | **1.45** | 0.79 | **1.63** | 1.03 | | | **1.85** | 0.87 | **1.42** | 0.75 | 0.78 | 0.63 |
| N-Nitrosopyrrolidine | 1.05 | 0.98 | 0.78 | **2.08** | | | **2.02** | 0 | 0 | 0.87 | 1.13 | 0.85 |
| NAS-(2-Carboxyethyl)-LC** | 1 | 1 | 0.99 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| NAS-(2-Hydroxyethyl)-LC** | 1.06 | 0.96 | 1.04 | 0.9 | | | **1.27** | 1.23 | 0.86 | 0.78 | 1.01 | 0.94 |
| NAS-(2-carbamoylethyl)-LC** | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| NAS-(2-cyanoethyl)-LC** | 0.95 | 1.04 | 0.89 | 1.01 | | | 1.05 | 1.19 | 0.94 | 0.94 | 0.93 | 1.01 |
| NAS-(2-hydroxy-3-butenyl)-LC** | 0.19 | **1.55** | 0.1 | 1.17 | | | 0.41 | **2.25** | 0.27 | 0.81 | 0.07 | **1.84** |
| NAS-(2-hydroxypropyl)-LC** | 0.99 | 1.01 | 1 | 1 | | | 1 | 1.04 | 0.98 | 0.97 | 0.99 | 1.01 |
| NAS-(3,4-dihydroxybutyl)-LC** | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| NAS-(3-Hydroxypropyl)-LC** | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| NAS-(N-methylcarbamoyl)-LC** | 1 | 1 | 0.99 | 1 | | | 1 | 1.01 | 0.99 | 1 | 1 | 1 |
| NAS-(3-hydroxypropyl-1-methyl)-LC** | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| NNAL** | 1.01 | 0.99 | 0.93 | 0.97 | | | 1.23 | 1.2 | 0.89 | 0.84 | 0.98 | 0.96 |
| Nickel | 1.01 | 0.99 | 1 | 1 | | | 1.02 | 1.01 | 1.02 | 0.96 | 1.01 | 0.99 |
| Nitromethane | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Oxypyrimidine** | 0.96 | 1.02 | 0.84 | 0.85 | | | **1.43** | **1.64** | 0.82 | 0.86 | 0.7 | 0.87 |
| PBB153† | 0.15 | 1.12 | 0.17 | 1.14 | 0.31 | 0.88 | 0.39 | 1.11 | 0 | 1.07 | 0.07 | 1.14 |
| PCB028† | 0.02 | 1.14 | 0 | 0.95 | 0 | **1.49** | 0.12 | 0.8 | 0 | 0.89 | 0 | 1.23 |
| PCB066† | 0.06 | 1.13 | 0 | 0.59 | 0.33 | **2.33** | 0.29 | 1.01 | 0 | 1.06 | 0 | 1.19 |
| PCB074† | 0.79 | 1.03 | 0.73 | 1 | 1.04 | 1.04 | 0.75 | 1.03 | 0.64 | 1.04 | 0.81 | 1.04 |
| PCB081† | 0 | 1.14 | 0 | **1.32** | 0 | **4.48** | 0 | 0 | 0 | 0 | 0 | 1.08 |
| PCB105† | 0.8 | 1.03 | 0.77 | 1.01 | 1.03 | 1.03 | 0.65 | 1.03 | 0.64 | 0.98 | 0.84 | 1.03 |
| PCB114† | 0.13 | 1.12 | 0.1 | 0.81 | 0.2 | 1.16 | 0 | 1.05 | 0 | **1.33** | 0.18 | 1.2 |
| PCB126† | 0.22 | 1.11 | 0.29 | 1.15 | 0.66 | **1.35** | 0.31 | 0.99 | 0 | 0.78 | 0.14 | 1.12 |
| PCB146† | 0.65 | 1.05 | 0.17 | 1.01 | 1.06 | 1.06 | 0.91 | 1.06 | 1.06 | 1.06 | 0.73 | 1.06 |
| PCB156† | 0.76 | 1.03 | 0.41 | 1.04 | 1.04 | 1.04 | 0.72 | 1.04 | 1.04 | 1.04 | 0.88 | 1.03 |
| PCB157† | 0.13 | 1.12 | 0.09 | 0.84 | 0.19 | **1.33** | 0.1 | 1.04 | 0 | 1.21 | 0.17 | 1.18 |
| PCB167† | 0.18 | 1.12 | 0.09 | 1.03 | 0.56 | **1.51** | 0.09 | 1.07 | 0 | 0.86 | 0.22 | 1.13 |
| PCB169† | 0.11 | 1.13 | 0 | 1 | 0.65 | **1.28** | 0 | 0.99 | 0 | 0.75 | 0.14 | 1.2 |
| PCB170† | 0.99 | 1 | 1.01 | 1 | 1.01 | 1.01 | 0.87 | 1.01 | 1.01 | 0.95 | 1.01 | 1.01 |
| PCB178† | 0.26 | 1.11 | 0.12 | 0.93 | 0.69 | 1.24 | 0.27 | 1.07 | 0 | 1.05 | 0.31 | 1.15 |
| PCB183† | 0.6 | 1.06 | 0.41 | 1.06 | 1.08 | 1.03 | 0.6 | 1.06 | 0.67 | 0.92 | 0.64 | 1.07 |
| PCB187† | 0.94 | 1.01 | 0.88 | 1 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 0.92 | 1 |
| PCB189† | 0 | 1.14 | 0 | 0.66 | 0 | 1.17 | 0 | 1.06 | 0 | **1.42** | 0 | **1.25** |
| PCB194† | 0.69 | 1.04 | 0.45 | 1.05 | 1.05 | 1.05 | 0.59 | 1.05 | 0.29 | 1.05 | 0.81 | 1.04 |
| PCB196† | 0.79 | 1.03 | 0.72 | 1.01 | 1.03 | 1.03 | 0.71 | 1.03 | 1.03 | 1.03 | 0.79 | 1.03 |
| **Dem. Subgroup:** | | | | | | | | | | | | |
| Age: | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Asian | NH Asian | NH Black | NH Black | NH Other | NH Other | NH White | NH White |

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**Table A15:** NHANES detected sample ratios: age-differentiated results

| **Chemical** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB199† | 0.63 | 1.05 | 0.17 | 1.03 | 0.87 | 1.06 | 0.49 | 1.06 | 1.06 | 1.06 | 0.81 | 1.06 |
| PCB206† | 0.04 | 1.14 | 0 | 1 | 0.16 | **1.27** | 0.22 | 1.18 | 0 | 1.17 | 0 | 1.15 |
| PCB209† | 0.07 | 1.13 | 0.08 | 1.06 | 0.41 | **1.37** | 0.22 | 1.15 | 0 | 1.18 | 0 | 1.12 |
| PeCDF (furan)† | 0.77 | 1.03 | 0.88 | 1.02 | 0.91 | 1.01 | 0.26 | 0.96 | 0.8 | 0.71 | 0.84 | 1.07 |
| Pentachlorophenol | 1.07 | 0.95 | 0.79 | 0.7 | | | 1.22 | 1.21 | 1.18 | 0.66 | 1.2 | 0.99 |
| Perfluorooctanesulfonic acid | 1 | 1 | 1 | 1 | | | 1 | 0.99 | 1 | 1 | 1 | 1 |
| Perfluorooctanoic acid | 1.01 | 1 | 1.01 | 1 | | | 1.01 | 0.99 | 1.01 | 1 | 1.01 | 1 |
| Phenylglyoxylic acid** | 1 | 1 | 1 | 1 | | | 1.01 | 1.01 | 1 | 1 | 1 | 1 |
| Styrene | 0.83 | 1.04 | 0.68 | 0.95 | | | 0.71 | 1.09 | 0.9 | 0.75 | 1.17 | 1.15 |
| TCDD (dioxin)† | 0.4 | 1.08 | 0.45 | 0.98 | **1.32** | **1.3** | 0 | 0.97 | 0 | 0.9 | 0.44 | 1.12 |
| Tetrachloroethylene | 0.76 | 1.05 | 0.51 | 0.95 | | | 0.36 | **1.32** | 1.03 | 0.67 | 1.07 | 1.13 |
| Tetrahydrofuran | 0.51 | 1.1 | 0 | 0.87 | | | 0 | 0.87 | **2.37** | 1.02 | 0 | **1.44** |
| Trichloroethylene | 0.34 | 1.13 | 0 | 0.58 | | | 0 | **1.76** | 0 | **1.36** | 1.12 | 0.95 |
| Trp-P-1 | 1.03 | 0.99 | 0.67 | 0.87 | | | 0.85 | **1.39** | 0.85 | **1.45** | **1.88** | 0.71 |
| **Dem. Subgroup:** | | | | | | | | | | | | |
| Age: | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ | <19 | 20+ |
| Race/eth: | | | Hispanic | Hispanic | NH Asian | NH Asian | NH Black | NH Black | NH Other | NH Other | NH White | NH White |



**Notes:** Age-based analysis of sample detection ratios for (N = 125) matched carcinogens and carcinogen-associated metabolites. Demographic subgroups presented by age, including age subgroups differentiated by race/ethnicity. Statistics based on both individual-level (N = 96) and pooled (N = 29) NHANES samples. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5. **: Carcinogen metabolite. †: Result based on pooled sampling data.

**Demographic subgroups:** Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Other race including multi-racial. Non-Hispanic Asian results presented separately only for chemicals with pooled sampling.

**Parent Chems:** {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol, 2-naphthol: *Naphthalene***}; {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid***}; {2,4-dichlorophenol: *Nitrofen***}; {2,4,5-trichlorophenol: *beta-Hexachlorocyclohexane***}; {2,4,5-trichlorophenol: *Lindane***}; {2,4,5-trichlorophenol: *1,2,3,4,5,6-Hexachlorocyclohexane***}; {2,4,5-trichlorophenol: *Pentachlorophenol***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {Dimethyl dithiophosphate: *Malathion***}; {Dimethyl thiophosphate: *Malathion***}; {Malathion dicarboxylic acid: *Malathion***}; {Mandelic acid: *Styrene***}; {Mandelic acid: *Ethylbenzene***}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-(2-ethylhexyl) phthalate Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA), N-acetyl-S-(2-Hydroxyethyl)-L-cysteine, N-acetyl-S-(2-cyanoethyl)-L-cysteine: *Acrylonitrile***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-Acetyl-S-(phenyl)-L-cysteine: *Benzene***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Vinyl Chloride***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Ethylene Oxide***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine, N-acetyl-S-(3,4-dihydroxybutyl)-L-cysteine: *1,3-Butadiene***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Oxypyrimidine: *Diazonon***}; {Phenylglyoxylic acid: *Styrene***}; {Phenylglyoxylic acid: *Ethylbenzene***}

**Return to:** Section 3.1.4.

**Table A16:** RSEI average ambient concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | Inc: <2xPL | Inc: >2xPL |
|---|---|---|---|---|---|---|---|---|
| 1,1,1,2-Tetrachloroethane | 0.36 | 0.24 | 0.42 | 1.24 | 0.39 | 1.23 | **1.31** | 0.93 |
| 1,1,1-Trichloroethane | 0.29 | 0.25 | 0.32 | **1.26** | 0.05 | **1.26** | **1.25** | 0.94 |
| 1,1,2,2-Tetrachloroethane | 0.88 | 0.24 | 0.35 | **1.78** | 0.13 | 0.96 | 1.22 | 0.92 |
| 1,1,2-Trichloroethane | 0.62 | 0.23 | 0.37 | **1.81** | 0.22 | 1.03 | **1.28** | 0.92 |
| 1,1-Dichloroethane | 0.37 | 0.25 | 0.34 | **1.5** | 0.04 | 1.18 | **1.27** | 0.94 |
| 1,1-Dichloroethylene | 0.41 | 0.19 | 0.3 | **1.38** | 0.16 | 1.2 | **1.26** | 0.93 |
| 1,1-Dimethylhydrazine | 1.08 | 0.4 | 0.51 | **2.18** | 0.33 | 0.82 | 1.19 | 0.95 |
| 1,2,3-Trichloropropane | **3.09** | 0.18 | 0.06 | **1.35** | 0.23 | 0.42 | 1.01 | 0.76 |
| 1,2-(Methylenedioxy)-4-propylbenzene | 0.1 | 0.11 | 0.23 | 0.38 | 1.18 | **1.49** | 0.99 | 0.99 |
| 1,2-Benzenediol | 1.02 | 0.4 | **3.13** | **1.97** | **4.15** | 0.57 | 1.01 | 1.03 |
| 1,2-Dibromo-3-chloropropane | 0.17 | 0.21 | 0.22 | **1.38** | 0.59 | **1.28** | 1.18 | 0.95 |
| 1,2-Dibromoethane | 0.65 | 0.32 | 0.63 | **4.1** | 0.31 | 0.52 | **1.83** | 0.82 |
| 1,2-Dichloroethane | 1.14 | 0.2 | 0.34 | **2.29** | 0.16 | 0.78 | **1.29** | 0.9 |
| 1,2-Dichloropropane | **1.74** | 0.24 | 0.14 | **1.96** | 0.41 | 0.68 | 1.19 | 0.81 |
| 1,2-Diphenylhydrazine | 1.12 | 0.47 | 0.46 | **2.16** | 0.28 | 0.82 | 1.09 | 0.98 |
| 1,2-Epoxybutane | **2.12** | 0.15 | 0.92 | **1.3** | 0.23 | 0.63 | 1.02 | 0.97 |
| 1,2-Phenylenediamine | 0.52 | 0.56 | 0.1 | **4.93** | 0.13 | 0.46 | 1.14 | 0.88 |
| 1,2-Propylene oxide | **1.65** | 0.42 | 0.64 | **1.43** | 0.63 | 0.76 | 1.22 | 0.93 |
| 1,3-Butadiene | **2.38** | 0.27 | 0.57 | **1.34** | 0.39 | 0.57 | **1.36** | 0.89 |
| 1,3-Dichloropropene | **2.08** | 0.29 | 0.37 | **1.6** | 0.51 | 0.63 | 1.23 | 0.84 |
| 1,3-Propane sultone | 0.87 | 0.13 | 0.54 | 1.05 | 0.08 | 1.09 | 1.15 | 0.94 |
| 1,4-Dichloro-2-butene | 0.36 | 0.38 | 0.11 | **5.45** | 0.08 | 0.4 | **1.34** | 0.87 |
| 1,4-Dichlorobenzene | 0.78 | 0.64 | 0.2 | **1.38** | 0.37 | 1.05 | 1.03 | 0.95 |
| 1,4-Dioxane | 1.08 | 0.27 | 0.93 | **1.66** | 0.25 | 0.87 | 1.18 | 0.96 |
| 1-Bromopropane | 1.02 | 0.29 | **1.66** | 0.94 | **5.02** | 0.93 | 0.97 | 1.03 |
| 1-Ethyl-1-nitrosourea | 0.11 | 0.1 | 0.27 | 0.39 | 0.9 | **1.49** | 0.93 | 1.01 |
| 1-Naphthalenol, 1-(N-methylcarbamate) | 0.4 | 0.24 | 0.41 | **2.94** | 0.19 | 0.82 | **1.26** | 0.91 |
| 1-Naphthylamine | 0.82 | 0.67 | 0.3 | **2.5** | 0.23 | 0.86 | 1.18 | 0.95 |
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin | 1.05 | 0.91 | 0.55 | 0.9 | 0.51 | 1.06 | 1.19 | 0.92 |
| 2,4,6-Trichlorophenol | 1.01 | 0.51 | 0.61 | **1.51** | 0.29 | 0.96 | 1.06 | 0.97 |
| 2,4-Diaminotoluene | 1.01 | 0.15 | 0.16 | **2.19** | 0.13 | 0.88 | **1.47** | 0.89 |
| 2,4-Dichlorophenoxyacetic acid | 0.42 | 0.27 | 0.39 | **1.79** | 0.15 | 1.1 | **1.43** | 0.89 |
| 2,4-Dinitrotoluene | 0.13 | 0.54 | 0.13 | 0.21 | 0.52 | **1.53** | **1.4** | 0.87 |
| 2,6-Dimethylaniline | 0.14 | 0.14 | 0.63 | 0.27 | 0.07 | **1.5** | 0.59 | 1.09 |
| 2,6-Dinitrotoluene | 0.06 | 0.12 | 0.1 | 0.23 | 0.13 | **1.56** | **1.39** | 0.88 |
| 2-Anisidine | 0.28 | **1.59** | 0.05 | 0.42 | 0.05 | **1.32** | 0.8 | 0.93 |
| 2-Mercaptobenzothiazole | 0.42 | 0.24 | 0.25 | 0.72 | 0.37 | **1.3** | **1.48** | 0.92 |
| 2-Methoxy-5-methylaniline | 0.15 | 0.25 | 0.37 | **4.9** | 0.38 | 0.54 | **1.76** | 0.8 |
| 2-Methylaniline | **2.66** | 0.58 | 0.41 | 1 | 0.32 | 0.55 | **1.48** | 0.82 |
| 2-Methylaniline hydrochloride | 0.09 | 0.13 | 0.18 | 0.36 | **1.67** | **1.5** | 1.1 | 0.95 |
| 2-Nitropropane | 0.16 | 0.1 | 0.23 | **1.72** | 0.07 | 1.23 | **1.6** | 0.89 |
| 2-Phenylphenol | **2.04** | 0.29 | **1.39** | **1.33** | 0.24 | 0.59 | 0.99 | 0.91 |
| 3,3',5,5'-Tetrabromobisphenol A | **1.8** | 0.2 | **2.07** | 1.07 | 1.1 | 0.65 | 1.09 | 0.98 |
| 3,3'-Dichlorobenzidine | 1.11 | 0.44 | 0.49 | **2.2** | 0.3 | 0.81 | 1.15 | 0.96 |
| 3,3'-Dichlorobenzidine dihydrochloride | 0.36 | 1.13 | 0.14 | 0.68 | 0.1 | **1.32** | 0.91 | 0.94 |
| 3,3'-Dimethylbenzidine | 1.13 | 0.49 | 0.37 | **2** | 0.23 | 0.86 | 0.97 | 1.01 |
| 3-Chloro-2-methylpropene | 0.28 | 0.62 | 0.54 | **1.63** | 0.25 | 1.13 | 1.07 | 0.99 |
| 4,4'-Diaminobiphenyl methane | 0.58 | 0.15 | 0.18 | **2.22** | 0.14 | 0.98 | 0.87 | 1.08 |
| 4,4'-Methylenebis(2-chloroaniline) | 0.58 | 0.15 | 0.86 | **1.36** | 0.14 | 1.09 | 0.85 | 1.03 |
| 4,4'-Oxydianiline | 0.5 | 0.15 | 0.49 | **1.52** | 0.16 | 1.12 | 1.15 | 0.98 |
| 4-Biphenylamine | 0.55 | 0.6 | 0.08 | **5.08** | 0.15 | 0.43 | 1.12 | 0.88 |
| 4-Chloroaniline | 0.51 | 0.21 | 0.37 | **1.76** | 0.42 | 1.06 | 0.77 | 1.05 |
| 4-Methyl-2-pentanone | 1.14 | 0.56 | 0.73 | **1.69** | 0.59 | 0.85 | 1.21 | 0.94 |

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**Table A16:** RSEI average ambient concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | Inc: <2xPL | Inc: >2xPL |
|---|---|---|---|---|---|---|---|---|
| 5,5-Diphenylhydantoin | 0.32 | 0.38 | 0.32 | 0.82 | 0.27 | **1.3** | 1.03 | 0.97 |
| Acetaldehyde | 1.06 | 0.36 | 0.59 | **1.43** | 0.34 | 0.95 | **1.25** | 0.92 |
| Acetamide | 0.26 | 0.11 | 0.29 | **1.5** | 0.24 | 1.2 | 1.24 | 0.94 |
| Acifluorfen sodium | 0.32 | 0.18 | 0.15 | **4.68** | 0.29 | 0.58 | **1.93** | 0.76 |
| Acrolein | 0.92 | 0.41 | 0.47 | 0.99 | 0.37 | 1.1 | 1.14 | 0.94 |
| Acrylamide | 0.71 | 0.49 | **1.3** | **3.09** | 0.57 | 0.63 | **1.4** | 0.89 |
| Acrylonitrile | 0.56 | 0.37 | 0.38 | **1.67** | 0.22 | 1.07 | 1.2 | 0.93 |
| Alachlor | 0.74 | 0.19 | 0.17 | 0.32 | 0.04 | **1.33** | 1 | 0.99 |
| Aldrin | 0.35 | 0.31 | 0.44 | **3.73** | 0.22 | 0.7 | **1.73** | 0.83 |
| Amitrole | 1.05 | 0.4 | 0.49 | **2.16** | 0.33 | 0.83 | 1.19 | 0.95 |
| Aniline | 0.61 | 0.34 | 0.48 | **2.49** | 0.11 | 0.89 | 0.82 | 1.03 |
| Anthracene | **1.64** | **1.27** | **1.26** | **1.43** | **1.66** | 0.68 | **1.25** | 0.94 |
| Arsenic | **1.72** | **4.58** | 0.42 | 0.38 | **3.87** | 0.92 | 1.03 | 0.99 |
| Asbestos | **1.46** | 0.84 | 0.73 | 1.18 | 0.42 | 0.85 | 1.07 | 0.97 |
| Auramine | 1.13 | 0.49 | 0.36 | **1.97** | 0.22 | 0.87 | 0.95 | 1.01 |
| Benzene | **1.58** | 0.5 | 0.79 | **1.56** | 1.18 | 0.74 | **1.31** | 0.91 |
| Benzotrichloride | 0.07 | 0.32 | 0.14 | 0.44 | 0.6 | **1.46** | **1.48** | 0.83 |
| Benzyl chloride | 0.65 | 0.25 | 1.18 | **1.83** | 0.17 | 0.93 | 1 | 0.93 |
| Beryllium | 0.36 | 0.39 | 0.4 | 0.69 | 0.26 | **1.34** | 1.05 | 0.98 |
| Bis(chloroethyl) ether | **1.36** | **7.17** | 0.5 | 0.86 | 0.45 | 0.87 | 1.19 | 0.91 |
| Bromodichloromethane | 0.15 | 0.2 | 0.11 | 0.43 | 0.34 | **1.49** | **1.29** | 0.92 |
| Bromoform | 0.15 | 0.2 | 0.11 | 0.43 | 0.34 | **1.49** | **1.29** | 0.92 |
| C.I. Azoic Diazo Component 112 | 1.14 | 0.49 | 0.4 | **2.06** | 0.23 | 0.84 | 1 | 1 |
| C.I. Direct Blue 14 | 1.16 | 0.41 | 0.5 | **2.13** | 0.33 | 0.81 | 1.18 | 0.95 |
| C.I. Direct Blue 218 | 0.4 | 0.26 | 0.37 | **1.85** | 0.48 | 1.07 | 0.78 | 1.06 |
| C.I. Disperse Black 6 | 1.13 | 0.48 | 0.42 | **2.09** | 0.25 | 0.84 | 1.03 | 0.99 |
| Cadmium | 1.04 | 0.93 | 0.39 | **1.48** | 0.69 | 0.96 | **1.33** | 0.92 |
| Captan | 0.46 | 1.22 | 0.04 | **1.78** | 0.04 | 1.11 | 1.23 | 0.86 |
| Carbon tetrachloride | 0.77 | 0.32 | 0.52 | **2.18** | 0.59 | 0.89 | 1.14 | 0.96 |
| Chlordane | 0.44 | 0.46 | 0.42 | **3.22** | 0.22 | 0.78 | **1.53** | 0.87 |
| Chlorobenzilate | 0.4 | 0.59 | 0.3 | **3.02** | 0.29 | 0.87 | **1.29** | 0.9 |
| Chloroethane | 0.58 | 0.2 | 0.4 | **3.18** | 0.25 | 0.75 | **1.61** | 0.8 |
| Chloroform | 0.62 | 0.24 | 0.45 | **2.09** | 0.22 | 0.97 | 1.16 | 0.95 |
| Chloromethyl methyl ether | 0.26 | 0.48 | 0.46 | 0.27 | 0.04 | **1.47** | 0.96 | 0.99 |
| Chloroprene | 0.41 | 0.41 | 0.2 | **4.41** | 0.09 | 0.58 | **1.29** | 0.89 |
| Chlorothalonil | 0.37 | 0.23 | 0.42 | **3.03** | 0.19 | 0.81 | **1.29** | 0.91 |
| Cobalt | **1.54** | 0.5 | 0.79 | **1.28** | 0.72 | 0.81 | 1.15 | 0.95 |
| Creosote | 0.36 | 0.36 | 0.21 | **3.03** | 0.15 | 0.88 | **1.58** | 0.81 |
| Crotonaldehyde | **3.75** | 0.37 | 0.17 | 0.41 | 0.24 | 0.37 | **2.24** | 0.79 |
| Cumene | **1.62** | 0.27 | 0.96 | **1.53** | 0.43 | 0.72 | **1.38** | 0.9 |
| Cupferron | 0.15 | 0.59 | 0.23 | **3.47** | 0.18 | 0.86 | **1.31** | 0.88 |
| Di(2-ethylhexyl) phthalate | **1.34** | 0.32 | **2.11** | 0.72 | **1.75** | 0.83 | 0.94 | 1.02 |
| Diazinon | 0.15 | 0.16 | 0.13 | **5.36** | 0.09 | 0.5 | **2.15** | 0.71 |
| Dichloromethane | 0.7 | 0.36 | 0.9 | **1.67** | 0.63 | 0.98 | 1.12 | 0.98 |
| Dichlorvos | 0.11 | **1.83** | 0.18 | **2.29** | 0.09 | 1.1 | **1.28** | 0.9 |
| Diethanolamine | **2.68** | 0.6 | 0.87 | **1.56** | 1.08 | 0.4 | **1.69** | 0.8 |
| Diethyl sulfate | 0.28 | 0.31 | 0.1 | 0.64 | 0.35 | **1.42** | **1.29** | 0.87 |
| Diglycidyl resorcinol ether | 0.17 | 0.05 | 0.62 | 0.14 | 0.06 | **1.52** | 0.31 | 1.24 |
| Dimethyl sulfate | 0.7 | 0.22 | **1.35** | **1.33** | 0.24 | 1.01 | 0.96 | 0.96 |
| Dimethylcarbamoyl chloride | 1.08 | 0.41 | 0.5 | **2.16** | 0.33 | 0.83 | 1.17 | 0.95 |
| Diuron | **1.39** | 0.3 | 1.06 | 1.13 | 1.06 | 0.85 | 0.97 | 1.01 |
| Epichlorohydrin | **1.62** | 0.65 | 0.75 | **1.47** | 0.84 | 0.75 | 1.19 | 0.9 |
| Ethoprop | 0.13 | **1.34** | 0.11 | **3.38** | 0.07 | 0.9 | **1.79** | 0.76 |

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**Table A16:** RSEI average ambient concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | Inc: <2xPL | Inc: >2xPL |
|---|---|---|---|---|---|---|---|---|
| Ethyl acrylate | 0.8 | 0.21 | 0.67 | **1.5** | 0.25 | 1 | **1.73** | 0.85 |
| Ethylbenzene | 1.23 | 0.5 | 0.9 | **1.39** | 1.15 | 0.86 | 1.19 | 0.94 |
| Ethylene oxide | **1.3** | 0.54 | 0.74 | **1.81** | 0.58 | 0.78 | 1.16 | 0.95 |
| Ethylene thiourea | 0.4 | 0.28 | 0.25 | 0.66 | 0.38 | **1.31** | **1.62** | 0.9 |
| Ethyleneimine | 0.22 | 0.43 | 0.1 | **1.58** | 0.51 | 1.24 | **1.32** | 0.9 |
| Formaldehyde | 0.82 | 1.02 | 0.55 | 1.24 | 0.66 | 1.05 | 1.21 | 0.93 |
| Furan | 0.54 | 0.41 | 0.27 | **4.69** | 0.04 | 0.45 | **2.12** | 0.69 |
| Glycidol | **1.55** | 0.51 | 0.44 | **1.59** | 0.17 | 0.77 | **1.31** | 0.9 |
| Heptachlor | 1.23 | 0.57 | 0.34 | **2.17** | 0.22 | 0.77 | **1.42** | 0.87 |
| Hexachloro-1,3-butadiene | 0.31 | 0.23 | 0.36 | **2.66** | 0.11 | 0.96 | 1.09 | 1.01 |
| Hexachlorobenzene | 0.39 | 0.18 | 0.46 | 0.95 | 0.1 | **1.29** | 1.21 | 0.99 |
| Hexachloroethane | 0.85 | 0.17 | 0.28 | **2.73** | 0.19 | 0.78 | 1.21 | 0.88 |
| Hydrazine | 0.45 | 0.36 | 0.23 | **1.96** | 0.14 | 1.08 | **1.67** | 0.86 |
| Hydrazine sulfate | 0.62 | 0.11 | 0.88 | **2.19** | 0.25 | 0.89 | 0.75 | 1.07 |
| Isoprene | **1.9** | 0.25 | 0.56 | **2.07** | 0.26 | 0.57 | **1.31** | 0.91 |
| Lead | 0.87 | 0.77 | 0.72 | **1.32** | **1.55** | 1 | 1.06 | 0.98 |
| Lindane | 1.14 | 0.61 | 0.44 | **1.77** | 0.29 | 0.89 | 1.16 | 0.93 |
| Malathion | 0.66 | 0.09 | 0.06 | **5.23** | 0.03 | 0.39 | **1.96** | 0.76 |
| Maneb | 0.33 | 0.48 | 0.12 | **3.66** | 0.01 | 0.78 | **1.74** | 0.82 |
| Metam-sodium | **2.5** | 0.56 | 0.36 | 0.19 | 0.77 | 0.77 | 1.09 | 0.89 |
| Methyl acrylate | **1.25** | 0.74 | 0.72 | **1.78** | 0.19 | 0.8 | **1.25** | 0.94 |
| Methyl iodide | 0.79 | 0.17 | 0.25 | 0.6 | 0.14 | **1.26** | **1.45** | 0.86 |
| Methylhydrazine | 1.12 | 0.46 | 0.47 | **2.19** | 0.29 | 0.81 | 1.12 | 0.97 |
| Molybdenum trioxide | **2.17** | 0.19 | 0.81 | **1.88** | 0.1 | 0.5 | **1.27** | 0.91 |
| N,N-Dimethylformamide | 1.15 | 0.39 | **1.47** | 1.11 | 0.66 | 0.89 | 0.98 | 1.02 |
| N-Methylolacrylamide | 0.79 | 0.17 | 0.71 | 0.89 | 0.16 | 1.13 | **2.27** | 0.73 |
| N-Nitroso-N-methylurea | 0.11 | 0.1 | 0.27 | 0.39 | 0.88 | **1.49** | 0.93 | 1.01 |
| N-Nitrosodi-n-propylamine | 1.04 | 0.25 | 0.14 | 0.2 | 0.02 | **1.25** | **1.26** | 0.86 |
| N-Nitrosodibutylamine | 0.11 | 0.11 | 0.25 | 0.38 | 1.02 | **1.49** | 0.96 | 1 |
| N-Nitrosodiethylamine | 0.11 | 0.11 | 0.26 | 0.38 | 0.97 | **1.49** | 0.95 | 1.01 |
| N-Nitrosodiphenylamine | 0.37 | 0.43 | 0.12 | **5.28** | 0.1 | 0.43 | **1.33** | 0.87 |
| N-Nitrosomorpholine | 0.2 | 0.06 | 0.3 | 1.2 | **1.56** | **1.28** | **1.96** | 0.73 |
| N-Nitrosopiperidine | 0.11 | 0.11 | 0.25 | 0.38 | 1.02 | **1.49** | 0.96 | 1 |
| Naphthalene | **1.89** | 0.47 | 0.98 | **1.43** | 0.86 | 0.65 | 1.22 | 0.93 |
| Nickel | 0.88 | 0.72 | 1.16 | 0.83 | **1.45** | 1.04 | 1.07 | 1 |
| Nitrapyrin | **1.96** | 0.37 | **2.39** | 1.19 | **4.92** | 0.49 | 1 | 1.01 |
| Nitrilotriacetic acid | **2** | 0.31 | 1.08 | **1.26** | 0.16 | 0.65 | 0.82 | 1.04 |
| Nitrobenzene | 0.64 | 0.19 | 0.69 | **1.83** | 0.23 | 1 | 0.77 | 1.07 |
| Nitromethane | 0.15 | 0.36 | 0.2 | **2.01** | 0.09 | 1.17 | **1.63** | 0.87 |
| Oxadiazon | 1 | 0.14 | 0.19 | 0.73 | 0.05 | 1.16 | **1.56** | 0.84 |
| Parathion | 0.39 | 0.32 | 0.05 | **4.5** | 0 | 0.61 | **1.64** | 0.86 |
| Pentachlorophenol | 0.6 | 1.01 | 1.15 | 0.77 | 1.05 | 1.14 | 0.88 | 1 |
| Pentaerythritol dibromide | 0.89 | 0.2 | 1.23 | **2.07** | 0.1 | 0.8 | **1.43** | 0.91 |
| Perfluorooctanesulfonic acid | 0.34 | 0.63 | 0.1 | **2.93** | 0.02 | 0.93 | **1.56** | 0.83 |
| Perfluorooctanoic acid | 0.4 | 0.48 | 0.83 | **3.18** | 0.24 | 0.76 | **1.71** | 0.84 |
| Phenolphthalein | 0.74 | 1 | 1.1 | 1.19 | 0.08 | 1.01 | 0.81 | 1.08 |
| Polychlorinated biphenyls | 0.86 | 1.02 | 0.45 | **1.77** | 0.28 | 0.95 | 1.17 | 0.95 |
| Polycyclic aromatic hydrocarbons | 1.24 | 0.42 | 0.83 | **1.48** | 0.73 | 0.86 | 1.2 | 0.94 |
| Potassium N-methyldithiocarbamate | 0.09 | **2.2** | 0.16 | **2.24** | 0.08 | 1.12 | **1.32** | 0.9 |
| Potassium bromate | 1.1 | 0.15 | **3.22** | 1.07 | 0.13 | 0.75 | 0.74 | 1.12 |
| Propachlor | 0.35 | 0.27 | 0.31 | 0.57 | 0.08 | **1.37** | 0.8 | 1.06 |
| Propargite | 0.35 | 0.09 | 0.22 | **5.11** | 0.7 | 0.47 | **2.2** | 0.57 |
| Propoxur | 0.38 | 0.34 | 0.05 | **4.47** | 0 | 0.62 | **1.66** | 0.85 |
| Propyleneimine | **1.98** | 0.35 | 0.71 | 0.79 | 0.15 | 0.79 | 0.92 | 1.02 |

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**Table A16:** RSEI average ambient concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | Inc: <2xPL | Inc: >2xPL |
|---|---|---|---|---|---|---|---|---|
| Propyzamide | 0.11 | 0.11 | 0.26 | 0.38 | 0.95 | **1.49** | 0.94 | 1.01 |
| Pyridine | 0.67 | 0.18 | 0.67 | **1.55** | 0.23 | 1.03 | **1.32** | 0.9 |
| Quinoline | **2.3** | 0.13 | 0.88 | **1.57** | 0.09 | 0.52 | **1.27** | 0.91 |
| Rhodamine B | **4.34** | 0.08 | 0.22 | 0.53 | 0.11 | 0.18 | **1.87** | 0.64 |
| Safrole | 0.1 | 0.12 | 0.22 | 0.37 | **1.32** | **1.5** | 1.03 | 0.98 |
| Sodium 2-phenylphenate | 0.14 | 0.33 | 0.2 | **3.02** | 0.11 | 0.96 | **1.62** | 0.87 |
| Styrene | **1.27** | 0.86 | 0.79 | 1.09 | 0.66 | 0.93 | 1.21 | 0.92 |
| Sulfuric acid | 1.16 | 0.46 | 1.06 | 1.22 | **1.73** | 0.9 | 1.07 | 0.99 |
| Tetrachloroethylene | **1.73** | 0.57 | 0.85 | 0.97 | 1.11 | 0.79 | 1.15 | 0.93 |
| Tetrafluoroethylene | 0.49 | 0.45 | 0.38 | **1.58** | 0.16 | 1.12 | 1.09 | 0.97 |
| Thioacetamide | 1.1 | 0.42 | 0.5 | **2.2** | 0.32 | 0.81 | 1.17 | 0.95 |
| Thiodicarb | 0.39 | 0.24 | 0.42 | **2.95** | 0.19 | 0.82 | **1.27** | 0.91 |
| Thiourea | 0.4 | 0.39 | **1.34** | 0.94 | **2.02** | 1.14 | 1.2 | 0.98 |
| Toluene 2,4-diisocyanate | 0.37 | 0.29 | 0.46 | **3.33** | 0.65 | 0.79 | 1.17 | 0.95 |
| Toluene diisocyanate | **1.58** | 0.63 | 0.86 | **1.84** | 0.69 | 0.66 | 1.02 | 0.98 |
| Toluene-2,6-diisocyanate | 0.54 | 0.22 | 0.5 | **3.15** | 0.58 | 0.77 | 1.1 | 0.97 |
| Toxaphene | 1.16 | 0.6 | 0.42 | **1.85** | 0.28 | 0.86 | 1.2 | 0.93 |
| Tribufos | 0.1 | **2.12** | 0.17 | **2.27** | 0.09 | 1.11 | **1.3** | 0.9 |
| Trichloroethylene | 0.69 | 0.25 | 0.65 | 1.22 | 0.18 | 1.09 | 1.19 | 0.94 |
| Tris(2,3-dibromopropyl) phosphate | 0.11 | 0.11 | 0.25 | 0.38 | 1.03 | **1.49** | 0.96 | 1 |
| Urethane | **2.1** | 0.11 | 0.27 | **3.06** | 0.07 | 0.35 | **1.61** | 0.84 |
| Vinyl acetate | **1.57** | 0.31 | 0.94 | **1.31** | 0.36 | 0.78 | 1.16 | 0.95 |
| Vinyl chloride | **1.34** | 0.21 | 0.44 | **2.55** | 0.19 | 0.66 | **1.43** | 0.88 |
| Vinyl fluoride | 0.39 | **2.7** | 0.43 | **2.53** | 0.36 | 0.92 | **1.6** | 0.85 |
| alpha-1,2,3,4,5,6-Hexachlorocyclohexane | 1.09 | 0.4 | 0.51 | **2.19** | 0.32 | 0.82 | 1.19 | 0.95 |
| bis(2-Chloro-1-methylethyl) ether | **2.2** | 0.31 | 0.11 | **2.28** | 0.7 | 0.49 | 1.24 | 0.74 |

**Notes:** Presentation of the complete set of *average* ambient concentration ratios for the 186 carcinogens matched to RSEI data for our analysis. Ratios calculated as the arithmetic mean ambient concentration for a given demographic subgroup divided by the national arithmetic mean ambient concentration. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5.
**Demographic subgroups:** Hispanic, non-Hispanic American Indian or Alaskan Native, non-Hispanic Asian, non-Hispanic Black, non-Hispanic Pacific Islander, non-Hispanic White, household income below 2 times the poverty line, household income above 2 times the poverty line.
**Return to:** Section 3.2.1.

**Table A17:** RSEI 95th percentile ambient concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | Inc: <2xPL | Inc: >2xPL |
|---|---|---|---|---|---|---|---|---|
| 1,1,1,2-Tetrachloroethane | * | * | * | * | * | * | * | * |
| 1,1,1-Trichloroethane | * | * | * | * | * | * | * | * |
| 1,1,2,2-Tetrachloroethane | * | * | * | * | * | * | * | * |
| 1,1,2-Trichloroethane | * | * | * | * | * | * | * | * |
| 1,1-Dichloroethane | * | * | * | * | * | * | * | * |
| 1,1-Dichloroethylene | * | * | * | * | * | * | * | * |
| 1,1-Dimethylhydrazine | * | * | * | * | * | * | * | * |
| 1,2,3-Trichloropropane | * | * | * | * | * | * | * | * |
| 1,2-(Methylenedioxy)-4-propylbenzene | * | * | * | * | * | * | * | * |
| 1,2-Benzenediol | * | * | * | * | * | * | * | * |
| 1,2-Dibromo-3-chloropropane | * | * | * | * | * | * | * | * |
| 1,2-Dibromoethane | * | * | * | * | * | * | * | * |
| 1,2-Dichloroethane | **15.65** | 0 | 0 | **1076.99** | 0 | 0.04 | **48.61** | 0.1 |
| 1,2-Dichloropropane | * | * | * | * | * | * | * | * |
| 1,2-Diphenylhydrazine | * | * | * | * | * | * | * | * |
| 1,2-Epoxybutane | **3.53** | 0 | **2.4** | **1.92** | 0.5 | 0.13 | 1.08 | 0.97 |
| 1,2-Phenylenediamine | * | * | * | * | * | * | * | * |
| 1,2-Propylene oxide | **1.32** | 0.31 | 0.37 | **3.67** | 0.02 | 0.72 | **1.4** | 0.91 |
| 1,3-Butadiene | **1.67** | 0.06 | 0.67 | **2.18** | 0.68 | 0.74 | **1.38** | 0.9 |
| 1,3-Dichloropropene | * | * | * | * | * | * | * | * |
| 1,3-Propane sultone | * | * | * | * | * | * | * | * |
| 1,4-Dichloro-2-butene | * | * | * | * | * | * | * | * |
| 1,4-Dichlorobenzene | * | * | * | * | * | * | * | * |
| 1,4-Dioxane | **2.08** | 0.05 | 1.04 | **3.74** | 0.04 | 0.69 | 1.09 | 0.98 |
| 1-Bromopropane | 0.91 | 0.07 | **2.55** | 1.22 | 0.89 | 0.83 | 0.79 | 1.12 |
| 1-Ethyl-1-nitrosourea | * | * | * | * | * | * | * | * |
| 1-Naphthalenol, 1-(N-methylcarbamate) | * | * | * | * | * | * | * | * |
| 1-Naphthylamine | * | * | * | * | * | * | * | * |
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin | 0.97 | 1.1 | 0.5 | 1.13 | 0.45 | 1.05 | 1.15 | 0.95 |
| 2,4,6-Trichlorophenol | * | * | * | * | * | * | * | * |
| 2,4-Diaminotoluene | * | * | * | * | * | * | * | * |
| 2,4-Dichlorophenoxyacetic acid | 0.58 | 0 | 0 | **79.94** | 0 | 0.72 | **1.83** | 0.94 |
| 2,4-Dinitrotoluene | * | * | * | * | * | * | * | * |
| 2,6-Dimethylaniline | * | * | * | * | * | * | * | * |
| 2,6-Dinitrotoluene | * | * | * | * | * | * | * | * |
| 2-Anisidine | * | * | * | * | * | * | * | * |
| 2-Mercaptobenzothiazole | * | * | * | * | * | * | * | * |
| 2-Methoxy-5-methylaniline | * | * | * | * | * | * | * | * |
| 2-Methylaniline | * | * | * | * | * | * | * | * |
| 2-Methylaniline hydrochloride | * | * | * | * | * | * | * | * |
| 2-Nitropropane | * | * | * | * | * | * | * | * |
| 2-Phenylphenol | * | * | * | * | * | * | * | * |
| 3,3',5,5'-Tetrabromobisphenol A | **2.6** | 0 | **3.8** | 1.11 | 0.15 | 0.2 | 0.96 | 1.03 |
| 3,3'-Dichlorobenzidine | * | * | * | * | * | * | * | * |
| 3,3'-Dichlorobenzidine dihydrochloride | * | * | * | * | * | * | * | * |
| 3,3'-Dimethylbenzidine | * | * | * | * | * | * | * | * |
| 3-Chloro-2-methylpropene | * | * | * | * | * | * | * | * |
| 4,4'-Diaminobiphenyl methane | * | * | * | * | * | * | * | * |
| 4,4'-Methylenebis(2-chloroaniline) | * | * | * | * | * | * | * | * |
| 4,4'-Oxydianiline | * | * | * | * | * | * | * | * |
| 4-Biphenylamine | * | * | * | * | * | * | * | * |
| 4-Chloroaniline | * | * | * | * | * | * | * | * |
| 4-Methyl-2-pentanone | **1.28** | 0.18 | 0.92 | **1.54** | 0.5 | 0.82 | 1.19 | 0.95 |

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**Table A17:** RSEI 95th percentile ambient concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | Inc: <2xPL | Inc: >2xPL |
|---|---|---|---|---|---|---|---|---|
| 5,5-Diphenylhydantoin | * | * | * | * | * | * | * | * |
| Acetaldehyde | 0.98 | 0.28 | 0.66 | **1.97** | 0.19 | 0.92 | **1.25** | 0.94 |
| Acetamide | * | * | * | * | * | * | * | * |
| Acifluorfen sodium | * | * | * | * | * | * | * | * |
| Acrolein | 0.7 | 0 | 0.34 | **1.27** | 0 | 1.17 | 1.16 | 0.94 |
| Acrylamide | 0.41 | 0 | **88.88** | **35.31** | **47.07** | 0.75 | 0.85 | 1.1 |
| Acrylonitrile | 0.45 | 0 | 0.6 | **3.39** | 0.32 | 1.05 | 1.21 | 0.95 |
| Alachlor | * | * | * | * | * | * | * | * |
| Aldrin | * | * | * | * | * | * | * | * |
| Amitrole | * | * | * | * | * | * | * | * |
| Aniline | 0.03 | 0.13 | 0.01 | **82.18** | 0 | 0.82 | **1.46** | 0.92 |
| Anthracene | 1.17 | 0.39 | **2.83** | **2.35** | **1.71** | 0.64 | 1.24 | 0.99 |
| Arsenic | 1 | **1.58** | 0.7 | 1.15 | **2.2** | 0.98 | 1.07 | 0.96 |
| Asbestos | * | * | * | * | * | * | * | * |
| Auramine | * | * | * | * | * | * | * | * |
| Benzene | **1.75** | 0.49 | 0.82 | **1.57** | 0.94 | 0.74 | **1.31** | 0.92 |
| Benzotrichloride | * | * | * | * | * | * | * | * |
| Benzyl chloride | **3.12** | 0 | **2.29** | **9.01** | 0 | 0.24 | 1.11 | 1.01 |
| Beryllium | 0.23 | 0 | 0.82 | **1.72** | 0 | 1.11 | 1.02 | 1.01 |
| Bis(chloroethyl) ether | * | * | * | * | * | * | * | * |
| Bromodichloromethane | * | * | * | * | * | * | * | * |
| Bromoform | * | * | * | * | * | * | * | * |
| C.I. Azoic Diazo Component 112 | * | * | * | * | * | * | * | * |
| C.I. Direct Blue 14 | * | * | * | * | * | * | * | * |
| C.I. Direct Blue 218 | * | * | * | * | * | * | * | * |
| C.I. Disperse Black 6 | * | * | * | * | * | * | * | * |
| Cadmium | 1.21 | 0.04 | 0.58 | **2.19** | **1.3** | 0.88 | 1.18 | 0.97 |
| Captan | * | * | * | * | * | * | * | * |
| Carbon tetrachloride | **65.56** | 0 | **74.97** | **14.72** | 0 | 0.17 | **1.85** | 0.9 |
| Chlordane | * | * | * | * | * | * | * | * |
| Chlorobenzilate | * | * | * | * | * | * | * | * |
| Chloroethane | **4.22** | 0 | 0 | **44.77** | 0 | 0 | **4.34** | 0.57 |
| Chloroform | 0.73 | 0 | 0.86 | **2.71** | 0 | 0.98 | 1.09 | 1 |
| Chloromethyl methyl ether | * | * | * | * | * | * | * | * |
| Chloroprene | * | * | * | * | * | * | * | * |
| Chlorothalonil | * | * | * | * | * | * | * | * |
| Cobalt | **1.33** | 0.18 | 0.9 | **1.59** | 0.57 | 0.87 | 1.18 | 0.97 |
| Creosote | 0.28 | 0 | 0 | **1275.01** | 0 | **6.29** | **2.83** | 0.83 |
| Crotonaldehyde | * | * | * | * | * | * | * | * |
| Cumene | **1.58** | 0.18 | **1.53** | **3.03** | 0.47 | 0.65 | **1.36** | 0.94 |
| Cupferron | * | * | * | * | * | * | * | * |
| Di(2-ethylhexyl) phthalate | **1.71** | 0.02 | **2.92** | 0.55 | **1.32** | 0.68 | 0.92 | 1.04 |
| Diazinon | * | * | * | * | * | * | * | * |
| Dichloromethane | 0.81 | 0.18 | 1.11 | 1.23 | 0.6 | 1.04 | 0.96 | 1.02 |
| Dichlorvos | * | * | * | * | * | * | * | * |
| Diethanolamine | **3.55** | 0.27 | **1.41** | **2.19** | 0.52 | 0.38 | **1.41** | 0.88 |
| Diethyl sulfate | * | * | * | * | * | * | * | * |
| Diglycidyl resorcinol ether | * | * | * | * | * | * | * | * |
| Dimethyl sulfate | * | * | * | * | * | * | * | * |
| Dimethylcarbamoyl chloride | * | * | * | * | * | * | * | * |
| Diuron | **1.71** | 0 | **1.64** | **1.58** | 0 | 0 | **1.29** | 0.94 |
| Epichlorohydrin | **1.71** | 0 | 0.96 | **3.32** | 0 | 0.65 | **1.61** | 0.89 |
| Ethoprop | * | * | * | * | * | * | * | * |

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**Table A17:** RSEI 95th percentile ambient concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | Inc: <2xPL | Inc: >2xPL |
|---|---|---|---|---|---|---|---|---|
| Ethyl acrylate | 0.98 | 0.03 | 0.97 | **1.88** | 0.11 | 0.85 | 1.14 | 0.98 |
| Ethylbenzene | **1.32** | 0.54 | 0.91 | **1.55** | **1.33** | 0.83 | **1.25** | 0.93 |
| Ethylene oxide | **1.6** | 0.47 | 0.62 | **3.16** | 0.82 | 0.72 | 1.2 | 0.94 |
| Ethylene thiourea | * | * | * | * | * | * | * | * |
| Ethyleneimine | * | * | * | * | * | * | * | * |
| Formaldehyde | 0.92 | 0.81 | 0.54 | **1.28** | 0.59 | 1.02 | 1.13 | 0.95 |
| Furan | * | * | * | * | * | * | * | * |
| Glycidol | * | * | * | * | * | * | * | * |
| Heptachlor | * | * | * | * | * | * | * | * |
| Hexachloro-1,3-butadiene | * | * | * | * | * | * | * | * |
| Hexachlorobenzene | 0.85 | 0 | 0.61 | **6.14** | 0.22 | 0.81 | **1.36** | 0.96 |
| Hexachloroethane | * | * | * | * | * | * | * | * |
| Hydrazine | **1.51** | 0 | **1.41** | **2.32** | 0.25 | 0.56 | 0.91 | 1.04 |
| Hydrazine sulfate | * | * | * | * | * | * | * | * |
| Isoprene | **7.09** | 0 | 0.92 | **4.99** | 0.33 | 0.22 | **1.84** | 0.83 |
| Lead | 0.78 | 0.69 | 0.78 | **1.41** | 1.24 | 1.01 | 1.11 | 0.98 |
| Lindane | * | * | * | * | * | * | * | * |
| Malathion | * | * | * | * | * | * | * | * |
| Maneb | * | * | * | * | * | * | * | * |
| Metam-sodium | * | * | * | * | * | * | * | * |
| Methyl acrylate | **1.47** | 0 | 1.08 | **1.83** | 0 | 0.58 | **1.33** | 0.92 |
| Methyl iodide | * | * | * | * | * | * | * | * |
| Methylhydrazine | * | * | * | * | * | * | * | * |
| Molybdenum trioxide | **5.6** | 0.03 | 1 | **5.08** | 0.12 | 0.42 | **1.62** | 0.91 |
| N,N-Dimethylformamide | **1.4** | 0.17 | **1.38** | 1.01 | 0.98 | 0.8 | 0.98 | 1.01 |
| N-Methylolacrylamide | 0.33 | 0 | **1.44** | **1.97** | 0 | 0.78 | 0.57 | 1.1 |
| N-Nitroso-N-methylurea | * | * | * | * | * | * | * | * |
| N-Nitrosodi-n-propylamine | * | * | * | * | * | * | * | * |
| N-Nitrosodibutylamine | * | * | * | * | * | * | * | * |
| N-Nitrosodiethylamine | * | * | * | * | * | * | * | * |
| N-Nitrosodiphenylamine | * | * | * | * | * | * | * | * |
| N-Nitrosomorpholine | * | * | * | * | * | * | * | * |
| N-Nitrosopiperidine | * | * | * | * | * | * | * | * |
| Naphthalene | **1.6** | 0.36 | 1.15 | **1.93** | 0.58 | 0.69 | **1.26** | 0.94 |
| Nickel | 1.11 | 0.36 | 0.88 | **1.27** | 0.71 | 0.93 | 1.18 | 0.96 |
| Nitrapyrin | * | * | * | * | * | * | * | * |
| Nitrilotriacetic acid | * | * | * | * | * | * | * | * |
| Nitrobenzene | * | * | * | * | * | * | * | * |
| Nitromethane | * | * | * | * | * | * | * | * |
| Oxadiazon | * | * | * | * | * | * | * | * |
| Parathion | * | * | * | * | * | * | * | * |
| Pentachlorophenol | * | * | * | * | * | * | * | * |
| Pentaerythritol dibromide | * | * | * | * | * | * | * | * |
| Perfluorooctanesulfonic acid | * | * | * | * | * | * | * | * |
| Perfluorooctanoic acid | * | * | * | * | * | * | * | * |
| Phenolphthalein | * | * | * | * | * | * | * | * |
| Polychlorinated biphenyls | * | * | * | * | * | * | * | * |
| Polycyclic aromatic hydrocarbons | 1.22 | 0.3 | 0.88 | **2.26** | 0.45 | 0.74 | **1.35** | 0.92 |
| Potassium N-methyldithiocarbamate | * | * | * | * | * | * | * | * |
| Potassium bromate | * | * | * | * | * | * | * | * |
| Propachlor | * | * | * | * | * | * | * | * |
| Propargite | * | * | * | * | * | * | * | * |
| Propoxur | * | * | * | * | * | * | * | * |
| Propyleneimine | * | * | * | * | * | * | * | * |

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**Table A17:** RSEI 95th percentile ambient concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | Inc: <2xPL | Inc: >2xPL |
|---|---|---|---|---|---|---|---|---|
| Propyzamide | * | * | * | * | * | * | * | * |
| Pyridine | 0.21 | 0 | **2.51** | 0.68 | 0.43 | **1.38** | 0.72 | 1.14 |
| Quinoline | * | * | * | * | * | * | * | * |
| Rhodamine B | * | * | * | * | * | * | * | * |
| Safrole | * | * | * | * | * | * | * | * |
| Sodium 2-phenylphenate | * | * | * | * | * | * | * | * |
| Styrene | **1.45** | 0.53 | 1.04 | 1.04 | 0.7 | 0.84 | 1.2 | 0.93 |
| Sulfuric acid | 1.18 | 0.41 | 0.93 | **1.26** | **1.82** | 0.88 | 1.09 | 0.98 |
| Tetrachloroethylene | **1.66** | 0.13 | 1 | 1.07 | 0.65 | 0.84 | 0.97 | 1 |
| Tetrafluoroethylene | * | * | * | * | * | * | * | * |
| Thioacetamide | * | * | * | * | * | * | * | * |
| Thiodicarb | * | * | * | * | * | * | * | * |
| Thiourea | * | * | * | * | * | * | * | * |
| Toluene 2,4-diisocyanate | 0.17 | 0 | 0.81 | **11.88** | 0 | 0.91 | 0.98 | 1.03 |
| Toluene diisocyanate | **2.39** | 0.16 | 0.99 | **1.51** | **1.69** | 0.78 | 0.94 | 1.01 |
| Toluene-2,6-diisocyanate | 0.01 | 0 | 0.32 | **16.28** | 0 | 0.75 | 0.96 | 1.03 |
| Toxaphene | * | * | * | * | * | * | * | * |
| Tribufos | * | * | * | * | * | * | * | * |
| Trichloroethylene | 0.51 | 0.01 | 0.78 | **1.58** | 0.01 | 1.07 | 1.05 | 1.01 |
| Tris(2,3-dibromopropyl) phosphate | * | * | * | * | * | * | * | * |
| Urethane | * | * | * | * | * | * | * | * |
| Vinyl acetate | **1.67** | 0.07 | 1.18 | **2.2** | 0.33 | 0.7 | 1.21 | 0.95 |
| Vinyl chloride | * | * | * | * | * | * | * | * |
| Vinyl fluoride | * | * | * | * | * | * | * | * |
| alpha-1,2,3,4,5,6-Hexachlorocyclohexane | * | * | * | * | * | * | * | * |
| bis(2-Chloro-1-methylethyl) ether | * | * | * | * | * | * | * | * |

**Notes:** Presentation of the complete set of *95th percentile* ambient concentration ratios for the 186 carcinogens matched to RSEI data for our analysis. Ratios calculated as the 95th percentile ambient concentration for a given subgroup divided by the national 95th percentile ambient concentration. Values marked as * denote 95th percentile ratios that were not calculable due to the national 95th percentile concentration falling at an effective value of zero. This occurs with high frequency for chemicals that are only released from a small number of facilities with modest population density in proximity. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5.
**Demographic subgroups:** Hispanic, non-Hispanic American Indian or Alaskan Native, non-Hispanic Asian, non-Hispanic Black, non-Hispanic Pacific Islander, non-Hispanic White, household income below 2 times the poverty line, household income above 2 times the poverty line.
**Return to:** Section 3.2.1.

**Table A18:** Drinking water 95th percentile concentration ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | <2x PL | >2x PL |
|---|---|---|---|---|---|---|---|---|
| 1,4-DIOXANE | 1.02 | 0.69 | 0.97 | 1.01 | 0.64 | 1.02 | 1.02 | 0.99 |
| ARSENIC | 1.11 | **2.15** | 0.81 | 0.69 | 0.92 | 0.98 | 1.01 | 0.98 |
| BROMATE | 0.73 | 0.96 | 0.84 | 1.04 | 0.74 | 1.04 | 1 | 0.96 |
| CHROMIUM-6 | **1.37** | **1.7** | 1.18 | 0.55 | 1.18 | 0.95 | 1.05 | 0.99 |
| DIBROMOACETIC ACID | **1.62** | 0.96 | 0.95 | 0.88 | 0.95 | 0.95 | 1.09 | 0.99 |
| DICHLOROACETIC ACID | 0.94 | 1.15 | 0.95 | 1.08 | 0.98 | 1.01 | 1.03 | 0.99 |
| DICHLOROMONOBROMOMETHANE | 1.01 | 1.15 | 0.91 | 1.01 | 0.92 | 1 | 1.01 | 1 |
| HAA5 | 1.1 | 0.87 | 1.1 | 1.1 | 0.75 | 0.89 | 1.02 | 0.96 |
| HAA6BR | 1.2 | 1.18 | 0.94 | 0.86 | 1.08 | 0.97 | 1.04 | 0.98 |
| HAA9 | 1.03 | 1.01 | 1.03 | 1.03 | 0.74 | 0.93 | 1.03 | 0.97 |
| MICROCYSTIN-LR | **5.59** | 1 | 1 | 1 | 1 | 1 | **5.59** | 1 |
| NDMA | 1.2 | 0.88 | 0.84 | 1.2 | 0.65 | 0.93 | 1.2 | 1 |
| TETRACHLOROETHYLENE | 1 | 1.04 | 1 | 0.92 | 0.98 | 0.95 | 1 | 1 |
| BROMOFORM | **1.43** | 0.95 | 0.99 | 0.8 | 1 | 0.88 | 1.02 | 0.99 |
| TRICHLOROACETIC ACID | 1.01 | 0.92 | 1.01 | 1.01 | 0.77 | 0.85 | 1.01 | 1 |
| TRICHLOROETHYLENE | **1.92** | 1.13 | **1.48** | 0.94 | 0.98 | 0.94 | 1.04 | 0.98 |
| CHLOROFORM | 0.91 | 1.15 | 0.96 | 1.03 | 0.97 | 1.02 | 1.02 | 0.99 |

**Notes:** Presentation of the complete set of *95th percentile* relative drinking water concentration ratios for the 17 carcinogens that were monitored and detectable. Ratios calculated as the 95th percentile concentration for a given subgroup divided by the national 95th percentile concentration. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5.
**Demographic subgroups:** Hispanic, non-Hispanic American Indian or Alaskan Native, non-Hispanic Asian, non-Hispanic Black, non-Hispanic Pacific Islander, non-Hispanic White, household income below 2 times the poverty line, household income above 2 times the poverty line.
**Return to:** Section 3.2.2.

**Table A19:** Drinking water sample detection ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | <2x PL | >2x PL |
|---|---|---|---|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | **2.27** | 0.82 | 0.73 | 0.85 | 0.37 | 0.67 | 1.04 | 0.98 |
| 1,1,2-TRICHLOROETHANE | **3.67** | **1.25** | 0.29 | 0.96 | 0.1 | 0.25 | **1.25** | 0.88 |
| 1,1-DICHLOROETHANE | 1.18 | 1.13 | 1.23 | 0.56 | 0.52 | 1.02 | 0.88 | 1.06 |
| 1,1-DICHLOROETHYLENE | **2.91** | 1.07 | 0.95 | 0.71 | 0.51 | 0.48 | 1.15 | 0.93 |
| 1,2,3-TRICHLOROPROPANE | **1.56** | 0.63 | **1.76** | 0.48 | **6.25** | 0.79 | 0.95 | 1.02 |
| 1,2-DIBROMO-3-CHLOROPROPANE | **2.23** | 0.8 | **1.5** | 0.55 | **1.73** | 0.61 | 1.12 | 0.94 |
| 1,2-DIBROMOMETHANE | **1.25** | **1.61** | **1.4** | **1.41** | **1.73** | 0.77 | 1.1 | 0.95 |
| 1,2-DICHLOROETHANE | **2.74** | 0.93 | 0.58 | 0.78 | 0.17 | 0.56 | 1.1 | 0.95 |
| 1,2-DICHLOROPROPANE | **3.19** | 1.12 | 0.6 | 0.91 | 0.25 | 0.38 | 1.18 | 0.92 |
| 1,3-BUTADIENE | **1.55** | 0.26 | 0.63 | **2.02** | 0.4 | 0.58 | **1.36** | 0.83 |
| 1,4-DIOXANE | 1.06 | 0.62 | 0.94 | 1.11 | 0.54 | 0.97 | 1.03 | 0.99 |
| 17-ALPHA-ETHYNYLESTRADIOL | 0.65 | 0.49 | 0.66 | **1.77** | 0.15 | 0.98 | 1.21 | 0.9 |
| 17-BETA-ESTRADIOL | 0.9 | 1.01 | 0.85 | 0.61 | **2.19** | 1.13 | **1.31** | 0.85 |
| 2,3,7,8-TCDD | 0.26 | **2.25** | 0.17 | 0.18 | 0.41 | **1.68** | 1.02 | 0.99 |
| 2,4-D | 0.6 | 0.64 | 0.8 | **1.42** | 0.28 | 1.06 | 1 | 1 |
| 4-ANDROSTENE-3,17-DIONE | 0.91 | 0.78 | 0.96 | **1.37** | 0.58 | 0.93 | 1.09 | 0.96 |
| ALACHOR | 0.74 | **1.46** | 0.98 | **1.91** | 0.25 | 0.88 | 1.18 | 0.91 |
| ALPHA-HEXACHLOROCYCLOHEXANE | 0.8 | 0.81 | 0.68 | 1.09 | 0.65 | 1.09 | 1.04 | 0.98 |
| ARSENIC | **1.54** | **1.42** | 0.92 | 0.75 | 0.98 | 0.88 | 1.04 | 0.98 |
| ASBESTOS | 0.76 | **1.76** | 0.64 | 1.15 | 0.33 | 1.1 | 0.94 | 1.03 |
| BENZENE | **3.03** | **1.4** | 0.34 | 0.99 | 0.23 | 0.44 | 1.21 | 0.9 |
| BERYLLIUM, TOTAL | 1.01 | 0.81 | 0.97 | 1.02 | 0.39 | 1 | 0.98 | 1 |
| BHC-GAMMA | **1.3** | 1.08 | 1.01 | **2.35** | 0.13 | 0.61 | **1.29** | 0.86 |
| BIS(2-ETHYLHEXYL) PHTHALATE | 0.74 | 0.7 | 0.81 | **1.78** | 0.3 | 0.94 | 0.98 | 1.01 |
| BROMATE | 1.22 | **1.27** | 1.23 | 0.78 | 1.13 | 0.9 | 1.02 | 0.99 |
| CADMIUM | 0.8 | **1.34** | 0.62 | 1 | 0.32 | 1.1 | 1.02 | 0.99 |
| CARBON TETRACHLORIDE | **1.88** | 0.95 | 0.68 | **1.45** | 0.32 | 0.66 | 1.18 | 0.91 |
| CHLORDANE | 0.47 | **2.32** | **4** | 0.53 | **13.64** | 0.86 | 0.87 | 1.06 |
| CHROMIUM-6 | 1.02 | 0.97 | 1.06 | 1.01 | 1.09 | 0.98 | 1 | 1 |
| COBALT | 0.98 | **1.27** | 0.83 | 0.89 | 0.21 | 1.06 | 0.79 | 1.1 |
| DECACHLOROBIPHENYL | 0.41 | **6.38** | 0.4 | 0.45 | 0.16 | **1.31** | 0.9 | 1.05 |
| DIBROMOACETIC ACID | 1.2 | 0.88 | 0.98 | 0.94 | 0.76 | 0.95 | 1.01 | 0.99 |
| DICHLOROACETIC ACID | 0.94 | 0.92 | 1.01 | 1.09 | 0.71 | 1 | 1 | 1 |
| DICHLOROMONOBROMOMETHANE | 0.96 | 0.95 | 0.99 | 1.05 | 0.75 | 1.01 | 0.99 | 1 |
| ETHOPROP | 0.3 | 0.38 | 0.22 | **1.38** | 0.37 | **1.26** | 1.08 | 0.96 |
| ETHYLBENZENE | **1.72** | 1.17 | 0.63 | 0.89 | 0.37 | 0.84 | 1.03 | 0.98 |
| GLYPHOSATE | **1.72** | **1.44** | **1.61** | 0.37 | 0.71 | 0.86 | 0.8 | 1.1 |
| HAA5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| HAA6BR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| HAA9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| HEPTACHLOR | 1.04 | **1.62** | 0.99 | 1.06 | 0.46 | 0.97 | 1.22 | 0.89 |
| HEPTACHLOR EPOXIDE | 0.58 | **1.41** | 0.67 | 1.06 | 0.75 | 1.15 | 0.99 | 1.01 |
| HEXACHLOROBENZENE | 0.82 | **2.29** | 0.47 | 0.6 | 0.24 | 1.19 | 0.82 | 1.09 |
| METHYLENE CHLORIDE | **1.79** | 0.96 | 0.77 | 1.05 | 0.91 | 0.76 | 1.08 | 0.96 |
| MICROCYSTIN-LR | **4.01** | 0 | 0 | 0.01 | 0 | 0.03 | **2.5** | 0.54 |
| NDBA | 0.93 | 0.78 | 0.7 | 0.7 | 0.64 | 1.18 | 0.93 | 1.03 |
| NDEA | 0.57 | 0.71 | 1.01 | **1.87** | 0.37 | 0.91 | 0.97 | 1.01 |
| NDMA | 1.11 | 0.79 | 0.81 | 0.95 | 0.61 | 1 | 1.02 | 0.99 |
| NMEA | 0.43 | **17.15** | 0.14 | 0.04 | 0.73 | **1.57** | 0.98 | 1.01 |
| NPYR | 0.72 | 0.53 | 0.85 | 1.11 | 0.28 | 1.13 | 1.03 | 0.99 |
| O-TOLUIDINE | **1.39** | 0.8 | 0.87 | 0.84 | 0.55 | 0.92 | 1.14 | 0.93 |
| P-DICHLOROBENZENE | **2.34** | **1.38** | 0.31 | 0.77 | 0.38 | 0.7 | 1.19 | 0.91 |

Continued, next page...

**Table A19:** Drinking water sample detection ratios: complete results

| Chemical | Hispanic | Amer. Ind. | Asian | Black | Pac. Isl. | White | <2x PL | >2x PL |
|---|---|---|---|---|---|---|---|---|
| PFOA | 0.9 | 0.71 | 1.22 | 1.06 | 0.63 | 1 | 0.95 | 1.03 |
| PFOS | **1.74** | 1.2 | 0.94 | **1.27** | 0.57 | 0.67 | 1.2 | 0.91 |
| PAHS | 1 | **3.3** | 0.87 | 0.91 | 0.8 | 1.01 | 0.93 | 1.04 |
| QUINOLINE | 0.7 | 0.75 | **2.44** | 0.57 | 1.14 | 1.04 | 0.79 | 1.1 |
| STYRENE | **2.55** | **1.29** | 1 | 0.9 | 0.16 | 0.54 | 1.18 | 0.91 |
| TESTOSTERONE | 0.88 | 0.5 | 0.85 | **1.51** | 0.57 | 0.92 | 1.09 | 0.96 |
| TETRACHLOROETHYLENE | **1.62** | 0.57 | **1.45** | 0.87 | 0.77 | 0.8 | 1.04 | 0.98 |
| TOXAPHENE | 0.3 | **8.13** | 0.13 | 0.28 | 0.02 | **1.43** | 0.81 | 1.09 |
| TRIBROMOMETHANE | **1.32** | 0.85 | 1.11 | 0.72 | **1.34** | 0.94 | 1 | 1 |
| TRIBUFOS | 0.13 | 0.23 | 0.07 | 0.38 | 0.08 | **1.63** | 0.98 | 1.01 |
| TRICHLOROACETIC ACID | 0.92 | 0.92 | 1.02 | 1.14 | 0.71 | 1 | 1 | 1 |
| TRICHLOROETHYLENE | **2.1** | 0.51 | **1.79** | 0.74 | 0.66 | 0.65 | 1.1 | 0.95 |
| TRICHLOROMETHANE | 0.93 | 0.95 | 0.99 | 1.07 | 0.74 | 1.01 | 0.99 | 1 |
| VINYL CHLORIDE | **2.53** | 0.94 | 0.47 | 1.07 | 0.11 | 0.57 | 1.15 | 0.93 |

**Notes:** Presentation of the complete set of drinking water sample detection concentration ratios for the 66 carcinogens that were monitored and had at least one detectable sample. The sample detection ratio for a given chemical and subgroup is given as the subgroup's survey-weighted fraction of samples with concentrations above the detection limit divided by the total population's survey-weighed fraction of samples with concentrations above the detection limit. Drinking water detection limits can vary both within and across PWSs; interpretation of these results should bear in mind the potential for correlations between a PWS's detection limit for a chemical, its size, and its customers' demographics. **Bold** values denote concentration ratios >=1.25. Underlined values denote concentration ratios >=1.5.
**Demographic subgroups:** Hispanic, non-Hispanic American Indian or Alaskan Native, non-Hispanic Asian, non-Hispanic Black, non-Hispanic Pacific Islander, non-Hispanic White, household income below 2 times the poverty line, household income above 2 times the poverty line.
**Return to:** Section 3.2.2.

**Table A20:** Household products consumption prevalence ratios: complete results

| Chemical | Hispanic | Asian | Black | White | <$30k | >$30k | Child <18 | Female, CBA |
|---|---|---|---|---|---|---|---|---|
| 1,2-Propylene oxide | **1.9** | **1.38** | 0.36 | 1.22 | | 1.01 | 0.68 | 0.80 |
| 1,4-Dichlorobenzene | 0.95 | 1.05 | **2.7** | 0.76 | **1.25** | 0.96 | 0.62 | 0.55 |
| 1,4-Dioxane | **1.39** | 1.24 | 0.79 | 0.83 | 0.49 | 0.95 | 1.24 | 1.24 |
| 1-Chloro-4-(trifluoromethyl)benzene | | | | **1.97** | | 1.01 | **1.27** | |
| 1-Naphthalenol, 1-(N-methylcarbamate) | 0.59 | 0.6 | 0.78 | 1.04 | 1.06 | 1.03 | 0.61 | 0.63 |
| 2,4-Dichlorophenoxyacetic acid | 0.98 | 0.98 | 0.98 | 1.02 | 0.91 | 1.04 | 0.73 | 0.67 |
| 4-Methyl-2-pentanone | **1.74** | 0.54 | 0.99 | 0.8 | 0.7 | 0.77 | 0.73 | 0.63 |
| Acetamide | 0.56 | 0.61 | | 0.94 | 0.87 | 0.89 | 0.3 | 0.09 |
| Amides, coco, N,N-bis(hydroxyethyl) | **1.63** | 0.47 | 0.31 | 1.07 | 0.98 | 0.95 | 0.95 | 0.93 |
| Arsenic | **1.42** | 0.91 | 0.86 | 0.98 | 0.64 | 1.01 | **1.47** | 1.60 |
| Asphalt, oxidized | 0.86 | **2.48** | 0.82 | 1.2 | 0.56 | **1.28** | 0.3 | 0.18 |
| Benzophenone | | **7.74** | | **1.47** | | | 0.95 | |
| Butylated hydroxyanisole | 0.9 | 1.24 | 0.97 | 1.02 | 0.83 | 1.02 | 0.78 | 0.76 |
| C.I. Solvent Yellow 14 | 1.06 | | 1.21 | 0.87 | **1.79** | 0.68 | 0.56 | |
| Cadmium | **1.51** | 0.76 | 0.71 | 0.96 | 0.69 | 0.95 | **1.41** | 1.55 |
| Chlorothalonil | 0.43 | 0.47 | 0.99 | 0.97 | 0.73 | 0.87 | 0.63 | 0.48 |
| Coal tar | | | **2.72** | 0.66 | | | | |
| Cobalt | | | | 0.98 | | | | |
| Cumene | 0.87 | 0.97 | 1.15 | 0.92 | 1.16 | 0.96 | 0.74 | 0.81 |
| Di(2-ethylhexyl) phthalate | **3.57** | | | 1.23 | | **1.52** | | |
| Dichloromethane | 1 | 0.43 | 0.91 | 1.09 | 1.21 | 1.22 | 1.01 | 0.85 |
| Diethanolamine | 0.73 | **1.76** | 1.19 | 0.88 | 1.17 | 0.9 | 0.86 | 0.57 |
| Diuron | **1.6** | 0.77 | 0.61 | 0.84 | 0.9 | 0.7 | **1.51** | 1.23 |
| Ethanol | 1.03 | 0.94 | 1.01 | 0.99 | 0.92 | 1.01 | 1.06 | 1.03 |
| Ethylbenzene | 0.92 | 0.83 | 1.05 | 0.94 | 1.07 | 0.96 | 0.72 | 0.73 |
| Ethylene oxide | **1.58** | 1.21 | 0.8 | 0.8 | 0.42 | 0.89 | **1.26** | 1.35 |
| Formaldehyde | 0.67 | 0.26 | 0.91 | 0.92 | 1.02 | 0.97 | 0.77 | 0.57 |
| Furan | **1.9** | **1.38** | 0.36 | 1.22 | | 1.01 | 0.68 | 0.80 |
| Lead | 0.94 | 0.6 | **1.25** | 0.9 | 0.77 | 0.97 | 1.05 | 0.98 |
| Melamine | | | **1.86** | 0.62 | **1.38** | 0.43 | 0.43 | |
| Mineral oil - includes paraffin oil | **1.25** | 1.11 | **1.83** | 0.88 | 0.92 | 1.02 | **1.27** | 1.28 |
| Myrcene | 0.72 | 0.31 | 0.5 | 1.17 | **1.47** | 0.8 | 1.23 | 1.28 |
| Naphthalene | 0.7 | 0.81 | 1.2 | 0.94 | 1.23 | 0.97 | 0.66 | 0.66 |
| Nickel | 0.81 | 0.36 | 0.91 | 0.96 | 1.11 | 0.93 | 0.74 | 0.68 |
| Nickel (II) oxide | 0.49 | 1.06 | **1.81** | 0.82 | 0.9 | 1.06 | 0.48 | 0.46 |
| Nitrofurazone | **1.46** | | | 0.35 | | 0.16 | 0.39 | 0.46 |
| Phenolphthalein | **1.6** | **2.25** | 0.73 | 0.96 | 1.06 | 0.92 | **2.19** | 1.69 |
| Phenyl glycidyl ether | **1.38** | | 0.2 | 1.21 | 1.07 | 1.13 | **1.56** | 0.98 |
| Quartz (SiO2) | 0.98 | 0.68 | **1.44** | 0.95 | 0.98 | 1.01 | 0.87 | 0.79 |
| Talc | 1.18 | 0.62 | 1.03 | 0.91 | 0.73 | 0.96 | **1.56** | 1.45 |
| Tetrachloroethylene | 0.61 | **1.33** | 0.53 | 1.04 | 0.95 | 1.11 | 0.74 | 1.16 |
| Thiourea | 0.68 | 0.34 | 0.94 | 1.07 | 0.73 | 1.06 | 0.7 | 0.64 |
| Titanium dioxide | 1.1 | 1.17 | 0.98 | 0.98 | 0.87 | 1 | 1.08 | 1.07 |
| Vinyl acetate | 1.01 | 0.35 | 0.12 | 1.02 | 0.52 | 0.88 | 0.92 | 0.94 |

**Notes:** Presentation of the complete set of chemical purchase prevalence ratios for the 44 carcinogens matched to the Stanfield et al. (2021) household purchasing and products data. Due to the original paper's data construction, racial subgroups (Asian, Black, White) are not exclusively non-Hispanic ethnicity. All racial/ethnic subgroup assignments are based on the female head of household. Household-income subgroups differentiated by those earning above and below $30,000 in the year of data collection. *Child <18* denotes whether there is a child younger than 18 in the household. *Female, CBA* denotes whether there is a female of child-bearing age (<45 years old) in the household.
**Return to:** Section 3.2.3.

**Table A21:** Extended synthesis: carcinogens with evidence of potential exposure disparities

| | NHANES Avg | | | NHANES P95 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Prim. | Int. | Age | Prim. | Int. | Age | HHP | DW | RSEI | NHANES Cycle |
| Arsenic | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 2015-2016 |
| 1-Naphthylamine | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2013-2014 |
| Acrylonitrile** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| 1,4-Dichlorobenzene* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | × | 2017-2018 |
| 2,4-Dichlorophenoxyacetic acid* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | × | | ✓ | 2015-2016 |
| Ethylene oxide* | × | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | 2015-2016 |
| Nitrofen** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | 2015-2016 |
| Acrylamide* | × | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| Melamine | ✓ | ✓ | ✓ | × | ✓ | ✓ | ✓ | | | 2003-2004 |
| 1-Naphthalenol, 1-(N-methylcarbamate)** | ✓ | ✓ | ✓ | × | ✓ | ✓ | × | | ✓ | 2015-2016 |
| Naphthalene** | ✓ | ✓ | ✓ | × | ✓ | ✓ | × | | ✓ | 2015-2016 |
| 2-Naphthylamine | ✓ | ✓ | ✓ | × | ✓ | ✓ | | | | 2013-2014 |
| 4-Biphenylamine | × | ✓ | ✓ | × | ✓ | ✓ | | | ✓ | 2013-2014 |
| Acrolein** | ✓ | ✓ | ✓ | × | ✓ | ✓ | | | × | 2015-2016 |
| Crotonaldehyde* | × | ✓ | ✓ | × | ✓ | ✓ | | | ✓ | 2015-2016 |
| Di(2-ethylhexyl) phthalate** | × | × | ✓ | × | ✓ | ✓ | ✓ | | ✓ | 2017-2018 |
| Diazinon** | | | | ✓ | ✓ | ✓ | | | ✓ | 2013-2014 |
| Ethylene thiourea | | | | ✓ | ✓ | ✓ | | | ✓ | 2007-2008 |
| PCBs† | ✓ | ✓ | ✓ | | | | | | ✓ | 2015-2016 |
| Vinyl chloride** | | | | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| Furan | | | | ✓ | ✓ | × | ✓ | | ✓ | 2017-2018 |
| 4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone** | ✓ | ✓ | ✓ | × | ✓ | × | | | | 2013-2014 |
| 2-Methylaniline | ✓ | ✓ | ✓ | × | × | × | | | ✓ | 2013-2014 |
| Dichlorvos** | × | × | ✓ | × | ✓ | ✓ | | | ✓ | 2017-2018 |
| Malathion** | × | × | ✓ | × | ✓ | ✓ | | | ✓ | 2017-2018 |
| Perfluorooctanesulfonic acid | × | × | × | ✓ | ✓ | ✓ | | | ✓ | 2017-2018 |
| Beta-Hexachlorocyclohexane† | ✓ | ✓ | ✓ | | | | | | | 2015-2016 |
| DDT† | ✓ | ✓ | ✓ | | | | | | | 2015-2016 |
| Dimethylarsinic acid | × | × | × | ✓ | ✓ | ✓ | | | | 2017-2018 |
| Z-Tetrachlorvinphos** | × | × | ✓ | × | ✓ | ✓ | | | | 2017-2018 |
| 1,3-Butadiene** | × | × | × | × | ✓ | ✓ | | | ✓ | 2015-2016 |
| 1-Bromopropane** | × | × | × | × | ✓ | ✓ | | | ✓ | 2015-2016 |
| Perfluorooctanoic acid | × | × | × | × | ✓ | ✓ | | | ✓ | 2017-2018 |
| 4-Methyl-2-pentanone | | | | | | | ✓ | | ✓ | 2017-2018 |
| 2-Amino-alpha-carboline | | | | × | ✓ | ✓ | | | | 2013-2014 |
| MeA-alpha-C | | | | × | ✓ | ✓ | | | | 2013-2014 |
| 2,4,6-Trichlorophenol | | | | × | ✓ | × | | | ✓ | 2009-2010 |
| 2-Phenylphenol | | | | × | × | ✓ | | | ✓ | 2009-2010 |
| Benzene* | | | | × | ✓ | × | | | ✓ | 2017-2018 |
| Tetrachloroethylene* | | | | × | ✓ | × | × | | ✓ | 2017-2018 |
| Styrene* | × | ✓ | × | × | ✓ | × | | | × | 2015-2016 |
| 1,2-Propylene oxide** | × | × | × | × | × | × | ✓ | | ✓ | 2015-2016 |
| Cadmium | × | × | ✓ | × | × | × | ✓ | | × | 2017-2018 |
| Ethylbenzene* | × | ✓ | × | × | ✓ | × | × | | × | 2017-2018 |
| Diethanolamine | | | | | | | ✓ | | ✓ | |
| 1,2,3,4,5,6-Hexachlorocyclohexane** | | | | × | ✓ | × | | | | 2009-2010 |
| Dieldrin | | | | × | ✓ | × | | | | 2003-2004 |
| Diisononyl phthalate | | | | × | ✓ | × | | | | 2017-2018 |
| N'-Nitrosonornicotine | | | | × | ✓ | × | | | | 2013-2014 |
| Pentachlorophenol* | | | | × | ✓ | × | | | × | 2009-2010 |
| Bromoform | | | | × | ✓ | × | | × | × | 2017-2018 |
| Tris(2-chloroethyl) phosphate** | × | × | × | × | ✓ | × | | | | 2015-2016 |

Continued, next page...

**Table A21:** Extended synthesis: carcinogens with evidence of potential exposure disparities

| | NHANES Avg | | | NHANES P95 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Prim. | Int. | Age | Prim. | Int. | Age | HHP | DW | RSEI | NHANES Cycle |
| 2,6-Dimethylaniline | × | × | × | × | ✓ | × | | | × | 2013-2014 |

**Notes:** Cross-analysis summary of chemical-specific exposure disparities, including extended set of NHANES demographic subgroups and based on ratio inclusion threshold value of 1.5. ✓: evidence of potential exposure disparities for at least of the analysis's primary subgroups. ×: no evidence of potential disparities in exposure. Chemicals listed in first column are parent carcinogens. NHANES results may be based on metabolite or pooled concentrations. **: Carcinogens for which only metabolite biomonitoring results were available. *: Carcinogens for which both direct and metabolite biomonitoring results were available. †: NHANES average analysis based on pooled data. For NHANES biomonitoring subcolumns, *Prim.* denotes results from the primary analyses (Tables A1, A4, A7), *Int.* denotes results from the demographic interaction analyses (Tables A2, A5, A8), and *Age* denotes results from the age-differentiated analyses (Tables A3, A6, A9). *HHP* denotes results from the household purchasing analysis. *DW* denotes results from the drinking water analysis. *RSEI* denotes results from the air toxics analysis. *NHANES Cycle* notes the biomonitoring data cycle years used to calculate chemical-specific statistics.

**Parent Chems:** {N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine, N-acetyl-S-(2-cyanoethyl)-L-cysteine, N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Acrylonitrile***}; {2,5-dichlorophenol: *1,4-Dichlorobenzene**}; {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid**}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Ethylene oxide**}; {2,4-dichlorophenol: *Nitrofen***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide**}; {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {1-naphthol: *Naphthalene***}; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde**}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {Oxypyrimidine: *Diazinon***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Vinyl chloride***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine: *1,3-Butadiene***}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-Acetyl-S-(phenyl)-L-cysteine: *Benzene**}; {N-acetyl-s-(trichlorovinyl)-L-cysteine: *Tetrachloroethylene**}; {Mandelic acid: *Styrene**}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {Mandelic acid: *Ethylbenzene**}; {2,4,5-trichlorophenol: *1,2,3,4,5,6-Hexachlorocyclohexane***}; {2,4,5-trichlorophenol: *Pentachlorophenol**}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}

**Return to:** Section 3.3, Section 3.4.

**Table A22:** Extended synthesis: alternative inclusion ratio threshold of 1.25

| | NHANES Avg | | | NHANES P95 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Prim. | Int. | Age | Prim. | Int. | Age | HHP | DW | RSEI | NHANES Cycle |
| Arsenic | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 2015-2016 |
| 1,4-Dichlorobenzene* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | 2017-2018 |
| Di(2-ethylhexyl) phthalate** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | 2017-2018 |
| Ethylene oxide* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | 2015-2016 |
| 1-Bromopropane** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| 1-Naphthylamine | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2013-2014 |
| 4-Biphenylamine | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2013-2014 |
| Acrylamide* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| Acrylonitrile** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| Crotonaldehyde* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| Melamine | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | 2003-2004 |
| Styrene* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| 1-Naphthalenol, 1-(N-methylcarbamate)** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | × | | ✓ | 2015-2016 |
| 2,4-Dichlorophenoxyacetic acid* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | × | | ✓ | 2015-2016 |
| Ethylbenzene* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | × | | ✓ | 2017-2018 |
| Naphthalene** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | × | | ✓ | 2015-2016 |
| 2-Naphthylamine | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | 2013-2014 |
| Dimethylarsinic acid | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | 2017-2018 |
| Nitrofen** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | 2015-2016 |
| 1,3-Butadiene** | × | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| 2-Methylaniline | ✓ | ✓ | ✓ | × | ✓ | ✓ | | | ✓ | 2013-2014 |
| Acrolein** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | × | 2015-2016 |
| Dichlorvos** | × | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2017-2018 |
| Malathion** | × | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | 2017-2018 |
| Perfluorooctanesulfonic acid | ✓ | ✓ | × | ✓ | ✓ | ✓ | | | ✓ | 2017-2018 |
| 1,2-Propylene oxide** | ✓ | ✓ | ✓ | × | ✓ | × | ✓ | | ✓ | 2015-2016 |
| Cadmium | × | ✓ | ✓ | × | ✓ | ✓ | ✓ | | ✓ | 2017-2018 |
| Bromoform | | | | ✓ | ✓ | ✓ | | ✓ | ✓ | 2017-2018 |
| Furan | | | | ✓ | ✓ | ✓ | ✓ | | ✓ | 2017-2018 |
| 4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone** | ✓ | ✓ | ✓ | ✓ | ✓ | × | | | | 2013-2014 |
| Tris(2-chloroethyl) phosphate** | × | ✓ | ✓ | ✓ | ✓ | ✓ | | | | 2015-2016 |
| Z-Tetrachlorvinphos** | × | ✓ | ✓ | ✓ | ✓ | ✓ | | | | 2017-2018 |
| 2,6-Dimethylaniline | ✓ | ✓ | ✓ | × | ✓ | × | | | ✓ | 2013-2014 |
| Lead | × | ✓ | ✓ | × | ✓ | ✓ | × | | ✓ | 2017-2018 |
| 2,4,6-Trichlorophenol | | | | ✓ | ✓ | ✓ | | | ✓ | 2009-2010 |
| 2-Phenylphenol | | | | ✓ | ✓ | ✓ | | | ✓ | 2009-2010 |
| Benzene* | | | | ✓ | ✓ | ✓ | | | ✓ | 2017-2018 |
| Diazinon** | | | | ✓ | ✓ | ✓ | | | ✓ | 2013-2014 |
| Ethylene thiourea | | | | ✓ | ✓ | ✓ | | | ✓ | 2007-2008 |
| PCBs† | ✓ | ✓ | ✓ | | | | | | ✓ | 2015-2016 |
| Vinyl chloride** | | | | ✓ | ✓ | ✓ | | | ✓ | 2015-2016 |
| Chloroform | | | | ✓ | ✓ | ✓ | | × | ✓ | 2017-2018 |
| N,N-Dimethylformamide** | × | × | ✓ | × | ✓ | ✓ | | | ✓ | 2015-2016 |
| Perfluorooctanoic acid | × | × | × | ✓ | ✓ | ✓ | | | ✓ | 2017-2018 |
| Nickel | × | ✓ | ✓ | × | × | ✓ | × | | ✓ | 2017-2018 |
| 2-Amino-alpha-carboline | | | | ✓ | ✓ | ✓ | | | | 2013-2014 |
| Beta-Hexachlorocyclohexane† | ✓ | ✓ | ✓ | | | | | | | 2015-2016 |
| DDT† | ✓ | ✓ | ✓ | | | | | | | 2015-2016 |
| Dieldrin | | | | ✓ | ✓ | ✓ | | | | 2003-2004 |
| Diisononyl phthalate | | | | ✓ | ✓ | ✓ | | | | 2017-2018 |
| MeA-alpha-C | | | | ✓ | ✓ | ✓ | | | | 2013-2014 |
| N'-Nitrosonornicotine | | | | ✓ | ✓ | ✓ | | | | 2013-2014 |

Continued, next page...

**Table A22:** Extended synthesis: alternative inclusion ratio threshold of 1.25

| | NHANES Avg | | | NHANES P95 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Prim. | Int. | Age | Prim. | Int. | Age | HHP | DW | RSEI | NHANES Cycle |
| PBB153† | ✓ | ✓ | ✓ | | | | | | | 2015-2016 |
| Pentachlorophenol* | | | | ✓ | ✓ | ✓ | | | × | 2009-2010 |
| Tetrachloroethylene* | | | | × | ✓ | × | ✓ | | ✓ | 2017-2018 |
| Nitromethane | × | × | × | × | ✓ | ✓ | | | ✓ | 2011-2012 |
| 4-Methyl-2-pentanone | | | | | | | ✓ | | ✓ | 2017-2018 |
| 1,4-Dioxane | | | | | | | ✓ | × | ✓ | 2015-2016 |
| 4,4'-Diaminobiphenyl methane | | | | × | × | ✓ | | | ✓ | 2015-2016 |
| Diethanolamine | | | | | | | ✓ | | ✓ | |
| Diuron | | | | | | | ✓ | | ✓ | |
| 1,2,3,4,5,6-Hexachlorocyclohexane** | | | | × | ✓ | × | | | | 2009-2010 |
| 2-Amino-1-methyl-6-phenylimidazo [4,5-b]pyridine | | | | × | ✓ | × | | | | 2013-2014 |
| Heptachlor epoxide B | | | | × | ✓ | × | | | | 2003-2004 |

**Notes:** Cross-analysis summary of chemical-specific exposure disparities, including extended set of NHANES demographic subgroups and *based on alternative ratio inclusion threshold value of 1.25*. ✓: evidence of potential exposure disparities for at least of the analysis's primary subgroups. ×: no evidence of potential disparities in exposure. Chemicals listed in first column are parent carcinogens. NHANES results may be based on metabolite or pooled concentrations. **: Carcinogens for which only metabolite biomonitoring results were available. *: Carcinogens for which both direct and metabolite biomonitoring results were available. †: NHANES average analysis based on pooled data. For NHANES biomonitoring subcolumns, *Prim.* denotes results from the primary analyses (Tables A1, A4, A7), *Int.* denotes results from the demographic interaction analyses (Tables A2, A5, A8), and *Age* denotes results from the age-differentiated analyses (Tables A3, A6, A9). *HHP* denotes results from the household purchasing analysis. *DW* denotes results from the drinking water analysis. *RSEI* denotes results from the air toxics analysis. *NHANES Cycle* notes the biomonitoring data cycle years used to calculate chemical-specific statistics.

**Parent Chems:** {2,5-dichlorophenol: *1,4-Dichlorobenzene**}; {Mono-(2-ethyl-5-hydroxyhexyl) phthalate, Mono-(2-ethyl-5-oxohexyl) phthalate, Mono-2-ethyl-5-carboxypentyl phthalate: *Di(2-ethylhexyl) phthalate***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Ethylene oxide**}; {N-Acetyl-S-(n-propyl)-L-cysteine: *1-Bromopropane***}; {N-acetyl-S-(2-carbamoylethyl)-L-cysteine: *Acrylamide**}; {N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine, N-acetyl-S-(2-cyanoethyl)-L-cysteine, N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Acrylonitrile***}; {N-acetyl-s-(3-hydroxypropyl-1-methyl)-L-cysteine: *Crotonaldehyde**}; {Mandelic acid: *Styrene**}; {1-naphthol: *1-Naphthalenol, 1-(N-methylcarbamate)***}; {2,4-dichlorophenol: *2,4-Dichlorophenoxyacetic acid**}; {Mandelic acid: *Ethylbenzene**}; {1-naphthol: *Naphthalene***}; {2,4-dichlorophenol: *Nitrofen***}; {N-acetyl-S-(2-hydroxy-3-butenyl)-L-cysteine: *1,3-Butadiene***}; }; {N-acetyl-S-(2-Carboxyethyl)-L-cysteine, N-acetyl-S-(3-Hydroxypropyl)-L-cysteine: *Acrolein***};{Dimethyl phosphate: *Dichlorvos***}; {Dimethyl phosphate: *Malathion***}; {N-acetyl-S-(2-hydroxypropyl)-L-cysteine: *1,2-Propylene oxide***}; {NNAL: *4-(N-Methyl-N-nitrosamino)-1-(3-pyridyl)-1-butanone***}; {Bis(2-chloroethyl) phosphate: *Tris(2-chloroethyl) phosphate***}; {Dimethyl phosphate: *Z-Tetrachlorvinphos***}; {N-Acetyl-S-(phenyl)-L-cysteine: *Benzene**}; {Oxypyrimidine: *Diazinon***}; {N-acetyl-S-(2-Hydroxyethyl)-L-cysteine: *Vinyl chloride***}; {N-acetyl-S-(N-methylcarbamoyl)-L-cysteine: *N,N-Dimethylformamide***}; {2,4,5-trichlorophenol: *Pentachlorophenol**}; {N-acetyl-s-(trichlorovinyl)-L-cysteine: *Tetrachloroethylene**}; {2,4,5-trichlorophenol:*1,2,3,4,5,6-Hexachlorocyclohexane***

**Return to:** Section 3.3, Section 3.4.

**Table A23:** Extended synthesis: chemicals with evidence of no exposure disparities

| | NHANES Avg | | | NHANES P95 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Prim. | Int. | Age | Prim. | Int. | Age | HHP | DW | RSEI | NHANES Cycle |
| Formaldehyde | × | × | × | × | × | × | × | | × | 2015-2016 |
| Arsenic acid | | | | × | × | × | | | | 2017-2018 |
| Methylarsonic acid | | | | × | × | × | | | | 2017-2018 |
| PeCDF (furan)† | × | × | × | | | | | | | 2015-2016 |
| 1,3-Propane sultone | | | | | | | | | × | |
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin | | | | | | | | | × | 2015-2016 |
| Bromate | | | | | | | | × | | |
| Butylated hydroxyanisole | | | | | | | × | | | |
| Dichloroacetic acid | | | | | | | | × | | |
| Ethanol | | | | | | | × | | | |
| N-Nitrosodimethylamine | | | | | | | | × | | |
| Titanium dioxide | | | | | | | × | | | |
| Trichloroethylene | | | | | | | | | × | 2017-2018 |

**Notes:** This table lists the carcinogens which, across all applicable analyses, provide suggestive evidence showing limited demographic heterogenity in exposure. ×: denotes an analysis showing no substantive evidence of exposure disparities, based on the *more lenient, alternative inclusion ratio threshold value of 1.25*. For NHANES biomonitoring subcolumns, *Prim.* denotes results from the primary analyses (Tables A1, A4, A7), *Int.* denotes results from the demographic interaction analyses (Tables A2, A5, A8), and *Age* denotes results from the age-differentiated analyses (Tables A3, A6, A9). *HHP* denotes results from the household purchasing analysis. *DW* denotes results from the drinking water analysis. *RSEI* denotes results from the air toxics analysis. *NHANES Cycle* notes the biomonitoring data cycle years used to calculate chemical-specific statistics.

**Return to:** Section 3.3.

**Table A24:** National cancer mortality by race/ethnicity and sex

| Cancer Type | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brain and Other Nervous System | 3.6 | 2.1 | 1.9 | 2.3 | 2.7 | 4.1 | 5.4 | 2.9 | 2.8 | 3.3 | 3.7 | 6.2 |
| Breast | 19.6 | 14.9 | 11.9 | **27.2** | 13.7 | 19.7 | 0.3 | | 0.1 | **0.5** | 0.1 | 0.3 |
| Cervix Uteri | 2.2 | 2.6 | 1.7 | **3.3** | 2.4 | 2.1 | | | | | | |
| Colon and Rectum | 10.9 | 11.2 | 7.8 | **13.9** | 8.6 | 11 | 15.6 | 16 | 10.9 | **21.9** | 13.6 | 15.4 |
| Corpus Uteri | 3.0 | 2.1 | 2 | **5.1** | 2.3 | 2.8 | | | | | | |
| Esophagus | 1.4 | 1.3 | 0.7 | 1.5 | 0.7 | 1.5 | 6.6 | 5.1 | 2.6 | 4.6 | 3.5 | 7.6 |
| Gallbladder | 0.6 | **0.9** | 0.7 | **1** | **1** | 0.5 | 0.4 | **0.6** | **0.5** | **0.7** | **0.5** | 0.3 |
| Kidney and Renal Pelvis | 2.2 | **3** | 1 | 2.1 | 2.1 | 2.2 | 5.1 | **6.8** | 2.3 | 5 | 4.7 | 5.3 |
| Larynx | 0.3 | **0.4** | 0.1 | **0.5** | 0.1 | **0.4** | 1.6 | 1.3 | 0.6 | **2.8** | 1.2 | 1.6 |
| Leukemias | 4.5 | 3.2 | 2.6 | 4.2 | 3.5 | 4.7 | 8.0 | 4.7 | 4.5 | 6.6 | 5.3 | 8.6 |
| Liver | 2.4 | **4.6** | **3.3** | **3** | **4.1** | 2.1 | 7.4 | **11.3** | **9.3** | **10.4** | **10.7** | 6.4 |
| Lung and Bronchus | 28.6 | 26.3 | 15.3 | 26.9 | 11.3 | 32.1 | 40.6 | 34.3 | 24.7 | 48.9 | 20.3 | 43.2 |
| Melanoma of the Skin | 1.3 | 0.4 | 0.3 | 0.3 | 0.5 | **1.7** | 3.0 | 1 | 0.3 | 0.4 | 0.9 | **3.8** |
| Myeloma | 2.4 | 2.1 | 1.2 | **5** | 2.1 | 2.2 | 3.9 | 3.2 | 1.9 | **7.4** | 3.1 | 3.7 |
| Non-Hodgkin Lymphoma | 3.8 | 2.7 | 2.7 | 2.9 | 3.6 | 4 | 6.7 | 5 | 4.7 | 5.1 | 5.5 | 7.1 |
| Oral Cavity and Pharynx | 1.4 | 1.1 | 1.2 | 1.2 | 0.8 | 1.5 | 4.0 | 2.7 | 3.1 | 4.3 | 2.4 | 4.2 |
| Ovary | 6.2 | 5.1 | 4.4 | 5.7 | 4.9 | 6.5 | | | | | | |
| Pancreas | 9.8 | 7.6 | 7.2 | **12.4** | 8.2 | 9.8 | 12.9 | 9.3 | 8.4 | 15.4 | 9.6 | 13.3 |
| Prostate | | | | | | | 19.2 | 15.2 | 8.8 | **37.5** | 15.6 | 18.2 |
| Stomach | 2.1 | **2.8** | **3.5** | **3.4** | **3.8** | 1.5 | 3.7 | **5.3** | **5.6** | **6.9** | **5.9** | 2.9 |
| Thyroid | 0.5 | 0.4 | 0.6 | 0.5 | **0.7** | 0.4 | 0.5 | 0.4 | 0.5 | 0.4 | 0.5 | 0.5 |
| Urinary Bladder | 2.0 | 1.4 | 0.9 | 2.2 | 1.3 | 2.2 | 7.2 | 3.8 | 2.8 | 5.3 | 3.9 | 8 |
| **Demographic subgroup:** | | | | | | | | | | | | |
| Sex: | Female | Female | Female | Female | Female | Female | Male | Male | Male | Male | Male | Male |
| Race/Ethnicity: | All | Amer Ind | Asian/PI | Black | Hisp | White | All | Amer Ind | Asian/PI | Black | Hisp | White |

**Notes:** Table presents national cancer mortality rates (per 100,000 population). Data obtained from CDC, 2021b in October 2024, and are based on mortality during the years 2017-2021. Cancer sites presented in this table include all leading and invasive cancer types. All statistics are age-adjusted rates, based on 2000 U.S. standard population. Race/ethnicity subgroups are: non-Hispanic American Indian and Alaska Native, non-Hispanic Asian and Pacific Islander, non-Hispanic Black, Hispanic, non-Hispanic White. **Bold font** designates subgroup-specific incidence rates that are 25% or more above the corresponding national average. Underlined values denote concentration ratios subgroup-specific incidence rates that are 50% or more above the corresponding national average.

**Return to:** Section 3.5.

# B Exposure pathways for known carcinogens with scarce biomonitoring

In this appendix, we conducted a supplement assessment of common exposure pathways and product types for *known carcinogens*. Though a chemical's status as an IARC- or ROC-listed known carcinogen may influence the creation of a health-protective regulation to address exposure (Mehta et al., 2023), to our knowledge, previous or current national-level exposure surveillance is only available for 18 of the 112 known carcinogens.[1] To explore a path forward in identifying potential exposure disparities for the many known carcinogens lacking biomonitoring or indirect measures of exposure, we summarized what is known regarding exposure pathways and major product categories for the subset of chemicals listed as known carcinogens. More specifically, using identical data and methods to the review exercise conducted in section 3.4, we individually researched the 112 known carcinogens to ascertain readily-available information on their common exposure pathways, product categories, exposure types, and associated cancer sites. In what follows, we highlighted exposure pathways and product categories that were most common for the broader set of known carcinogens, and noted the carcinogens known to be associated with cancer types that differentially impact demographic subgroups.

Figure B1 and Figure B2 visually summarize general exposure pathway and product category trends for this set of chemicals. The two most common exposure pathways across chemicals with known carcinogenicity were via manufacturing (78 of 112 chemicals) and materials processing (71/112). As one would expect, these two exposure pathways are largely occupational. The set of known carcinogens with industrial exposure pathways included several dozen heavy metals and asbestos varieties; some of these carcinogens are still actively used, while others are now legacy contaminants. Other common occupational exposure pathways included construction (22/112), farming/agriculture (22/112), medical/dental (21/112), and mining (20/112).

Our review found that the general population was exposed to 53 of 112 known carcinogen via environmental releases (either ongoing or former) in the soil, air or surface water. And perhaps logically, we observed a strong correlation between a known carcinogen having potential for general population exposure via environmental releases and potential for occupational exposure via manufacturing and/or processing. Other common general exposure pathways included food/food additives (42/112), medical/dental (36/112), drinking water (34/112), and art/office supplies (33/112).

We next considered the set of key product categories in which known carcinogens were found to occur. The most commonly occurring product category (53 of 112 known carcinogens) was metals and electronics. As described above, many known carcinogens are heavy metal compounds, which were used directly or as an intermediate in larger industrial or electronic processes. The second most commonly occurring product category was pharmaceuticals; 43 of 112 known carcinogens were used in pharmaceutical products. The reason for this is fairly intuitive: several hormones and/or chemicals are carcinogenic, but have potential benefits via therapeutic use in treating other conditions. These pharmaceutical uses included as a chemotherapy, an immunosuppressant, a hormone replacement therapies, or as a birth control. Other common product categories included paints/adhesives (39/112), mining (32/112), and plastics/rubber (32/112).

We next considered the subset of 16 known carcinogens that our review found to be associated with liver cancer. Recall from Section 3.5 that national statistics showed elevated incidence of liver cancer among both females and males of several racial and ethnic subgroups. These 16 known carcinogens vary widely in

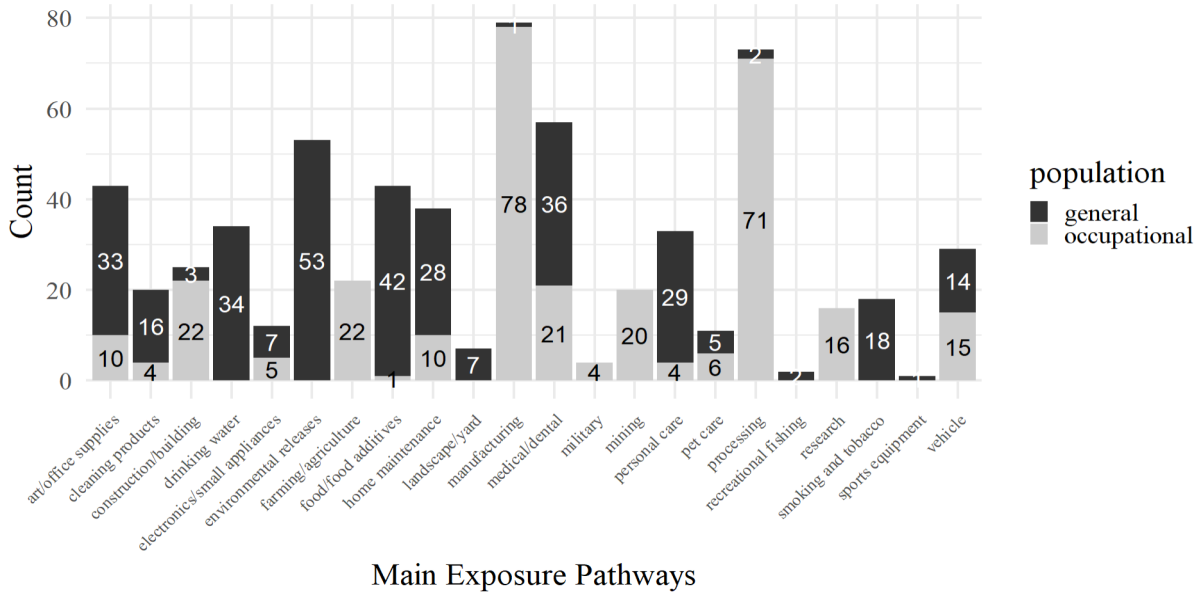
[1] See Table B1 for more information on exposure pathways, associated cancer types, and biomonitoring availability for each of the known carcinogens.

chemical structure, though arsenic is a component of nearly half of them. Common exposure pathways among these 16 chemicals included food and food additives (general population; 10/16), drinking water (general population; 10/16), and manufacturing and processing (occupational; 12/16). Though we've strictly noted correlations here, these 16 chemicals and the noted pathways might prove promising starting points for further exploration of potential exposure disparities.

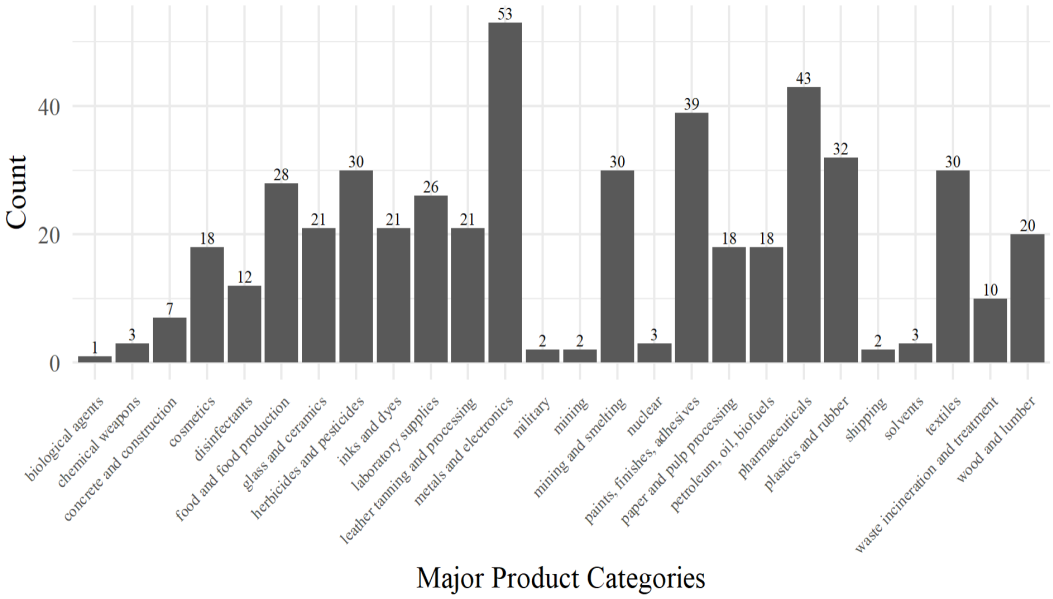
We performed a similar logical extrapolation for two other cancer types: kidney and the renal system (for which national incidence was especially elevated for American Indian individuals), and prostate (for which Black males had highly elevated incidence). Thirteen known carcinogens were found to be associated with renal cancers; again a large fraction of them (6/13) are chemicals containing arsenic. The most common exposure pathways were manufacturing and processing (occupational; 11 of 13 carcinogens), food and food additives (general; 6/13), pet care (general/occupational; 6/13), and art/office supplies (general/occupational; 6/13). Five known carcinogens were found to be associated with prostrate cancer: cadmium, coal tar, diethylstilbestrol, lindane, and cadmium chloride. Four chemicals shared a common medical/dental general exposure pathway, and three chemicals shared drinking water and food/food additive general exposure pathways. While this information is fairly limited and again, strictly built from correlations, these chemicals and exposure pathways might merit further exploration as research on exposure disparities continues.

**Figure B1:** Known carcinogens: likely pathways and product categories

**(a)** Frequency of identified uses (general/occupational) amongst known carcinogens

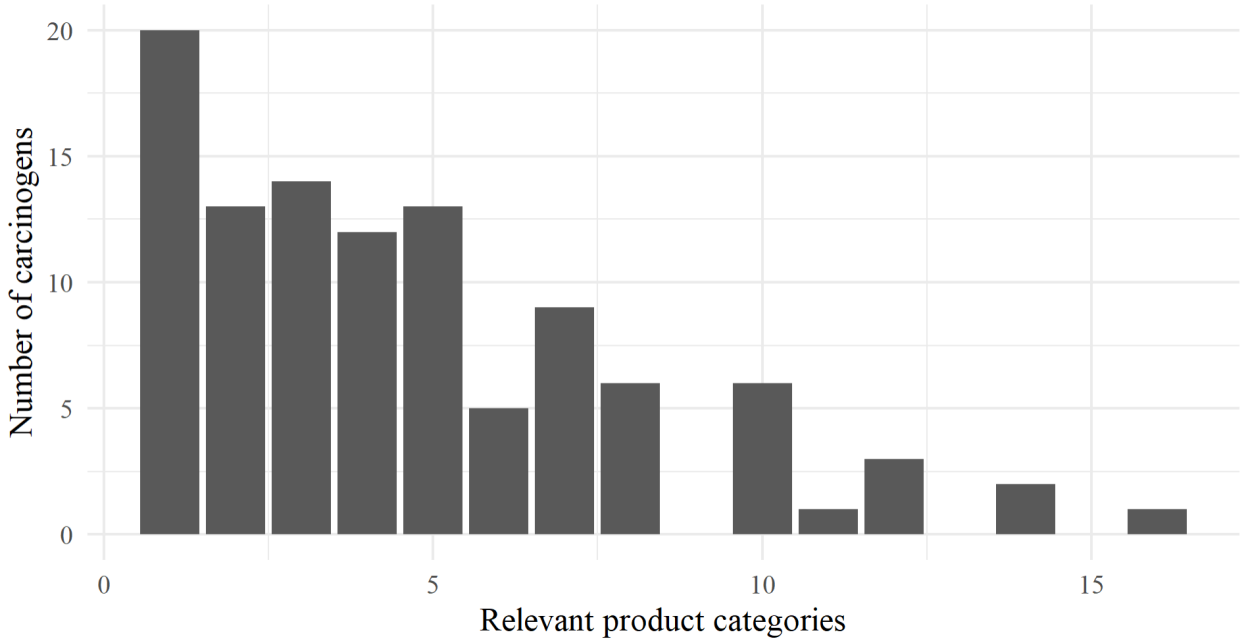



**(b)** Product category frequency amongst known carcinogens




**Notes:** Panel (a) shows the prevalence of exposure pathways across chemicals known to be carcinogenic, distinguishing between general population and occupational pathways. Panel (b) presents the count of known carcinogens (out of N=112) which were found to be associated with the given product category. See Section 2.4 and Section 3.4 for description of exposure pathway information collection and product categorization methods.

**Figure B2:** Exposure sourcing for known carcinogens: number of identified product categories in which each chemical is used




**Notes:** Histogram of the count of associated product categories for each known carcinogen (N = 112). For example, twenty known carcinogens are associated with a single product category, thirteen known carcinogens are associated with two different product categories, ..., and one carcinogen is associated with sixteen different product categories. See Section 2.4 and Section 3.4 for description of exposure pathway information collection and product categorization methods.

**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| 1,3-Butadiene | Plastics and Rubber; | Inhalation; | Leukemia; Non-Hodgkin Lymphoma; | Manufacturing; Vehicle | Environmental Releases; Smoking and Tobacco; Vehicle | ✓ |
| 2,3,7,8-Tetrachlorodibenzo-P-Dioxin | Waste Incineration and Treatment; Paper and Pulp Processing; Herbicides and Pesticides; | Dermal; Inhalation; Ingestion; | Lung; Non-Hodgkin Lymphoma; Thyroid; | Processing; Research | Environmental Releases | |
| 2-Methylaniline | Textiles; Pharmaceuticals; Herbicides and Pesticides; | Dermal; Inhalation; Ingestion; | Bladder; | Manufacturing; Research | Personal Care; Smoking and Tobacco | ✓ |
| 2-Naphthylamine | Plastics and Rubber; Textiles; | Dermal; Inhalation; Ingestion; | Bladder; | Manufacturing | Cleaning Products; Smoking and Tobacco; Environmental Releases | ✓ |
| 4-Biphenylamine | Textiles; Plastics and Rubber; | Dermal; Inhalation; | Bladder; | Manufacturing; Research | Smoking and Tobacco; Food/ Food Additives; Personal Care | ✓ |
| 8-Methoxypsoralen | Cosmetics; | Dermal; Ingestion; | Skin; | Manufacturing | Personal Care; Medical/ Dental; Food/ Food Additives | |
| Aflatoxin | Biological Agents; Food and Food Production; | Inhalation; Ingestion; Dermal; | Liver; | Farming/ Agriculture | Food/ Food Additives | |
| Aristolochic Acid | Pharmaceuticals; | Ingestion; | Renal Pelvis and Ureter; Bladder; | NA | Personal Care; Food/ Food Additives | |
| Arsenic | Mining and Smelting; Herbicides and Pesticides; Metals and Electronics; | Ingestion; | Bladder; Skin; Lung; Stomach / Digestive; Liver; Kidney; Lymphatic; Hemtopoeitic; | Manufacturing; Processing; Vehicle; Farming/ Agriculture; Medical/ Dental | Electronics/ Small Appliances; Cleaning Products; Art/ Office Supplies; Home Maintenance; Vehicle; Food/ Food Additives; Smoking and Tobacco; Drinking Water; Environmental Releases | ✓ |
| Azathioprine | Pharmaceuticals; | Ingestion; Injection; Inhalation; | Skin; Non-Hodgkin Lymphoma; Leukemia; Liver; Gallbladder; | Manufacturing; Medical/ Dental | NA | |

Continued, next page...

**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Benzene | Solvents; Petroleum, Oil, Biofuels; Pharmaceuticals; Textiles; Plastics and Rubber; Inks and Dyes; | Inhalation; Ingestion; Dermal; | Leukemia; Hodgkin's Lymphoma; | Manufacturing; Vehicle; Processing | Vehicle; Smoking and Tobacco; Art/ Office Supplies; Cleaning Products; Home Maintenance; Landscape/ Yard; Food/ Food Additives; Environmental Releases; Drinking Water | ✓ |
| Beryllium | Metals and Electronics; Mining and Smelting; | Inhalation; Ingestion; | Lung; | Processing; Mining; Manufacturing | Environmental Releases; Smoking and Tobacco; Drinking Water | ✓ |
| Bis-(2-Chloroethyl)Sulfide | Chemical Weapons; | Inhalation; Dermal; | Lung; | Military | Environmental Releases; Recreational Fishing | |
| Busulfan | Pharmaceuticals; | Ingestion; | Leukemia; | Manufacturing; Medical/ Dental | Medical/ Dental | |
| C.i. Azoic Diazo Component 112 | Leather Tanning and Processing; Paper and Pulp Processing; Textiles; Laboratory Supplies; | Inhalation; Ingestion; Dermal; | Bladder; | Processing; Research | Home Maintenance; Environmental Releases; Drinking Water; Food/ Food Additives | |
| Cadmium | Mining and Smelting; Metals and Electronics; Paints, Finishes, Adhesives; Textiles; Plastics and Rubber; | Ingestion; Inhalation; | Lung; Prostate; Bladder; Kidney; Pancreatic; Breast; | Processing; Mining; Manufacturing | Food/ Food Additives; Drinking Water; Smoking and Tobacco; Art/ Office Supplies; Recreational Fishing; Environmental Releases; Medical/ Dental | ✓ |
| Chlorambucil | Pharmaceuticals; | Ingestion; Inhalation; Dermal; | Leukemia; | Medical/ Dental | Medical/ Dental; Manufacturing; Processing; Environmental Releases | |
| Chromium (Vi) Ion | Metals and Electronics; Paints, Finishes, Adhesives; Textiles; Leather Tanning and Processing; | Ingestion; Inhalation; Dermal; | Lung; Sinus/Nasal; | Construction/ Building; Processing; Vehicle | Home Maintenance; Art/ Office Supplies; Environmental Releases; Drinking Water | |
| Coal Tar | Pharmaceuticals; Metals and Electronics; Herbicides and Pesticides; Paints, Finishes, Adhesives; Plastics and Rubber; | Ingestion; Inhalation; Dermal; | Skin; Lung; Leukemia; Digestive; Bladder; Kidney; Oral; Stomach; Prostate; | Processing; Construction/ Building; Manufacturing | Personal Care; Cleaning Products; Medical/ Dental; Environmental Releases; Pet Care | |

Continued, next page...

**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Diethylstilbestrol | Pharmaceuticals; | Ingestion; Injection; | Cervix; Prostate; Breast; Pancreatic; | NA | Medical/ Dental | |
| Erionite | Mining and Smelting; Food and Food Production; Waste Incineration and Treatment; | Inhalation; Ingestion; | Lung; | Farming/ Agriculture; Construction/ Building; Mining; Processing; Food/ Food Additives | Home Maintenance; Environmental Releases; Pet Care; Food/ Food Additives | |
| Ethylene Oxide | Laboratory Supplies; Herbicides and Pesticides; Food and Food Production; Disinfectants; Cosmetics; | Inhalation; Ingestion; | Leukemia; Stomach; Lymphatic; | Medical/ Dental; Manufacturing; Farming/ Agriculture | Environmental Releases; Smoking and Tobacco; Personal Care; Home Maintenance; Food/ Food Additives; Vehicle | ✓ |
| Formaldehyde | Herbicides and Pesticides; Disinfectants; Laboratory Supplies; Food and Food Production; Plastics and Rubber; Paints, Finishes, Adhesives; Metals and Electronics; Leather Tanning and Processing; Paper and Pulp Processing; Textiles; | Inhalation; Dermal; | Leukemia; Nasal/Sinus; | Manufacturing; Research; Medical/ Dental; Farming/ Agriculture | Smoking and Tobacco; Food/ Food Additives; Home Maintenance; Environmental Releases; Vehicle; Cleaning Products; Art/ Office Supplies | ✓ |
| Melphalan | Pharmaceuticals; Chemical Weapons; Herbicides and Pesticides; | Injection; Ingestion; Inhalation; Dermal; | Leukemia; | Medical/ Dental; Manufacturing | Medical/ Dental; Environmental Releases | |
| Phenacetin | Pharmaceuticals; Cosmetics; Laboratory Supplies; | Ingestion; Inhalation; Dermal; | Kidney; | Pet Care; Medical/ Dental; Manufacturing | Pet Care; Medical/ Dental; Personal Care | |
| Pitch, Coal Tar, High-Temp. | Metals and Electronics; Paints, Finishes, Adhesives; Textiles; Leather Tanning and Processing; Pharmaceuticals; | Inhalation; Dermal; | Lung; Kidney; Skin; | Manufacturing; Construction/ Building; Processing; Vehicle; Cleaning Products | Art/ Office Supplies; Medical/ Dental; Home Maintenance; Vehicle; Cleaning Products | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Quartz (Sio2) | Food and Food Production; Cosmetics; Metals and Electronics; Petroleum, Oil, Biofuels; Mining and Smelting; Glass and Ceramics; Plastics and Rubber; Paper and Pulp Processing; Paints, Finishes, Adhesives; Herbicides and Pesticides; | Inhalation; Dermal; | Lung; | Manufacturing; Construction/ Building; Processing; Cleaning Products; Vehicle; Farming/ Agriculture | Art/ Office Supplies; Medical/ Dental; Home Maintenance; Cleaning Products; Vehicle; Cleaning Products; Personal Care | |
| Radon | Pharmaceuticals; Petroleum, Oil, Biofuels; Mining and Smelting; Laboratory Supplies; | Radiation; Inhalation; Ingestion; | Lung; Salivary Glands; Stomach; Colon; Bladder; Ovary; Brain; Skin; | Medical/ Dental; Military; Mining; Research; Construction/ Building | Environmental Releases; Medical/ Dental; Environmental Releases; Drinking Water; Construction/ Building | |
| Semustine | Pharmaceuticals; | Dermal; Injection; | Lung; Leukemia; | Manufacturing; Medical/ Dental | Medical/ Dental | |
| Tamoxifen | Pharmaceuticals; | Injestion; Inhalation; | Uterus; | Manufacturing; Processing | Medical/ Dental | |
| Thiotepa | Herbicides and Pesticides; Pharmaceuticals; | Injection; Ingestion; Inhalation; Dermal; | Leukemia; | Medical/ Dental; Manufacturing | Medical/ Dental; Environmental Releases | |
| Trichloroethylene | Metals and Electronics; Textiles; Paints, Finishes, Adhesives; Inks and Dyes; Plastics and Rubber; Wood and Lumber; Leather Tanning and Processing; | Inhalation; Dermal; | Liver; Kidney; Non-Hodgkin's Lymphoma; | Art/ Office Supplies; Manufacturing; Processing; Military | Art/ Office Supplies; Home Maintenance; Cleaning Products; Drinking Water; Environmental Releases; Food/ Food Additives | ✓ |
| Vinyl Chloride | Plastics and Rubber; Food and Food Production; Metals and Electronics; Wood and Lumber; Leather Tanning and Processing; | Ingestion; Inhalation; Dermal; | Liver; Brain; Lung; Lymphoma; Leukemia; | Manufacturing; Processing; Vehicle; Construction/ Building | Smoking and Tobacco; Environmental Releases; Drinking Water; Food/ Food Additives; Vehicle; Home Maintenance | ✓ |
| (˜32˜P)Phosphane | Pharmaceuticals; | Injection; | Leukemia; | NA | Medical/ Dental | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| 1,2-Dichloropropane | Paints, Finishes, Adhesives; Food and Food Production; Paper and Pulp Processing; Petroleum, Oil, Biofuels; Plastics and Rubber; | Ingestion; Inhalation; Dermal; | Biliary Tract; | Manufacturing; Processing; Farming/ Agriculture | Home Maintenance; Environmental Releases; Drinking Water | ✓ |
| 2,3,4,7,8-Pentachlorodibenzofuran | Petroleum, Oil, Biofuels; Herbicides and Pesticides; Plastics and Rubber; Inks and Dyes; Waste Incineration and Treatment; Laboratory Supplies; Wood and Lumber; | Inhalation; Dermal; Ingestion; | Non-Hodgkin Lymphoma; Breast; | Manufacturing; Processing; Farming/ Agriculture; Construction/ Building; Vehicle | Environmental Releases; Food/ Food Additives; Drinking Water; Vehicle | ✓ |
| 3,3',4,4',5-Pentachlorobiphenyl | Inks and Dyes; Paper and Pulp Processing; Paints, Finishes, Adhesives; Metals and Electronics; Herbicides and Pesticides; Laboratory Supplies; Waste Incineration and Treatment; | Ingestion;; | Melanoma; Liver; Bile-Duct; Gastro-Intestinal; | Research; Processing | Food/ Food Additives; Environmental Releases; Drinking Water | ✓ |
| 4,4'-Methylenebis(2-Chloroaniline) | Paints, Finishes, Adhesives; Metals and Electronics; Plastics and Rubber; Food and Food Production; | Dermal; Inhalation; Ingestion; | Bladder; | Manufacturing; Vehicle | Food/ Food Additives; Environmental Releases | |
| Acetaldehyde | Food and Food Production; Cosmetics; Mining and Smelting; Paints, Finishes, Adhesives; Wood and Lumber; Herbicides and Pesticides; Inks and Dyes; Paper and Pulp Processing; Pharmaceuticals; Disinfectants; Leather Tanning and Processing; | Inhalation; Ingestion; Dermal; | Lung; Oral-Cavity; | Mining; Construction/ Building; Processing; Manufacturing | Smoking and Tobacco; Food/ Food Additives; Cleaning Products; Art/ Office Supplies; Home Maintenance; Personal Care; Vehicle; Construction/ Building; Environmental Releases | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Benzo[A]Pyrene | Food and Food Production; Wood and Lumber; Metals and Electronics; Petroleum, Oil, Biofuels; Mining and Smelting; Glass and Ceramics; Laboratory Supplies; Inks and Dyes; | Inhalation; Ingestion; Dermal; | Lung; Skin; | Processing; Manufacturing; Mining; Research | Food/ Food Additives; Vehicle; Art/ Office Supplies; Smoking and Tobacco; Personal Care; Drinking Water; Environmental Releases; Home Maintenance | |
| Chlornaphazine | Pharmaceuticals; | Injection; | Bladder; | NA | Medical/ Dental | |
| Ethanol | Food and Food Production; Pharmaceuticals; Disinfectants; Solvents; Cosmetics; Petroleum, Oil, Biofuels; Paints, Finishes, Adhesives; Herbicides and Pesticides; Laboratory Supplies; Leather Tanning and Processing; | Ingestion; Inhalation; Dermal; | Mouth; Larynx; Pharynx; Esophagus; Cholorectal; Liver; Breast; | Manufacturing; Processing; Cleaning Products; Farming/ Agriculture; Medical/ Dental; Construction/ Building; Personal Care | Cleaning Products; Medical/ Dental; Environmental Releases; Food/ Food Additives; Drinking Water; Personal Care; Art/ Office Supplies | |
| Etoposide | Pharmaceuticals; | Injection; Ingestion; Dermal; | Leukemia; | Medical/ Dental | Medical/ Dental; Environmental Releases | |
| Lindane | Herbicides and Pesticides; Cosmetics; Pharmaceuticals; Laboratory Supplies; | Ingestion; Inhalation; Dermal; | Non-Hodgkin Lymphoma; Leukemia; Prostate; Testicular; | Farming/ Agriculture; Research | Personal Care; Medical/ Dental; Food/ Food Additives; Drinking Water; Environmental Releases | ✓ |
| Pentachlorophenol | Wood and Lumber; Disinfectants; Herbicides and Pesticides; Paints, Finishes, Adhesives; Leather Tanning and Processing; Paper and Pulp Processing; | Dermal; Inhalation; Ingestion; | Non-Hodgkin Lymphoma; | Processing; Manufacturing | Art/ Office Supplies; Food/ Food Additives; Drinking Water; Home Maintenance; Landscape/ Yard | ✓ |
| Plutonium | Metals and Electronics; Military; Nuclear; | Inhalation; Dermal; | Lung; Liver; Bone; | Research; Military; Processing; Research | Environmental Releases; Food/ Food Additives; Drinking Water | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Polychlorinated Biphenyls | Metals and Electronics; Paints, Finishes, Adhesives; Herbicides and Pesticides; Inks and Dyes; Food and Food Production; Laboratory Supplies; Plastics and Rubber; Waste Incineration and Treatment; | Inhalation; | Melanoma; Liver; Bile-Duct; Gastro-Intestinal; | Farming/ Agriculture; Manufacturing; Research | Environmental Releases; Drinking Water; Food/ Food Additives | ✓ |
| Radium-226 | Mining and Smelting; Paints, Finishes, Adhesives; Pharmaceuticals; Metals and Electronics; | Ingestion; Inhalation; | Bone; Nasal; | Research; Medical/ Dental; Manufacturing; Processing | Medical/ Dental; Drinking Water; Food/ Food Additives; Environmental Releases | |
| Radium-228 | Mining and Smelting; Paints, Finishes, Adhesives; Pharmaceuticals; Metals and Electronics; | Ingestion; Inhalation; | Bone; Nasal; | Research; Medical/ Dental; Manufacturing; Processing | Medical/ Dental; Drinking Water; Food/ Food Additives; Environmental Releases | |
| Shale Oils | Mining and Smelting; | Ingestion; Inhalation; Dermal; | Skin; | Manufacturing; Processing | NA | |
| Thorium | Glass and Ceramics; Metals and Electronics; Mining and Smelting; Food and Food Production; Nuclear; | Inhalation; Injection; Ingestion; Dermal; | Liver; Lung; Pancreatic; Bone; | Processing; Manufacturing | Drinking Water; Art/ Office Supplies; Electronics/ Small Appliances; Food/ Food Additives | |
| Treosulfan | Pharmaceuticals; | Ingestion; | Leukemia; | NA | Medical/ Dental | |
| 17alpha-Ethinylestradiol | Pharmaceuticals; Cosmetics; Food and Food Production; | Ingestion; Dermal; Inhalation; | Breast; Ovarian; | Medical/ Dental; Manufacturing | Medical/ Dental; Food/ Food Additives; Drinking Water | |
| 17beta-Estradiol | Pharmaceuticals; Cosmetics; Food and Food Production; | Ingestion; Dermal; Injection; Inhalation; | Breast; Ovarian; | Medical/ Dental; Manufacturing; Processing | Medical/ Dental; Personal Care; Food/ Food Additives; Drinking Water; Environmental Releases | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Actinolite Asbestos | Paints, Finishes, Adhesives; Paper and Pulp Processing; Concrete and Construction; Shipping; Mining and Smelting; Metals and Electronics; Plastics and Rubber; Waste Incineration and Treatment; Glass and Ceramics; Petroleum, Oil, Biofuels; | Inhalation; Ingestion; | Larynx; Mesothelioma; Lung; Ovarian; Stomach; Pharynx; Colorectum; | Home Maintenance; Manufacturing; Processing; Construction/ Building; Vehicle; Mining | Landscape/ Yard; Art/ Office Supplies; Personal Care; Environmental Releases | |
| Ammonium Chromate | Metals and Electronics; Textiles; Inks and Dyes; Laboratory Supplies; | Inhalation; | Lung; Sinus/Nasal; | Art/ Office Supplies; Manufacturing; Research | Art/ Office Supplies | |
| Ammonium Dichromate | Metals and Electronics; Inks and Dyes; Leather Tanning and Processing; Petroleum, Oil, Biofuels; Glass and Ceramics; Wood and Lumber; Paints, Finishes, Adhesives; Textiles; Food and Food Production; Cosmetics; Chemical Weapons; Herbicides and Pesticides; | Inhalation; Ingestion; Dermal; | Lung; | Art/ Office Supplies; Processing; Manufacturing | Art/ Office Supplies; Personal Care; Environmental Releases | |
| Amosite | Paints, Finishes, Adhesives; Paper and Pulp Processing; Concrete and Construction; Shipping; Mining and Smelting; Metals and Electronics; Plastics and Rubber; Waste Incineration and Treatment; Glass and Ceramics; Petroleum, Oil, Biofuels; | Inhalation; Ingestion; | Larynx; Mesothelioma; Lung; Ovarian; Stomach; Pharynx; Colorectum; | Home Maintenance; Manufacturing; Processing; Construction/ Building; Vehicle; Mining | Landscape/ Yard; Art/ Office Supplies; Personal Care; Environmental Releases | |
| Aristolochic Acids | Pharmaceuticals; Food and Food Production; | Ingestion; Dermal; | Urothelial; | Farming/ Agriculture | Medical/ Dental; Landscape/ Yard; Food/ Food Additives | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Arsenic Oxide (As2o3) | Glass and Ceramics; Leather Tanning and Processing; Wood and Lumber; Mining and Smelting; Metals and Electronics; Textiles; Inks and Dyes; Mining and Smelting; Paints, Finishes, Adhesives; Food and Food Production; Herbicides and Pesticides; Pharmaceuticals; | Ingestion; Inhalation; Dermal; | Skin; Lung; Stomach; Liver; Bladder; Kidney; Lymphatic; Hematopoietic; | Processing; Manufacturing; Farming/ Agriculture; Mining | Food/ Food Additives; Art/ Office Supplies; Landscape/ Yard; Drinking Water; Smoking and Tobacco; Environmental Releases | |
| Asbestos | Metals and Electronics; Cosmetics; Plastics and Rubber; Concrete and Construction; Paints, Finishes, Adhesives; Laboratory Supplies; Textiles; | Ingestion; Inhalation; | Lung; Mesothelioma; Larynx; | Vehicle; Construction/ Building; Home Maintenance; Manufacturing | Vehicle; Personal Care; Electronics/ Small Appliances; Home Maintenance; Art/ Office Supplies | |
| Beryllium Carbonate Hydroxide (3/2/2) | Metals and Electronics; Mining and Smelting; | Inhalation; Dermal; | Lung; | Processing; Manufacturing; Mining | NA | |
| Beryllium Chloride | Mining and Smelting; Metals and Electronics; | Inhalation; Dermal; | Lung; | Processing | NA | |
| Beryllium Hydroxide | Metals and Electronics; Mining and Smelting; | Inhalation; Dermal; | Lung; | Processing | NA | |
| Beryllium Oxide (Beo) | Metals and Electronics; Military; Glass and Ceramics; Plastics and Rubber; Laboratory Supplies; Mining and Smelting; Paints, Finishes, Adhesives; | Inhalation; Dermal; | Lung; | Manufacturing; Processing; Mining; Electronics/ Small Appliances; Construction/ Building | NA | |
| Beryllium Sulfate | Glass and Ceramics; Metals and Electronics; Mining and Smelting; | Inhalation; Dermal; | Lung; | Manufacturing; Processing; Mining; Electronics/ Small Appliances; Construction/ Building | Art/ Office Supplies; Environmental Releases; Drinking Water | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| C.i. Direct Black 38 | Inks and Dyes; Textiles; Leather Tanning and Processing; Paper and Pulp Processing; Wood and Lumber; Laboratory Supplies; Plastics and Rubber; | Inhalation; Dermal; Ingestion; | Bladder; | Personal Care; Processing; Art/ Office Supplies; Manufacturing | Personal Care; Art/ Office Supplies; Environmental Releases | |
| C.i. Direct Blue 6 | Inks and Dyes; Textiles; Leather Tanning and Processing; Paper and Pulp Processing; Wood and Lumber; Laboratory Supplies; Plastics and Rubber; | Inhalation; Dermal; Ingestion; | Bladder; | Personal Care; Processing; Art/ Office Supplies; Manufacturing | Personal Care; Art/ Office Supplies; Environmental Releases | |
| C.i. Direct Brown 95 | Inks and Dyes; Textiles; Leather Tanning and Processing; Paper and Pulp Processing; Wood and Lumber; Laboratory Supplies; Plastics and Rubber; | Inhalation; Dermal; Ingestion; | Bladder; | Personal Care; Processing; Art/ Office Supplies; Manufacturing | Personal Care; Art/ Office Supplies; Environmental Releases | |
| Cadmium Chloride | Herbicides and Pesticides; Textiles; Glass and Ceramics; Metals and Electronics; Plastics and Rubber; | Ingestion; Inhalation;; | Lungs; Prostate; Kidney; | Farming/ Agriculture; Processing | Art/ Office Supplies; Drinking Water; Food/ Food Additives | |
| Calcium Arsenate | Herbicides and Pesticides; Disinfectants; | Inhalation; Dermal; Ingestion; | Lung; Skin; Lymphatic; | Farming/ Agriculture; Manufacturing; Processing | Drinking Water; Environmental Releases | |
| Calcium Monochromate | Metals and Electronics; Paints, Finishes, Adhesives; | Inhalation; Ingestion; Dermal; | Lung; Sinus/Nasal; | Manufacturing; Processing; Home Maintenance | Electronics/ Small Appliances; Drinking Water; Home Maintenance; Environmental Releases | |
| Chloromethyl Methyl Ether | Food and Food Production; Laboratory Supplies; Paints, Finishes, Adhesives; Metals and Electronics; | Inhalation; Dermal; | Lung; | Manufacturing; Processing | Environmental Releases | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Chromium Lead Oxide | Metals and Electronics; Paints, Finishes, Adhesives; Inks and Dyes; Plastics and Rubber; Paper and Pulp Processing; Glass and Ceramics; Textiles; | Inhalation; Ingestion; | Lung; Sinus/Nasal; | Home Maintenance; Manufacturing; Processing; Construction/ Building | Home Maintenance; Food/ Food Additives | |
| Chromium Trioxide | Wood and Lumber; Metals and Electronics; Paints, Finishes, Adhesives; Pharmaceuticals; | Inhalation; Dermal; Ingestion; | Lung; Sinus/Nasal; | Processing; Construction/ Building; Home Maintenance; Vehicle; Manufacturing | Home Maintenance | |
| Chrysotile | Concrete and Construction; Food and Food Production; Mining and Smelting; Metals and Electronics; Paints, Finishes, Adhesives; Paper and Pulp Processing; Plastics and Rubber; Laboratory Supplies; | Inhalation; | Lung; | Vehicle; Construction/ Building; Mining; Processing; Home Maintenance; Manufacturing; Processing | Vehicle; Personal Care; Electronics/ Small Appliances; Home Maintenance; Art/ Office Supplies; Drinking Water; Medical/ Dental | |
| Cristobalite | Pharmaceuticals; Food and Food Production; Metals and Electronics; Mining and Smelting; Glass and Ceramics; Plastics and Rubber; Paints, Finishes, Adhesives; Cosmetics; Wood and Lumber; Paper and Pulp Processing; Disinfectants; Herbicides and Pesticides; Concrete and Construction; Petroleum, Oil, Biofuels; | Inhalation; | Lung; | Mining; Construction/ Building; Farming/ Agriculture; Processing; Manufacturing; Medical/ Dental | Home Maintenance; Environmental Releases; Personal Care; Food/ Food Additives; Art/ Office Supplies; Smoking and Tobacco; Medical/ Dental | |
| Cyclophosphamide | Pharmaceuticals; | Ingestion; Injection; Dermal; Inhalation; | Bladder; Leukemia; | Manufacturing; Processing | Medical/ Dental | |
| Cyclosporin A | Pharmaceuticals; | Ingestion; Injection; Dermal; Inhalation; | Lymphoma; Skin; | Manufacturing; Processing | Medical/ Dental; Pet Care | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Estrone | Pharmaceuticals; Cosmetics; Food and Food Production; | Ingestion; Dermal; | Uterus; Breast; | NA | Personal Care; Medical/ Dental; Food/ Food Additives | |
| Lead Arsenate | Metals and Electronics; Herbicides and Pesticides; | Inhalation; Ingestion; Dermal; | Lung; Skin; Liver; Kidney; Bladder; | Farming/ Agriculture; Manufacturing; Pet Care | Drinking Water; Environmental Releases; Processing; Smoking and Tobacco | |
| Mestranol | Pharmaceuticals; | ; | ; | NA | Medical/ Dental | |
| Mineral Oil - Includes Paraffin Oil | Petroleum, Oil, Biofuels; Herbicides and Pesticides; Plastics and Rubber; Metals and Electronics; Inks and Dyes; Cosmetics; Disinfectants; Pharmaceuticals; Textiles; Paints, Finishes, Adhesives; Solvents; Food and Food Production; | Dermal; Ingestion; | Skin; Testicular/Scrotal; Gastrointestinal; Rectal; Bladder; | Farming/ Agriculture; Art/ Office Supplies; Manufacturing; Processing | Cleaning Products; Art/ Office Supplies; Personal Care; Medical/ Dental; Food/ Food Additives | |
| Nickel (Ii) Oxide | Metals and Electronics; Glass and Ceramics; Paints, Finishes, Adhesives; Mining and Smelting; Laboratory Supplies; | Inhalation; | Lung; Sinus/Nasal; | Vehicle; Art/ Office Supplies; Manufacturing; Processing; Mining | Art/ Office Supplies | |
| Nickel Hydroxide (Ni(Oh)2) | Metals and Electronics; Mining and Smelting; Plastics and Rubber; | Inhalation; Ingestion; Dermal; | Lung; Sinus/Nasal; | Electronics/ Small Appliances; Processing | NA | |
| Nickel Subsulfide | Metals and Electronics; Mining and Smelting; Petroleum, Oil, Biofuels; | Inhalation; Ingestion; Dermal; | Lung; Sinus/Nasal; | Electronics/ Small Appliances; Processing | NA | |
| Nickel Sulfate | Metals and Electronics; Mining and Smelting; Inks and Dyes; Glass and Ceramics; Textiles; | Inhalation; Ingestion; Dermal; | Lung; Sinus/Nasal; | Electronics/ Small Appliances; Manufacturing; Processing | Cleaning Products; Drinking Water | |
| Nickel Sulfide | Petroleum, Oil, Biofuels; Metals and Electronics; | Inhalation; | Lung; Sinus/Nasal; | Processing | NA | |
| Nickel(Ii) Acetate | Textiles; | Inhalation; | Lung; Sinus/Nasal; | Manufacturing | NA | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Potassium Arsenite Anhydrous | Glass and Ceramics; Metals and Electronics; Herbicides and Pesticides; Wood and Lumber; Laboratory Supplies; Pharmaceuticals; | Inhalation; Ingestion; Dermal; | Skin; Lung; Stomach; Liver; Bladder; Kidney; Lymphatic; Hematopoietic; | Pet Care; Manufacturing; Processing; Farming/ Agriculture | Medical/ Dental | |
| Potassium Chromate(Vi) | Leather Tanning and Processing; Paints, Finishes, Adhesives; Textiles; Metals and Electronics; Laboratory Supplies; | Inhalation; Ingestion; Dermal; | Lung; Sinus/Nasal; | Manufacturing; Processing | Art/ Office Supplies | |
| Potassium Dichromate | Pharmaceuticals; Textiles; Leather Tanning and Processing; Paints, Finishes, Adhesives; Wood and Lumber; Metals and Electronics; Disinfectants; Food and Food Production; | Ingestion; Inhalation; Dermal; | Lung; Sinus/Nasal; | Processing; Manufacturing | Personal Care; Art/ Office Supplies; Cleaning Products; Home Maintenance; Food/ Food Additives | |
| Premarin | Pharmaceuticals; | Ingestion; | Uterus; Breast; | NA | Medical/ Dental | |
| Riebeckite | Concrete and Construction; Plastics and Rubber; Mining; Paints, Finishes, Adhesives; | Inhalation; Dermal; Ingestion; | Lung; | Construction/ Building; Home Maintenance; Manufacturing; Processing; Mining | Food/ Food Additives; Smoking and Tobacco; Home Maintenance | |
| Sodium Arsenate | Herbicides and Pesticides; Glass and Ceramics; Textiles; Cosmetics; Pharmaceuticals; | Inhalation; Dermal; Ingestion; | Bladder; Lung; Liver; Kidney; Skin; | Processing; Manufacturing; Pet Care | Personal Care | |
| Sodium Arsenite | Herbicides and Pesticides; Leather Tanning and Processing; Disinfectants; Pharmaceuticals; Inks and Dyes; Laboratory Supplies; Wood and Lumber; Textiles; | Ingestion; Inhalation; Dermal; | Bladder; Lung; Liver; Kidney; Skin; | Pet Care; Processing; Manufacturing; Farming/ Agriculture; Art/ Office Supplies | Art/ Office Supplies | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Sodium Chromate | Leather Tanning and Processing; Textiles; Inks and Dyes; Wood and Lumber; Herbicides and Pesticides; Laboratory Supplies; Petroleum, Oil, Biofuels; Paints, Finishes, Adhesives; | Dermal; Inhalation; Ingestion; | Lung; Sinus/Nasal; | Manufacturing; Processing; Medical/ Dental | Electronics/ Small Appliances; Home Maintenance; Environmental Releases; Food/ Food Additives | |
| Sodium Dichromate | Metals and Electronics; Wood and Lumber; Inks and Dyes; Waste Incineration and Treatment; Disinfectants; Herbicides and Pesticides; Glass and Ceramics; Food and Food Production; Textiles; Petroleum, Oil, Biofuels; | Dermal; Inhalation; Ingestion; | Lung; Sinus/Nasal; | Processing; Manufacturing; Home Maintenance | Cleaning Products; Home Maintenance; Food/ Food Additives; Drinking Water | |
| Strontium Chromate | Metals and Electronics; Plastics and Rubber; Leather Tanning and Processing; Paints, Finishes, Adhesives; | Inhalation; Dermal; | Lung; Sinus/Nasal; | Manufacturing; Processing; Home Maintenance | Home Maintenance | |
| Sulfuric Acid | Food and Food Production; Metals and Electronics; Paper and Pulp Processing; Leather Tanning and Processing; Textiles; Herbicides and Pesticides; Mining and Smelting; Glass and Ceramics; Inks and Dyes; Cosmetics; Pharmaceuticals; Plastics and Rubber; Waste Incineration and Treatment; Wood and Lumber; Paints, Finishes, Adhesives; Petroleum, Oil, Biofuels; | Inhalation; Ingestion; Dermal; | Larynx; Lung; Sinus/Nasal; | Art/ Office Supplies; Manufacturing; Processing; Mining; Farming/ Agriculture; Cleaning Products | Art/ Office Supplies; Electronics/ Small Appliances; Home Maintenance; Landscape/ Yard; Personal Care; Pet Care; Environmental Releases; Cleaning Products; Sports Equipment; Vehicle; Food/ Food Additives; Drinking Water | |

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**Table B1:** Exposure pathways and cancer types for known carcinogens

| Chemical | Major Prod. Categories | Exp. route | Associated cancers | Occupational exposure | General exposure | NHANES data |
|---|---|---|---|---|---|---|
| Thorium(Iv) Oxide | Pharmaceuticals; Glass and Ceramics; Nuclear; Mining; Metals and Electronics; Laboratory Supplies; | Inhalation; Injection; Ingestion; Dermal; | Liver; Leukemia; Bone; Bile Duct; Pancreatic; | Manufacturing; Processing; Medical/ Dental; Research; Pet Care; Mining | Medical/ Dental; Environmental Releases | |
| Tremolite Asbestos | Glass and Ceramics; Paints, Finishes, Adhesives; Cosmetics; Mining and Smelting; Metals and Electronics; Waste Incineration and Treatment; | Inhalation; | Lung; | Construction/ Building; Manufacturing; Processing; Mining | Construction/ Building; Personal Care; Environmental Releases; Drinking Water | |
| Tridymite | Pharmaceuticals; Food and Food Production; Metals and Electronics; Mining and Smelting; Glass and Ceramics; Plastics and Rubber; Paints, Finishes, Adhesives; Cosmetics; Wood and Lumber; Paper and Pulp Processing; Disinfectants; Herbicides and Pesticides; Concrete and Construction; Petroleum, Oil, Biofuels; | Inhalation; | Lung; | Mining; Construction/ Building; Farming/ Agriculture; Processing; Manufacturing; Medical/ Dental | Home Maintenance; Environmental Releases; Personal Care; Food/ Food Additives; Art/ Office Supplies; Smoking and Tobacco; Medical/ Dental | |
| Zinc Chromate | Paints, Finishes, Adhesives; Inks and Dyes; Leather Tanning and Processing; Food and Food Production; Metals and Electronics; | Inhalation; Ingestion; Dermal; | Lung; Sinus/Nasal; | Manufacturing; Processing | Food/ Food Additives | |
| Bis(Chloromethyl) Ether | Textiles; Plastics and Rubber; Laboratory Supplies; | ; | Lung; | Manufacturing; Processing | NA | |

**Notes:** Compiled exposure source and type, product category, and associate cancer type information for the complete list of 112 known carcinogens. See Section 2.4 and Section 3.4 for description of exposure pathway information collection and product categorization methods.

# C Information on data construction and exposure literature review

## Additional details of NHANES data processing and analysis

This analysis primarily relied on a merged and harmonized version of the continuous NHANES data; we analyzed examination-level biomonitoring samples drawn cross-sections of individuals between 2003-2004 and 2017-2018 (Nguyen et al., 2023). We examined blood, serum, and urine biomarkers only for chemicals that were on the ubiquitous carcinogen list. We followed best practices in the use of NHANES: examination or subsample survey weights were used to account for NHANES' sampling design (Nguyen et al., 2023; CDC, 2020), efforts were taken to ensure metabolites of carcinogens were correctly assigned to the parent chemical (Stanfield et al., 2024), and the analysis followed the CDC's convention of not reporting geometric mean estimates for stratification subgroups with 40% of test results below the reported limit of detection (CDC, 2024). For subgroups with sufficient detected observations, we imputed a value of $\frac{LOD}{\sqrt{2}}$ for samples below the detection limit when reporting geometric mean values. This is a common approximation method of censored values below the detection threshold for screening work. For carcinogens studied in multiple NHANES cycles, statistics were calculated based on only the most recent cycle of data. The most recent cycle varied by chemical: the earliest cycle considered in this analysis was from 2003-2004 and the latest was from 2017-2018.

There were some instances in which multiple biomarker media or measurement variations were available for a given chemical or metabolite. We made the following set of selected choices. We relied on lipid-adjusted statistics for the following chemicals: heptachlor epoxide, Dieldrin, and p,p'-DDE. We relied on statistics from blood rather than urine concentrations for the following metals that were tested in both media: lead, cadmium, cobalt. We calculated urine concentration statistics for total and speciated arsenic chemicals, which tend to be less detectable. Biomonitoring results listed as "Arsenic" refer to total arsenic throughout the analysis. We calculated statistics based on total PFOS and PFOA concentrations rather than separately analyzing the branched and linear isomers. Total chromium levels in blood and urine are available in the NHANES microdata; because only hexavalent chromium is on our carcinogen list and cannot be differentiated from trivalent chromium via existing biomonitoring, we elected not to present results for total chromium.

Demographic variables used in the analysis of individual-level biomonitoring data include race/ethnicity, age, sex, and household income. We relied on the "RIDRETH1" race and ethnicity recode variable throughout our analysis. This decision resulted in uniform categories across the different NHANES cycle, but limited our racial/ethnic groups to Hispanic, non-Hispanic Black, non-Hispanic White, and Other.[1] A decomposition of the Other category that differentiates non-Hispanic Asian respondents was available from the 2011-2012 cycle onwards using the "RIDRETH3" variable, but to maintain within-analysis consistency across the dozens of chemicals assessed, we solely relied on the more limited racial/ethnic sub-groupings. As our measurement for household income, we relied on the "INDFMPIR" variable, which is an index for the ratio of family income to poverty. Using this variable, we categorized surveyed individuals as below 2x the poverty line or above 2x the poverty line. The small set of individuals for which this variable was missing were dropped from our analysis. We coded individual's age and sex based on the variables "RIDAGEYR" and "RIAGENDR". Remaining statistical details of GM and P95 concentration ratios are in the main text.

[1] Prior to 2007-2008, NHANES oversampled for Mexican Americans only (versus all Hispanic people), so the small number of estimates based on data from pre-2007 are representative of Mexican Americans rather than Hispanics.

For a subset of biomonitored chemicals – namely, organochloride pesticides, dioxins/furans, PCBs, and brominated flame retardants – the most recent NHANES samples available are pooled. In those cases, we directly acquired and relied on the original, unharmonized NHANES microdata from the 2011-2012 and 2015-2016 cycles (CDC, 2020). Due to the pooled nature of these biomonitoring data and their sampling design, we could only assess arithmetic means and create differentiated statistics by race/ethnicity, sex, and age (CDC, 2021a). As before, we followed the CDC's convention of not reporting mean estimates for stratification subgroups with 40% of test results below the reported limit of detection. Because all pooled samples were from cycles in 2011-2012 or later, we relied on the "RIDRETH3" race/ethnicity indicator. Thus, pooled biomonitoring results in the paper were presented with separate non-Hispanic Asian and Other groupings. We used these estimates from the pooled data to calculate arithmetic mean ratios ($AMR$s) analogous to the geometric mean ratio described in the main text, again using the entire national population as the reference group.

## Additional details of DW sample processing, national representativeness

Despite rigorous quality assurance and quality control assessments that were conducted prior to publishing the SYR and UCMR drinking water sampling data, their analytical use comes with complexities (US Environmental Protection Agency, 2016a, 2022a). These are largely related to missing detection limits, inconsistencies in state-reported concentration units for sampling and detection limits, and heterogeneity in the types of samples drawn by community water systems. Our processing of SYR data followed much of Ravalli et al. (2022), with details described as follows:

1. We first removed all unfinished and raw drinking water samples.
2. For samples flagged as non-detects that are typically reported in $\mu$g/L, all reported limits of detection (LOD) were standardized to $\mu$g/L. For samples flagged as non-detects that are typically reported in mg/L, all reported limits of detection (LOD) were standardized to mg/L. The exception is asbestos which is measured in fibers (mf/L).
3. The modal LOD was calculated for each chemical sampled. Any non-detect sample with a reported LOD four orders of magnitude or smaller ($10^{-4}$) than the modal LOD were imputed with the modal LOD due to likely reporting errors from the state or CWS. Modal LODs for each SYR chemical are reported below in Table C1.
4. Samples without a reported LOD were imputed with the modal LOD for the chemical.
5. Using the reported or imputed LOD as described above, all non-detect samples were assigned sample concentration values equal to $\frac{LOD}{\sqrt{2}}$.

Our processing of UCMR data was similar in nature, though less complex. By design, UCMR2 through UCMR4 samples were drawn from finished water only. An EPA-established, chemical-specific Minimum Reporting Level (MRL) was provided for all non-detected samples; using this MRL, we imputed sample concentration values equal to $\frac{MRL}{\sqrt{2}}$ for all non-detects.[2]

[2]UCMR data can be considered a census of large systems, but they do not fully represent water quality at small systems. While the vast majority of the US population is served by large systems, we acknowledge that our statistics may somewhat under-represent smaller systems.

Next, we combined samples across monitoring regimes. Only the most recent round of monitoring samples for a given chemical was included in our final data: if a chemical was monitored in SYR4, we dropped any samples of it that were taken during SYR3. Similarly, if a chemical was monitored in UCMR4, we dropped any samples of it that were taken during UCMR2 or UCMR3.

We then followed Ravalli et al. (2022) and restricted our main analyses to only chemicals with more than 10% of samples above the LOD/MRL. In the absence of this restriction, any statistics generated could lend a sense of false precision. By requiring a 10% sample detection threshold, we generated statistics built from observed signals in the data rather than a reliance on distributional assumptions below censoring thresholds.[3]. Fifteen of the 70 original chemicals met the detection requirement, and we proceeded using this subsample.

For each CWS and retained chemical, we calculated an average carcinogen concentration based on all of the system's collected samples from 2006-2020. We used customer demographics information for each CWS as calculated by Austin et al. (2024) using the EPA-ORD water system boundaries described in the paper. These included a count of the population served by the CWS, the fraction of constituents of each race/ethnicity, the fraction with household income below the poverty line and the fraction with household income below twice the poverty line, all as of 2022. With this information, we calculated population-weighted average carcinogen concentrations in drinking water ($DW^*_{cs}$) for each demographic subgroup:

$$DW^*_{cs} = \sum_J \frac{DW_{jc} Pop_{js}}{Pop_s}$$

where $J$ indexes the complete set of CWSs for which a given carcinogen has sampling data, $DW_{jc}$ is the average concentration level of carcinogen $c$ in the drinking water of CWS $j$, $Pop_{js}$ is the population count of demographic subgroup $s$ in CWS $j$, and $Pop_s$ is the national population count of subgroup $s$ across CWSs for which a carcinogen has data.[4]

With these average drinking water concentrations for each subgroup and carcinogen, we calculated carcinogen-specific relative concentration ratios for each racial/ethnic or household income subgroup as in Equation 1, again with the national average concentration for the carcinogen acting as a reference value. These relative concentration ratios served as our measure of differences in exposure via drinking water.

Table C1 below provides summary measures to help illustrate the processing description above. Column (2) describes the percentage of a chemical's samples with a detectable concentration. Column (3) shows the number of CWSs that reported any sample of the chemical. Column (4) shows the 2022 population count for the set of CWSs that reported sampling the chemical. Column (5) describes the percentage of CWSs for which at least 10% of samples had detectable concentrations. Column (6) shares the chemical's modal reported limit of detection. Column (7) shares the chemical's unit of measurement. Column (8) shows the data source from which samples were drawn for each chemical.

[3]Our selected 10% threshold is not fully immune from this concern; as such we caveated our results in the limitations section of the main paper. Future research could examine correlations between sociodemographic characteristics of a community and the LODs/RLs used by the CWS serving them, with an eye to understanding how such correlations could affect subgroup-specific drinking water exposure metrics

[4]A reviewer pointed out that much of the meaningful historic variation in disinfection byproduct (DBP) exposure occurred within a given distribution system, and thus certain subpopulations may be differentially affected even though the system-wide average of DBP concentrations does not deviate from national norms. These within-system deviations have dampened over time, and therefore our reliance on the most recent possible vintage of SYR data may somewhat mitigate this concern. But this fact nonetheless should be kept in mind while interpreting results for DBPs.

**Table C1:** Drinking water data: underlying data info and representativeness

| (1) Chemical | (2) % Detect | (3) PWS count | (4) Pop. Count | (5) % PWS Det. | (6) Modal DL | (7) DL Unit | (8) Source |
|---|---|---|---|---|---|---|---|
| HAA5* | 100.00 | 4,751 | 254,581,887 | 100.00 | | ug/L | UCMR4 |
| HAA6BR* | 100.00 | 4,751 | 254,581,887 | 100.00 | | ug/L | UCMR4 |
| HAA9* | 100.00 | 4,751 | 254,581,887 | 100.00 | | ug/L | UCMR4 |
| DICHLOROACETIC ACID* | 78.09 | 28,112 | 210,841,018 | 68.42 | 1 | ug/L | SYR4 |
| DICHLOROMONOBROMOMETHANE* | 75.75 | 31,728 | 223,654,395 | 72.54 | 1 | ug/L | SYR4 |
| CHROMIUM-6* | 75.61 | 4,659 | 253,306,908 | 88.35 | 0.03 | ug/L | UCMR3 |
| TRICHLOROMETHANE* | 75.04 | 31,763 | 223,711,184 | 72.46 | 1 | ug/L | SYR4 |
| TRICHLOROACETIC ACID* | 70.47 | 28,105 | 210,161,481 | 58.68 | 1 | ug/L | SYR4 |
| ARSENIC* | 44.97 | 27,858 | 216,001,168 | 38.26 | 0.002 | mg/L | SYR3 |
| DIBROMOACETIC ACID* | 41.21 | 28,106 | 210,775,662 | 53.49 | 1 | ug/L | SYR4 |
| TRIBROMOMETHANE* | 33.13 | 31,703 | 223,399,206 | 46.09 | 1 | ug/L | SYR4 |
| BROMATE* | 22.97 | 256 | 32,153,441 | 35.94 | 5 | ug/L | SYR4 |
| MICROCYSTIN-LR* | 20.00 | 5 | 88,293 | 20.00 | 0.02 | ug/L | UCMR4 |
| 1,4-DIOXANE* | 11.71 | 4,655 | 253,224,006 | 20.21 | 0.07 | ug/L | UCMR3 |
| NDMA* | 10.94 | 1,042 | 142,332,591 | 24.28 | 0.002 | ug/L | UCMR2 |
| TRICHLOROETHYLENE | 6.41 | 28,837 | 213,565,611 | 1.15 | 0.5 | ug/L | SYR3 |
| TETRACHLOROETHYLENE | 6.09 | 28,838 | 213,585,357 | 1.56 | 0.5 | ug/L | SYR3 |
| BIS(2-ETHYLHEXYL) PHTHALATE | 4.19 | 19,146 | 167,952,482 | 7.72 | 0.6 | ug/L | SYR3 |
| 1,2-DIBROMO-3-CHLOROPROPANE | 3.26 | 20,328 | 173,545,539 | 0.48 | 0.02 | ug/L | SYR3 |
| ASBESTOS | 2.95 | 3,132 | 69,737,620 | 2.91 | 0.2 | mf/L | SYR3 |
| 1,1-DICHLOROETHANE | 2.33 | 4,656 | 253,242,431 | 3.57 | 0.03 | ug/L | UCMR3 |
| 1,1-DICHLOROETHYLENE | 1.57 | 28,829 | 213,328,575 | 0.36 | 0.5 | ug/L | SYR3 |
| CADMIUM | 1.51 | 25,781 | 201,881,945 | 3.29 | 0.001 | mg/L | SYR3 |
| COBALT | 1.35 | 4,660 | 253,354,223 | 3.05 | 1 | ug/L | UCMR3 |
| ETHYLBENZENE | 1.09 | 28,844 | 213,292,583 | 2.90 | 0.5 | ug/L | SYR3 |
| PFOA | 1.07 | 4,660 | 253,354,223 | 2.02 | 0.02 | ug/L | UCMR3 |
| BERYLLIUM, TOTAL | 0.99 | 25,563 | 201,078,820 | 1.89 | 0.001 | mg/L | SYR3 |
| 4-ANDROSTENE-3,17-DIONE | 0.83 | 1,082 | 154,022,064 | 5.36 | 0.0003 | ug/L | UCMR3 |
| PFOS | 0.77 | 4,660 | 253,354,223 | 1.46 | 0.04 | ug/L | UCMR3 |
| CARBON TETRACHLORIDE | 0.76 | 28,833 | 213,405,463 | 0.80 | 0.5 | ug/L | SYR3 |
| 1,2,3-TRICHLOROPROPANE | 0.70 | 4,656 | 253,242,431 | 0.88 | 0.03 | ug/L | UCMR3 |
| TESTOSTERONE | 0.56 | 1,082 | 154,022,064 | 3.33 | 0.0001 | ug/L | UCMR3 |
| METHYLENE CHLORIDE | 0.54 | 28,826 | 213,218,763 | 1.27 | 0.5 | ug/L | SYR3 |
| 1,1,1-TRICHLOROETHANE | 0.46 | 28,828 | 213,238,681 | 0.40 | 0.5 | ug/L | SYR3 |
| 1,2-DICHLOROETHANE | 0.43 | 28,828 | 213,275,283 | 0.36 | 0.5 | ug/L | SYR3 |
| HEPTACHLOR EPOXIDE | 0.37 | 21,276 | 174,134,820 | 0.24 | 0.02 | ug/L | SYR3 |
| 1,2-DIBROMOMETHANE | 0.35 | 21,043 | 173,763,025 | 0.30 | 0.01 | ug/L | SYR3 |
| O-TOLUIDINE | 0.32 | 4,823 | 255,422,296 | 0.95 | 0.007 | ug/L | UCMR4 |
| 1,2-DICHLOROPROPANE | 0.31 | 28,827 | 213,230,545 | 0.29 | 0.5 | ug/L | SYR3 |
| QUINOLINE | 0.31 | 4,823 | 255,422,296 | 1.16 | 0.02 | ug/L | UCMR4 |
| BENZENE | 0.30 | 28,829 | 213,305,081 | 0.46 | 0.5 | ug/L | SYR3 |
| NDEA | 0.27 | 1,042 | 142,332,591 | 0.58 | 0.005 | ug/L | UCMR2 |
| NPYR | 0.25 | 1,042 | 142,332,591 | 1.44 | 0.002 | ug/L | UCMR2 |
| 2,4-D | 0.23 | 20,227 | 176,364,002 | 0.37 | 0.1 | ug/L | SYR3 |
| P-DICHLOROBENZENE | 0.20 | 28,829 | 212,919,949 | 0.54 | 0.5 | ug/L | SYR3 |
| VINYL CHLORIDE | 0.20 | 28,484 | 212,298,096 | 0.32 | 0.5 | ug/L | SYR3 |
| PAHs | 0.12 | 19,647 | 170,136,287 | 0.19 | 0.1 | ug/L | SYR3 |
| CHLORDANE | 0.11 | 20,103 | 169,740,088 | 0.10 | 0.2 | ug/L | SYR3 |
| STYRENE | 0.11 | 28,823 | 213,223,684 | 0.39 | 0.5 | ug/L | SYR3 |
| ALACHOR | 0.08 | 23,244 | 187,744,943 | 0.12 | 0.2 | ug/L | SYR3 |
| ALPHA-HEXACHLOROCYCLOHEXANE | 0.07 | 4,821 | 255,433,030 | 0.37 | 0.01 | ug/L | UCMR4 |
| BHC-GAMMA | 0.07 | 21,517 | 176,036,138 | 0.07 | 0.02 | ug/L | SYR3 |
| HEPTACHLOR | 0.06 | 21,309 | 174,230,503 | 0.08 | 0.04 | ug/L | SYR3 |
| NDBA | 0.05 | 1,042 | 142,332,591 | 0.00 | 0.004 | ug/L | UCMR2 |
| TOXAPHENE | 0.05 | 20,665 | 172,289,075 | 0.07 | 1 | ug/L | SYR3 |
| 1,1,2-TRICHLOROETHANE | 0.04 | 28,826 | 213,228,594 | 0.13 | 0.5 | ug/L | SYR3 |

Continued, next page...

**Table C1:** Drinking water data: underlying data info and representativeness

| (1) Chemical | (2) % Detect | (3) PWS count | (4) Pop. Count | (5) % PWS Det. | (6) Modal DL | (7) DL Unit | (8) Source |
|---|---|---|---|---|---|---|---|
| 17-ALPHA-ETHYNYLESTRADIOL | 0.04 | 1,082 | 154,022,064 | 0.18 | 0.0009 | ug/L | UCMR3 |
| 2,3,7,8-TCDD | 0.04 | 1,726 | 51,384,238 | 0.17 | 0.000005 | ug/L | SYR3 |
| DECACHLOROBIPHENYL | 0.04 | 11,602 | 115,238,214 | 0.12 | 0.1 | ug/L | SYR3 |
| 17-BETA-ESTRADIOL | 0.03 | 1,082 | 154,022,064 | 0.00 | 0.0004 | ug/L | UCMR3 |
| GLYPHOSATE | 0.03 | 9,483 | 109,125,633 | 0.12 | 6 | ug/L | SYR3 |
| HEXACHLOROBENZENE | 0.03 | 21,251 | 173,474,370 | 0.08 | 0.1 | ug/L | SYR3 |
| NMEA | 0.02 | 1,042 | 142,332,591 | 0.29 | 0.003 | ug/L | UCMR2 |
| ETHOPROP | 0.01 | 4,821 | 255,433,030 | 0.06 | 0.03 | ug/L | UCMR4 |
| TRIBUFOS | 0.01 | 4,820 | 255,408,264 | 0.04 | 0.07 | ug/L | UCMR4 |
| 1,3-BUTADIENE | 0.00 | 4,656 | 253,242,431 | 0.00 | 0.1 | ug/L | UCMR3 |
| ACETOCHLOR | 0.00 | 1,042 | 142,332,591 | 0.00 | 2 | ug/L | UCMR2 |
| ESTRONE | 0.00 | 1,082 | 154,022,064 | 0.00 | 0.002 | ug/L | UCMR3 |
| NDPA | 0.00 | 1,042 | 142,332,591 | 0.00 | 0.007 | ug/L | UCMR2 |
| TNT | 0.00 | 3,794 | 216,424,871 | 0.00 | 0.8 | ug/L | UCMR2 |

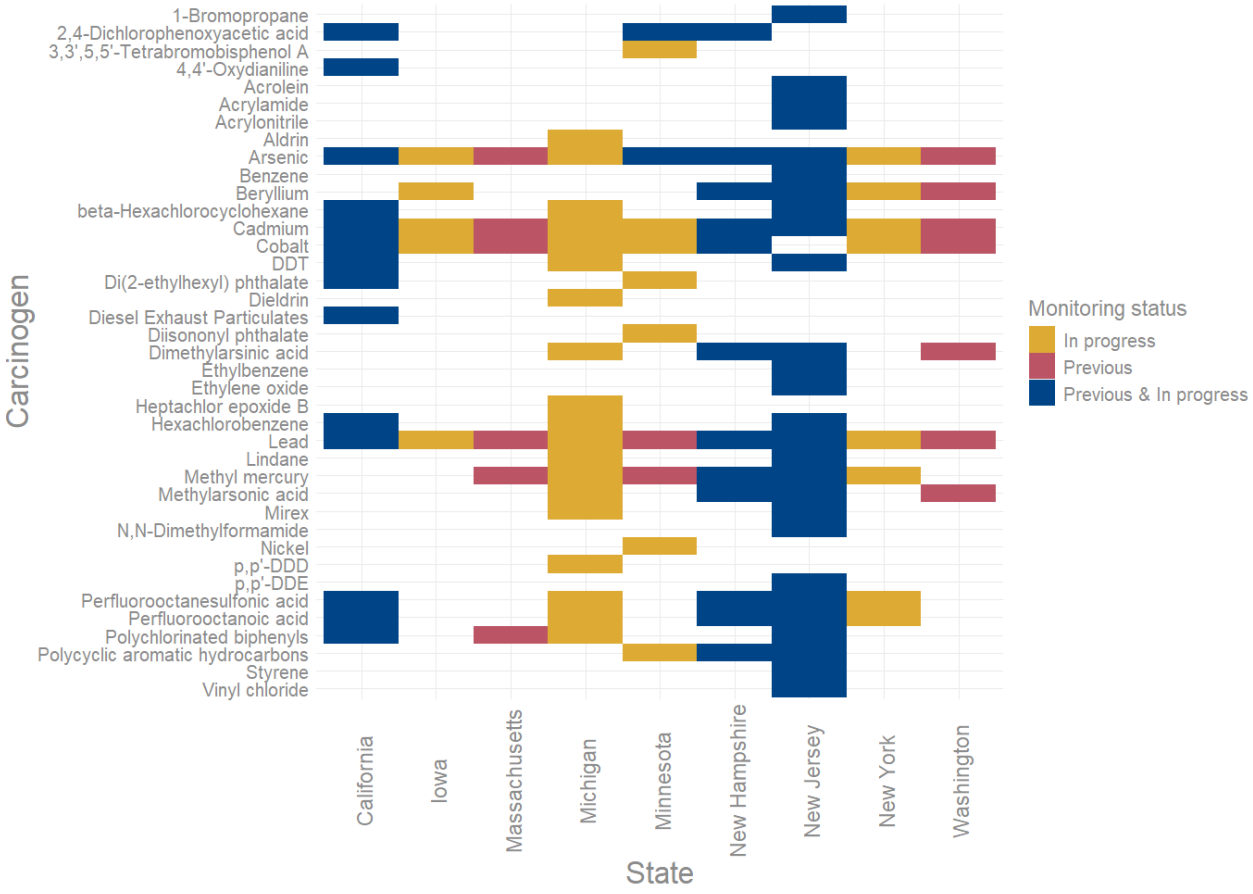
**Return to:** Section 2.2.3. Section 3.2.2.

# D Summary of carcinogen biomonitoring by states[5]

Several US states possess their own biomonitoring programs. Many of these programs were started and have continued operations using money from competitive CDC state biomonitoring grants. Together, these states form the core of the National Biomonitoring Network, a collaborative effort consisting of federal, state, and local laboratories that aim to ensure quality laboratory practices, helping produce comparable biomonitoring data across levels of government (Latshaw et al. (2017), Nassif et al. (2021)).

In scoping available biomonitoring data for the paper's main analysis, we contacted nine states. The following appendix summarizes information collected in early 2024 about several states' individual biomonitoring efforts, including the extent to which carcinogens are or were being monitored, and any available summary exposure statistics stratified by demographic subgroups. Figure D1 below summarizes findings on surveillance data availability for carcinogens across the states.

**Figure D1:** Carcinogen surveillance data availability by state




Across the states that made information available, 39 carcinogens in total were biomonitored. All of these carcinogens except 4,4'-Oxydianiline, 1-Bromopropane, Aldrin, p,p'-DDD, and TBBPA were monitored in

[5]Several individuals involved in state biomonitoring programs were incredibly generous with their time. We are very grateful to the following individuals for their helpful conversations and, when possible, the provision of data, as this project got off the ground: Nerissa Wu, Kathleen Attfield, Tina Fan, Chang Yu, Melissa Josefiak, Madhumita Chatterjee, Jessica Nelson, Sheila Amenumey, Meg Blanchet, Rachel Long, Rebecca Hunt, Gonza Namulanda, and Robin Dodson.

NHANES at some point from 1988-2018. The modest additional carcinogen coverage from state biomonitoring is logical. States rely on the same laboratory methods used nationally by NHANES and are unlikely to have time and resources dedicated to expanding such capabilities. Additionally, a key justification for state biomonitoring programs is the need to understand how local and regional exposures compare to the national distribution. This requires surveillance of chemicals for which the national exposure distribution is known.

Because of the limited value-add that state level biomonitoring results can contribute relative to NHANES, our analysis relied on the national data alone. Nevertheless, a summary of findings from the aborted scoping exercise follows:

## California

California was one of the earliest state biomonitoring programs to receive a CDC grant (2009), and today is likely the most advanced in terms of capabilities. By law, California has a formal biomonitoring selection process in place to filter down the universe of chemicals into a single designation list of several hundred. From this designation list, a Scientific Guidance Panel recommends prioritization of a subset based on degree of potential exposure, likelihood of a chemical being a carcinogen/toxicant, the limits of laboratory detection, and more. From this priority list, California DPH selects a final group of chemicals for biomonitoring based on laboratory considerations, feasibility, public resources, and special relevance of a chemical to a particular sub-population being studied. In practice, the state typically has resources to monitor less than 100 chemicals.

California has performed a wide variety of biomonitoring projects over the years; some surveilled a statewide population sample while others focused on particular regions, certain demographic or occupational groups, or populations affected by health outcomes of concern. Ensuring biomonitoring for a diverse set of populations is a primary goal of CA DPH. In sum, California monitored 113 chemicals over this period. 12 of these chemicals are on the carcinogen list.

Of these studies, the California Regional Exposure (CARE) Study and Biomonitoring Exposures Study (BEST) provide the best coverage of chemicals and populations more representative of regions or the entire state. The expanded wave of BEST is now complete, but CA DPH does not have weighted and demographically-stratified summary statistics on hand at this time. CA DPH was able to share a new public report including demographically-stratified carcinogen summary statistics for CARE-LA (LA County) and CARE-2 (Riverside, San Bernardino, Imperial, Mono, and Inyo Counties) which were conducted from 2018-2020.

## Washington

In 2010-2011, Washington state conducted a state-level biomonitoring program. Urine samples were obtained from a representative sample of households across the state and paired with a household questionnaire used to determine demographics. The Washington Tracking Network shares the results of this biomonitoring, stratified by demographic variables of interest, on a public dashboard.

The dashboard data were procured, cleaned and standardized. Of the 25 chemical chemicals surveilled in WA, only 7 are on the carcinogen list. Five are metals: arsenic, beryllium, cadmium, cobalt, and lead. The other two are carcinogenic metabolites of arsenic: DMA and MMA.

## New Jersey

New Jersey was awarded CDC grants in 2014 and 2019 for development of its biomonitoring program, NJHANES. During the 2014-2019 grant cycle, statewide surveillance was performed on metals in blood and urine, on PFAS in serum, and on PCBs in serum. Demographic information was also collected during a corresponding household survey.

NJ DOH was unable to immediately provide machine-readable chemical-by-chemical summary statistics stratified by demographics or access to the underlying microdata. They did refer to published and working papers that include results stratified by sex, though these do not include measures varying by race/ethnicity or household income (Du et al. (2020); Yu et al. (2020)).

In addition to these results, NJ DOH kindly provided a complete list of NJHANES analytes for the 2019-2024 project cycle. This list included 122 analytes, including around 20 variations of heavy metals, several polycyclic aromatic hydrocarbons (PAH) metabolites, several VOC metabolites, 12 PFAS and dozens of polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs). Of these 122 analytes, 27 are carcinogens. Five are metals, two are metabolites of arsenic, and the remainder can be classified as PFAS (PFOA and PFOS), PAHs, PCBs, metabolites of VOCs (e.g. 1-Bromopropane, Benzene, Styrene, etc.), and pesticides or their byproducts (DDT, DDE, Mirex, and hexachlorocyclohexanes).

## New Hampshire

New Hampshire was awarded CDC grants in 2014 and 2019 for development of their biomonitoring program, NH TrACE. During the 2014-2019 grant cycle, statewide surveillance was performed on roughly 20 heavy metals, roughly 15 PFAS, and roughly 10 pesticides. Demographic information was also collected during a corresponding household survey. Linked water testing was also conducted for private wells and publicly-sourced water, providing information on household exposure to metals, radiologicals, PFAS, and a large variety of VOCs and pesticides via the drinking water pathway. In sum, these data provide substantial potential for stratified exposure summary statistics by demographics of interest.

NH produced a summary report of findings from this initial cycle in 2019. Unfortunately, this report does not contain any statistics of interest and the underlying raw microdata are not publicly available at the present time. While there is very limited racial and ethnic diversity in NH's population sample, there may be interesting heterogeneity along the household income dimension.

NH has continued NH TrACE during the 2019-2024 award cycle, surveilling 35 of the chemicals studied previously as well as metabolites of polycyclic aromatic hydrocarbons. A summary report on findings is expected late in 2024 and may include demographically-stratified summary statistics. In addition, smaller-scale biomonitoring studies are targeting residents who rely on private well water, Medicaid recipients, and upstate residents located near an EPA Superfund site; these studies will test for a similar set of chemicals.

Of the chemicals monitored during both cycles, only the 11 shown below are on the carcinogen list. These carcinogens consist of five heavy metals, two metabolites of arsenic (DMA and MMA), 2 PFAS, metabolites of PAHs, and a single herbicide (2,4-D).

## Minnesota

Minnesota established a biomonitoring program by state law in 2007. This program has conducted a variety of projects including a study of PFAS exposure in urban adults, a study of arsenic levels in child living in a neighborhood with known soil contamination, plastic and paraben exposure levels for pregnant women in

Minneapolis, and mercury and other heavy metal blood concentrations of newborns in the Twin Cities and Lake Superior region of the state.

Staff at MDoH kindly shared demographically-stratified results from these projects, as available. More specifically, results come from the state's MN FEET study and the 2018 Healthy Rural and Urban Kids pilot project. Of note there is meaningful heterogeneity in exposure to arsenic, methylmercury, lead, and 2,4-D across racial/ethnic and income subgroups.

In 2019, the MDoH was awarded a CDC grant to perform statewide biomonitoring on the child-aged population. Data collection is ongoing; MDoH intends to perform disparity analyses for all chemical analytes and will share in a public report when available. The state is surveilling a set of 62 chemicals, all by urine, including the standard metals panel, PFAS, pesticides, phthalates, flame retardants, phenols, and metabolites of PAHs. Of these chemicals, nine are carcinogens.

## Iowa

Iowa was awarded a CDC grant for development of a biomonitoring program in 2019. The program is currently in progress, with a summary report describing (sub-)population-level findings expected in December 2024. Surveillance focuses two particular sub-populations: IA residents who rely on private wells for drinking water and pregnant women. The program will study exposure to 32 individual chemicals. These consist of the usual set of metals, a group of neonicotinoid insecticides that may be found in private wells, and several phenols for which exposure during pregnancy is of potential concern.

Of these 32 monitored chemicals, only the set of 5 metals shown below are on the carcinogen list. Because the program is ongoing, no stratified statistics are current available.

## New York

New York state was awarded a CDC grant for development of a biomonitoring program in 2019. Sample collection is complete in some regions of the state, while participant recruitment is ongoing in others. Eligibility was restricted to adults aged 20 years or older who reside at randomly selected addresses across the state.

The program is taking blood samples to screen for eleven unique PFAS and seven heavy metals. Urine samples are tested for a group of 17 heavy metals and pesticides including organophosphates, phenoxy acids, and pyrethroids. Unfortunately, the exact pesticide chemicals being screened for were not public information at time of writing and NY state did not respond to outreach.

Of the known chemicals being monitored by NY state, only 5 metals and 2 PFAS, shown below, are on the carcinogen list. Again, because the program is ongoing, no stratified statistics are currently available.

## Massachusetts

Massachusetts was awarded a CDC grant for development of their state biomonitoring during the 2014 award cycle. From 2014-2019, MA DPH conducted both a statewide representative study and a smaller-scale study targeting low income residents. Unfortunately, MA DPH was unable to provide stratified biomonitoring statistics from these studies at this time; the program's funding expired before a final report with such information could be drafted. MA DPH staff plans to finish this report in the near future for public consumption, but in the meantime was able to provide a list of analytes that were monitored during the study period.

## Michigan

Michigan has varying biomonitoring projects complete and underway. Michigan DHHS received a biomonitoring grant in 2019 to perform a large-scale, state-representative exposure study. The state is measuring 197 analytes, including 45 PFAS, 100 PCBs, 17 organochlorine pesticides, 24 heavy metals, 10 PDBEs, and PBB. Most of the sample collection has already been completed. Of these 197 analytes, 19 are on the carcinogen list.

## Other notable governmental biomonitoring efforts

Several states not listed above were recipients of biomonitoring grants from the CDC in 2014 but did not publicly provide useful data from their programs nor effective contact information. These states include Virginia and the Four Corners State Consortium (Utah, Arizona, Colorado, and New Mexico). The National Biomonitoring Network includes in its ranks several states that do not yet have biomonitoring programs but aspire to in the future; these states include TX, LA, AR, TN, SC, NC, WI, VT, RI, and DC.

In multiple conversations with scientists at state health departments, it was noted that New York City has previously done two rounds of biomonitoring (NYC HANES). In the most recent 2013-2014 survey, however, blood and urine samples for relevant carcinogens were limited; only information on Pb and Hg were available. The earlier 2004 survey round produced academic publications where demographically-stratified summary statistics were presented for Pb, Hg, and Cd, as well as several pesticides (McKelvey et al. (2007); McKelvey et al. (2013)).

ATSDR and its state health department partners conducted the Biomonitoring of Great Lakes Populations program from 2010-2020. This program targeted vulnerable populations (including subsistence anglers, immigrants, and tribal communities) in the Great Lakes region (MN, WI, MI, and NY). Carcinogenic legacy contaminants and chemicals of emerging concern were measured in blood and urine, including Pb, Hg, Mirex, Hexachlorobenzene, DDT, DDE, PCBs, PAHs, PFAS, and Toxaphene. Data collected from the multiple cross-sectional studies were not available in a consistent and accessible public fashion, so were not included in this appendix.

# E Full list of candidate carcinogens

Table E1 below contains information on the full set of carcinogens considered in this analysis. The following describes the information in each column as well as the data sources.

Column (1) describes the chemical name. Column (2) is the CompTox DTXSID used to uniquely identify each carcinogen throughout the analysis. Column (3) is the chemical's CAS number. Column (4) denotes whether the chemical was a member of the IARC's carcinogen groupings: group 1 is known carcinogenic, group 2A is probably carcinogenic, and group 2B is possibly carcinogenic. Column (5) denotes whether the chemical was a member of the NTP's ROC groupings: "Known" is a known carcinogen, and "RAHC" is a reasonably anticipated human carcinogen. Column (6) denotes whether a chemical is listed as a carcinogen on California's Proposition 65 list. Column (7) denotes whether a chemical is a substance of very high concern due to carcinogenicy in the EU, UK, or both. Column (8) denotes whether a chemical is listed as active on the TSCA Inventory (T stands for true). Column (9) denotes it was reported as actively manufactured or imported into the U.S. per EPA's 2020 Chemical Data Reporting. Column (10) denotes whether the chemical was reported in version 1 of the harmonized Multimedia Monitoring Database. Column (11) denotes the numeric count of patents in which a chemical was mentioned, per PubChem. Column (12) denotes the numeric count of scientific articles in which a chemical was mentioned, per PubChem. And Column (13) denotes whether based on the aforementioned criteria, we ultimately considered the carcinogen to be ubiquitous.

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (+-)-Diclofop-methyl | DTXSID0032605 | 51338-27-3 | | | T | | | | T | 18020 | 422 | T |
| (2E,4E)-2,4-Hexadienal | DTXSID2025391 | 142-83-6 | 2B | | T | | T | | | 2041 | 280 | T |
| (˜32˜P)Phosphane | DTXSID80932734 | 14596-37-3 | 1 | | | | | | | 7438 | 58 | T |
| 1,1'-Biphenyl, 2,2',3,3', | DTXSID9065572 | 13654-09-6 | | RAHC | | | | | | 3374 | 285 | T |
| 1,1,1,2-Tetrachloroethane | DTXSID2021317 | 630-20-6 | 2B | | T | | T | | T | 37408 | 1534 | T |
| 1,1,1-Trichloroethane | DTXSID0021381 | 71-55-6 | | | T | | T | T | T | 71988 | 3850 | T |
| 1,1,2,2-Tetrachloroethane | DTXSID7021318 | 79-34-5 | 2B | | T | | T | T | T | 117420 | 1210 | T |
| 1,1,2-Trichloroethane | DTXSID5021380 | 79-00-5 | | | T | | T | T | T | 28732 | 757 | T |
| 1,1-Dichloroethane | DTXSID1020437 | 75-34-3 | | | T | | T | T | T | 52627 | 6186 | T |
| 1,1-Dichloroethylene | DTXSID8021438 | 75-35-4 | 2B | | T | | T | T | T | 24947 | 2693 | T |
| 1,1-Dimethylhydrazine | DTXSID1020516 | 57-14-7 | 2B | RAHC | T | | T | | | 37431 | 2195 | T |
| 1,2,3,4,5,6-Hexachlorocyc | DTXSID7020687 | 608-73-1 | 2B | RAHC | T | | | | T | 104118 | 10426 | T |
| 1,2,3-Trichloropropane | DTXSID9021390 | 96-18-4 | 2A | RAHC | T | Both | T | T | T | 6848 | 331 | T |
| 1,2-(Methylenedioxy)-4-pr | DTXSID7020475 | 94-58-6 | 2B | | T | | T | T | | 612 | 33 | T |
| 1,2-Benzenediol | DTXSID3020257 | 120-80-9 | 2B | | T | | T | T | | 109916 | 22836 | T |
| 1,2-Dibromo-3-chloropropa | DTXSID3020413 | 96-12-8 | 2B | RAHC | T | | T | | T | 6152 | 1119 | T |
| 1,2-Dibromoethane | DTXSID3020415 | 106-93-4 | 2A | RAHC | T | | T | T | T | 75644 | 3132 | T |
| 1,2-Dichloroethane | DTXSID6020438 | 107-06-2 | 2B | RAHC | T | Both | T | T | T | 46484 | 8353 | T |
| 1,2-Dichloropropane | DTXSID0020448 | 78-87-5 | 1 | | T | | T | T | T | 25792 | 741 | T |
| 1,2-Diethylhydrazine | DTXSID1043754 | 1615-80-1 | 2B | | T | | | | | 510 | 63 | |
| 1,2-Dimethylhydrazine | DTXSID0041228 | 540-73-8 | 2A | | T | | | | | 7574 | 2763 | T |
| 1,2-Diphenylhydrazine | DTXSID7020710 | 122-66-7 | | RAHC | T | | T | | T | 4109 | 631 | T |
| 1,2-Epoxybutane | DTXSID6020569 | 106-88-7 | 2B | | | | T | T | | 45747 | 505 | T |
| 1,2-Phenylenediamine | DTXSID3025881 | 95-54-5 | 2B | | T | | T | T | | 100546 | 10564 | T |
| 1,2-Phenylenediamine dihy | DTXSID3021140 | 615-28-1 | 2B | | | | T | | | 9832 | 1443 | T |
| 1,2-Propylene oxide | DTXSID5021207 | 75-56-9 | 2B | RAHC | T | Both | T | T | T | 71341 | 13480 | T |
| 1,3-Butadiene | DTXSID3020203 | 106-99-0 | 1 | Kwn | T | | T | T | T | 131292 | 18381 | T |
| 1,3-Dichloro-2-propanol | DTXSID6025010 | 96-23-1 | 2B | | T | | T | T | T | 16827 | 434 | T |
| 1,3-Dichloropropene | DTXSID1022057 | 542-75-6 | 2B | RAHC | T | | T | T | T | 12543 | 319 | T |
| 1,3-Dinitropyrene | DTXSID5074975 | 75321-20-9 | 2B | | T | | | | | 16 | 124 | |
| 1,3-Propane sultone | DTXSID8021195 | 1120-71-4 | 2A | RAHC | T | Both | T | | | 35746 | 576 | T |
| 1,4-Dichloro-2-butene | DTXSID9027310 | 764-41-0 | | | T | | T | | T | 1794 | 39 | T |
| 1,4-Dichloro-2-nitrobenze | DTXSID7052602 | 89-61-2 | 2B | | T | | T | | T | 1788 | 82 | T |
| 1,4-Dichlorobenzene | DTXSID1020431 | 106-46-7 | 2B | RAHC | T | | T | T | T | 88600 | 3229 | T |
| 1,4-Dioxane | DTXSID4020533 | 123-91-1 | 2B | RAHC | T | EU | T | T | T | 98992 | 33889 | T |
| 1,6-Dinitropyrene | DTXSID90872819 | 42397-64-8 | 2B | RAHC | T | | | | | 78 | 219 | T |
| 1,8-Dinitropyrene | DTXSID2073514 | 42397-65-9 | 2B | RAHC | T | | | | | 225 | 244 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-Amino-2,4-dibromoanthra | DTXSID4039235 | 81-49-2 | 2B | RAHC | T | | T | | | 417 | 37 | T |
| 1-Amino-2-methylanthraqui | DTXSID7020057 | 82-28-0 | | RAHC | T | | T | | | 3706 | 150 | T |
| 1-Bromo-3-chloropropane | DTXSID1051565 | 109-70-6 | 2B | | T | | T | T | | 12322 | 512 | T |
| 1-Bromopropane | DTXSID6021874 | 106-94-5 | 2B | RAHC | T | | T | T | T | 48362 | 1069 | T |
| 1-Chloro-2-nitrobenzene | DTXSID0020280 | 88-73-3 | 2B | | T | | T | | T | 11434 | 964 | T |
| 1-Chloro-4-(trifluorometh | DTXSID7024821 | 98-56-6 | 2B | | T | | T | T | T | 5199 | 203 | T |
| 1-Chloro-4-nitrobenzene | DTXSID5020281 | 100-00-5 | 2B | | T | | T | | T | 10406 | 1312 | T |
| 1-Ethyl-1-nitrosourea | DTXSID8020593 | 759-73-9 | 2A | RAHC | T | | T | | | 4396 | 4967 | T |
| 1-Hydroxyanthraquinone | DTXSID1020722 | 129-43-1 | 2B | | T | | | | | 3821 | 676 | T |
| 1-Methoxy-2-nitrobenzene | DTXSID3020962 | 91-23-6 | 2A | RAHC | T | | T | | | 2587 | 301 | T |
| 1-Naphthalenol, 1-(N-meth | DTXSID9020247 | 63-25-2 | | | T | | T | | T | 56447 | 5942 | T |
| 1-Naphthylamine | DTXSID7020920 | 134-32-7 | | | T | | T | | T | 78091 | 4475 | T |
| 1-Nitropyrene | DTXSID6020983 | 5522-43-0 | 2A | RAHC | T | | T | | T | 1401 | 1067 | T |
| 1-tert-Butoxy-2-propanol | DTXSID8025967 | 57018-52-7 | 2B | | T | | T | | | 13984 | 50 | T |
| 1-{[3-(2-Chlorophenyl)-2- | DTXSID901034223 | 135319-73-2 | | | T | | | | | | | |
| 17alpha-Ethinylestradiol | DTXSID5020576 | 57-63-6 | | Kwn | T | | T | | T | 54975 | 16986 | T |
| 17beta-Estradiol | DTXSID0020573 | 50-28-2 | | Kwn | T | | | | T | 92825 | 143623 | T |
| 2',3'-Dideoxycytidine | DTXSID0023747 | 7481-89-2 | 2B | | T | | | | | 49690 | 1815 | T |
| 2,2'-Bioxirane | DTXSID0041307 | 1464-53-5 | | RAHC | T | | T | | | 9677 | 1138 | T |
| 2,2-Dimethylvinyl chlorid | DTXSID5020520 | 513-37-1 | 2B | RAHC | T | | | | | 704 | 73 | |
| 2,3,4,7,8-Pentachlorodibe | DTXSID7030066 | 57117-31-4 | 1 | | | | | | T | 428 | 278 | T |
| 2,3,7,8-Tetrachlorodibenz | DTXSID2021315 | 1746-01-6 | 1 | Kwn | T | | | | T | 75481 | 16728 | T |
| 2,3-Benzofuran | DTXSID6020141 | 271-89-6 | 2B | | T | | T | | | 107257 | 3657 | T |
| 2,3-Dibromopropanol | DTXSID7021817 | 96-13-9 | 2B | RAHC | T | EU | T | | T | 3890 | 94 | T |
| 2,4,5-Trimethylaniline | DTXSID9021398 | 137-17-7 | | | T | | | | | 707 | 75 | |
| 2,4,6-Trichlorophenol | DTXSID5021386 | 88-06-2 | 2B | RAHC | T | | T | | T | 6269 | 1983 | T |
| 2,4,6-Trinitrotoluene | DTXSID7024372 | 118-96-7 | | | T | | T | T | T | 32001 | 4985 | T |
| 2,4-Diaminoanisole | DTXSID5041358 | 615-05-4 | 2B | | T | | T | | | 4840 | 168 | T |
| 2,4-Diaminotoluene | DTXSID4020402 | 95-80-7 | 2B | RAHC | T | Both | T | T | | 69530 | 980 | T |
| 2,4-Dichloronitrobenzene | DTXSID3024998 | 611-06-3 | 2B | | T | | T | | T | 1510 | 108 | T |
| 2,4-Dichlorophenoxyacetic | DTXSID0020442 | 94-75-7 | 2B | | | | T | T | T | 51498 | 23242 | T |
| 2,4-Dinitrotoluene | DTXSID0020529 | 121-14-2 | 2B | | T | Both | T | T | T | 9869 | 1503 | T |
| 2,6-Dimethylaniline | DTXSID8026307 | 87-62-7 | 2B | | T | | T | T | | 11788 | 643 | T |
| 2,6-Dinitrotoluene | DTXSID5020528 | 606-20-2 | 2B | | T | | T | | T | 1994 | 604 | T |
| 2-Acetylaminofluorene | DTXSID0039227 | 53-96-3 | | RAHC | T | | T | | T | 2355 | 4181 | T |
| 2-Amino-1-methyl-6-phenyl | DTXSID3037628 | 105650-23-5 | 2B | RAHC | T | | | | T | 1571 | 1413 | T |
| 2-Amino-3-methyl-3H-imida | DTXSID4020745 | 76180-96-6 | 2A | RAHC | T | | | | T | 262 | 473 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-Amino-4-chlorophenol | DTXSID5024473 | 95-85-2 | 2B | | T | | T | | | 5706 | 193 | T |
| 2-Amino-5-(5-nitro-2-fury | DTXSID7020059 | 712-68-5 | 2B | | T | | | | | 81 | 26 | |
| 2-Amino-alpha-carboline | DTXSID7020001 | 26148-68-5 | 2B | | T | | | | T | 72 | 170 | T |
| 2-Aminoanthraquinone | DTXSID6020068 | 117-79-3 | | RAHC | T | | T | | | 12302 | 193 | T |
| 2-Aminofluorene | DTXSID1049223 | 153-78-6 | | | T | | | | | 1627 | 1066 | T |
| 2-Anisidine | DTXSID5023877 | 90-04-0 | 2A | RAHC | T | Both | T | T | | 19169 | 969 | T |
| 2-Bromopropane | DTXSID7030197 | 75-26-3 | | | T | | T | T | | 29140 | 529 | T |
| 2-Ethylhexyl acrylate | DTXSID9025297 | 103-11-7 | 2B | | T | | T | T | | 80423 | 486 | T |
| 2-Mercaptobenzothiazole | DTXSID1020807 | 149-30-4 | 2A | | T | | T | T | T | 105584 | 2307 | T |
| 2-Methoxy-5-methylaniline | DTXSID1020350 | 120-71-8 | 2B | RAHC | T | Both | T | T | | 5313 | 131 | T |
| 2-Methoxyaniline hydrochl | DTXSID8020092 | 134-29-2 | 2A | RAHC | T | | | | | 94 | 91 | |
| 2-Methyl-1-nitroanthraqui | DTXSID7020847 | 129-15-7 | 2B | | T | | | | | 138 | 33 | |
| 2-Methylaniline | DTXSID1026164 | 95-53-4 | 1 | Kwn | T | Both | T | T | T | 85377 | 5852 | T |
| 2-Methylaniline hydrochlo | DTXSID7021364 | 636-21-5 | | | T | | T | | | 645 | 238 | T |
| 2-Methylimidazole | DTXSID4022107 | 693-98-1 | 2B | | T | | T | T | | 97732 | 2231 | T |
| 2-Naphthylamine | DTXSID2020921 | 91-59-8 | 1 | Kwn | T | | | | T | 25477 | 3105 | T |
| 2-Nitrofluorene | DTXSID2020971 | 607-57-8 | 2B | | T | | T | | T | 3168 | 560 | T |
| 2-Nitropropane | DTXSID6020981 | 79-46-9 | 2B | RAHC | T | | T | T | T | 9814 | 762 | T |
| 2-Nitrotoluene | DTXSID4025791 | 88-72-2 | 2A | RAHC | T | | T | | T | 24089 | 1572 | T |
| 2-Phenylphenol | DTXSID2021151 | 90-43-7 | | | T | | T | | T | 81633 | 2003 | T |
| 3'-Azido-3'-deoxythymidin | DTXSID8020127 | 30516-87-1 | 2B | | T | | | | | 66977 | 20676 | T |
| 3,3',4,4',5-Pentachlorobi | DTXSID3032179 | 57465-28-8 | 1 | | | | | | T | 1103 | 912 | T |
| 3,3',4,4'-Tetrachloroazob | DTXSID6026086 | 14047-09-7 | 2A | | T | | | | | 83 | 93 | |
| 3,3',5,5'-Tetrabromobisph | DTXSID1026081 | 79-94-7 | 2A | | T | EU | T | T | T | 69436 | 1669 | T |
| 3,3'-Dichloro-4,4'-diamin | DTXSID5074842 | 28434-86-8 | 2B | | T | | | | | 1068 | 23 | |
| 3,3'-Dichlorobenzidine | DTXSID6020432 | 91-94-1 | 2B | RAHC | T | | T | | T | 10366 | 266 | T |
| 3,3'-Dichlorobenzidine di | DTXSID1020433 | 612-83-9 | | RAHC | T | | T | T | | 158 | 24 | T |
| 3,3'-Dimethylbenzidine | DTXSID5024059 | 119-93-7 | 2B | RAHC | T | | T | | T | 28842 | 1116 | T |
| 3,3'-Dimethylbenzidine di | DTXSID6020511 | 612-82-8 | | RAHC | T | | T | | | 72 | 25 | T |
| 3,4-Dihydroxycinnamic aci | DTXSID5020231 | 331-39-5 | 2B | | T | | | | | 9282 | 2010 | T |
| 3,7-Dinitrofluoranthene | DTXSID20147305 | 105735-71-5 | 2B | | T | | | | | 1 | 31 | |
| 3,9-Dinitrofluoranthene | DTXSID40177028 | 22506-53-2 | 2B | | T | | | | | | 41 | |
| 3-(3,5-Dichlorophenyl)-N- | DTXSID3024154 | 36734-19-7 | | | T | | | | T | 44692 | 1283 | T |
| 3-Amino-9-ethylcarbazole | DTXSID2020054 | 6109-97-3 | | | T | | | | | | 48 | |
| 3-Bromo-2,2-bis(bromometh | DTXSID9024641 | 1522-92-5 | | | | EU | | | | 2137 | 33 | T |
| 3-Chloro-1,2-propanediol | DTXSID4020664 | 96-24-2 | 2B | | T | | T | T | | 15314 | 1961 | T |
| 3-Chloro-2-methylpropene | DTXSID1020279 | 563-47-3 | 2B | RAHC | T | | T | T | | 9777 | 359 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3-Chloro-4-(dichloromethy | DTXSID6020276 | 77439-76-0 | 2B | | T | | | | | 107 | 248 | T |
| 3-Methylcholanthrene | DTXSID0020862 | 56-49-5 | | | T | | T | | T | 3441 | 10553 | T |
| 3-Nitrobenzanthrone | DTXSID60881271 | 17117-34-9 | 2B | | | | | | | 20 | 167 | T |
| 4'-(9-Acridinylamino)meth | DTXSID4022604 | 51264-14-3 | 2B | | T | | | | | 92967 | 2843 | T |
| 4,4'-Bis(dimethylamino)-4 | DTXSID00204642 | 561-41-1 | | | | Both | | | | 3 | 0 | |
| 4,4'-Diaminobiphenyl meth | DTXSID6022422 | 101-77-9 | 2B | RAHC | T | Both | T | T | | 44067 | 1102 | T |
| 4,4'-Methylenebis(2-chlor | DTXSID5020865 | 101-14-4 | 1 | RAHC | T | Both | T | T | T | 26656 | 291 | T |
| 4,4'-Methylenebis(N,N-dim | DTXSID5020869 | 101-61-1 | 2B | RAHC | T | Both | T | | | 9674 | 185 | T |
| 4,4'-Methylenebis(o-tolui | DTXSID5020867 | 838-88-0 | 2B | | T | Both | T | | | 13684 | 76 | T |
| 4,4'-Methylenedianiline d | DTXSID9020871 | 13552-44-8 | | RAHC | T | | | | | 6 | 26 | |
| 4,4'-Oxydianiline | DTXSID0021094 | 101-80-4 | 2B | RAHC | T | Both | T | T | | 81122 | 886 | T |
| 4,4'-Thiodianiline | DTXSID9021344 | 139-65-1 | 2B | RAHC | T | | T | | | 28691 | 128 | T |
| 4-(N-Methyl-N-nitrosamino | DTXSID3020881 | 64091-91-4 | | RAHC | T | | | | T | 2005 | 1756 | T |
| 4-Amino-2-nitrophenol | DTXSID6020064 | 119-34-6 | | | T | | T | | | 1604 | 89 | T |
| 4-Androstene-3,17-dione | DTXSID8024523 | 63-05-8 | | | T | | | | T | 19459 | 16688 | T |
| 4-Biphenylamine | DTXSID5020071 | 92-67-1 | 1 | Kwn | T | Both | T | | T | 12729 | 1448 | T |
| 4-Chloro-1,2-diaminobenze | DTXSID5020283 | 95-83-0 | 2B | RAHC | T | | T | | | 4362 | 166 | T |
| 4-Chloro-2-methylaniline | DTXSID1041508 | 95-69-2 | 2A | RAHC | T | | T | | | 4196 | 204 | T |
| 4-Chloro-2-methylaniline | DTXSID0020288 | 3165-93-3 | | RAHC | | | T | | | 518 | 52 | T |
| 4-Chloroaniline | DTXSID9020295 | 106-47-8 | 2B | | T | | T | T | T | 30952 | 2557 | T |
| 4-Chloroaniline hydrochlo | DTXSID4020296 | 20265-96-7 | | | T | | T | | | 105 | 181 | T |
| 4-Chlorobenzotrichloride | DTXSID2027593 | 5216-25-1 | | | T | | T | | | 960 | 59 | T |
| 4-Methyl-2-pentanone | DTXSID5021889 | 108-10-1 | 2B | | T | | T | T | T | 169480 | 7089 | T |
| 4-Methylimidazole | DTXSID9025617 | 822-36-6 | 2B | | T | | T | | | 27997 | 525 | T |
| 4-Nitrobiphenyl | DTXSID9041522 | 92-93-3 | | | T | | T | | T | 1923 | 457 | T |
| 4-Nitropyrene | DTXSID5074844 | 57835-92-4 | 2B | RAHC | T | | | | T | 48 | 73 | T |
| 4-Nitrosodiphenylamine | DTXSID1021031 | 156-10-5 | | | T | | T | | | 1176 | 101 | T |
| 4-Vinyl-1-cyclohexene dio | DTXSID0020604 | 106-87-6 | 2B | RAHC | T | | T | | | 25715 | 296 | T |
| 4-Vinylcyclohexene | DTXSID3021437 | 100-40-3 | 2B | | T | | T | T | | 15726 | 464 | T |
| 5,5-Diphenylhydantoin | DTXSID8020541 | 57-41-0 | 2B | RAHC | T | | | | T | 64206 | 41453 | T |
| 5-Azacytidine | DTXSID9020116 | 320-67-2 | 2A | RAHC | T | | | | | 105360 | 10779 | T |
| 5-Chloro-2-methylaniline | DTXSID5020287 | 95-79-4 | | | T | | T | | T | 2809 | 105 | T |
| 5-Chloro-3-methyl-4-nitro | DTXSID3058454 | 6814-58-0 | | | T | | | | | 159 | 19 | |
| 5-Methoxypsoralen | DTXSID1025560 | 484-20-8 | 2A | | T | | | | | 3739 | 1743 | T |
| 5-Methylchrysene | DTXSID6063143 | 3697-24-3 | 2B | RAHC | T | | | | T | 363 | 176 | T |
| 5-Nitroacenaphthene | DTXSID3020960 | 602-87-9 | 2B | | T | | T | | T | 2805 | 92 | T |
| 6-Methyl-2-thiouracil | DTXSID2020890 | 56-04-2 | 2B | | T | | T | | | 2388 | 1622 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-Nitrochrysene | DTXSID9075454 | 7496-02-8 | 2A | RAHC | T | | | | T | 177 | 232 | T |
| 6-Propyl-2-thiouracil | DTXSID5021209 | 51-52-5 | 2B | RAHC | T | | T | | | 21250 | 9048 | T |
| 7,12-Dimethylbenz(a)anthr | DTXSID1020510 | 57-97-6 | | | T | | T | | T | 8066 | 8782 | T |
| 7H-Dibenzo[c,g]carbazole | DTXSID9059755 | 194-59-2 | 2B | RAHC | T | | | | | 517 | 131 | |
| 8-Methoxypsoralen | DTXSID8020830 | 298-81-7 | 1 | Kwn | T | | T | | | 23415 | 5583 | T |
| AF-2 | DTXSID9020033 | 3688-53-7 | 2B | | T | | | | | 1057 | 283 | T |
| Acetaldehyde | DTXSID5039224 | 75-07-0 | 2B | RAHC | T | | T | T | T | 103204 | 37295 | T |
| Acetaldehyde methylformyl | DTXSID0039225 | 16568-02-8 | | | T | | | | | 23 | 16 | |
| Acetamide | DTXSID7020005 | 60-35-5 | 2B | | T | | T | | | 39321 | 6893 | T |
| Acetochlor | DTXSID8023848 | 34256-82-1 | | | T | | | | T | 31891 | 976 | T |
| Acid Red 26 | DTXSID8021228 | 3761-53-3 | 2B | | T | | T | | | 545 | 20 | T |
| Acifluorfen sodium | DTXSID7023853 | 62476-59-9 | | | T | | T | | T | 9359 | 83 | T |
| Acrolein | DTXSID5020023 | 107-02-8 | 2A | | | | T | T | T | 99308 | 13624 | T |
| Acrylamide | DTXSID5020027 | 79-06-1 | 2A | RAHC | T | Both | T | T | T | 99862 | 39858 | T |
| Acrylonitrile | DTXSID5020029 | 107-13-1 | 2B | RAHC | T | | T | T | T | 118855 | 15690 | T |
| Actinolite asbestos | DTXSID40108998 | 77536-66-4 | | Kwn | | | | | | | | |
| Actinomycin D | DTXSID9020031 | 50-76-0 | | | T | | | | | 127517 | 23440 | T |
| Adriamycin hydrochloride | DTXSID3030636 | 25316-40-9 | | RAHC | T | | | | | 98190 | 63557 | T |
| Aflatoxin | DTXSID4020036 | 1402-68-2 | 1 | Kwn | T | | | | T | | | T |
| Aflatoxin M1 | DTXSID40891797 | 6795-23-9 | 2B | | | | | | T | 370 | 1391 | T |
| Alachlor | DTXSID1022265 | 15972-60-8 | | | T | | | | T | 42062 | 2297 | T |
| Aldrin | DTXSID8020040 | 309-00-2 | | | T | | | | T | 16830 | 5301 | T |
| Amides, coco, N,N-bis(hyd | DTXSID0024842 | 68603-42-9 | 2B | | T | | T | T | T | | | T |
| Amitrole | DTXSID0020076 | 61-82-5 | | RAHC | T | | T | | | 43395 | 3022 | T |
| Ammonium chromate | DTXSID3064857 | 7788-98-9 | | Kwn | | | T | | | 3929 | 20 | T |
| Ammonium dichromate | DTXSID70872953 | 7789-09-5 | | Kwn | | Both | T | T | | 2436 | 451 | T |
| Amosite | DTXSID5030741 | 12172-73-5 | | Kwn | | | | | T | | | T |
| Aniline | DTXSID8020090 | 62-53-3 | 2A | | T | | T | T | T | 103761 | 44443 | T |
| Aniline hydrochloride | DTXSID3020091 | 142-04-1 | 2A | | T | | T | | | 10062 | 3325 | T |
| Anthracene | DTXSID0023878 | 120-12-7 | | | T | | T | T | T | 32643 | 21569 | T |
| Anthracene oil | DTXSID9029067 | 90640-80-5 | | | | Both | T | | | | | T |
| Anthracene oil, anthracen | DTXSID701020329 | 90640-81-6 | | | | Both | | | | | | |
| Anthracene oil, anthracen | DTXSID001020330 | 90640-82-7 | | | | Both | | | | | | |
| Anthracene oil, anthracen | DTXSID701020331 | 91995-15-2 | | | | Both | | | | | | |
| Anthracene oil, anthracen | DTXSID401020332 | 91995-17-4 | | | | Both | | | | | | |
| Anthraquinone | DTXSID3020095 | 84-65-1 | 2B | | T | | T | T | T | 125902 | 18957 | T |
| Antimony trioxide | DTXSID4023880 | 1309-64-4 | 2B | RAHC | T | | T | T | | 15180 | 194 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aramite | DTXSID3020097 | 140-57-8 | 2B | | T | | | | T | 3338 | 136 | T |
| Arecoline | DTXSID3022617 | 63-75-2 | 2B | | | | | | | 7103 | 2568 | T |
| Aristolochic acid | DTXSID0040969 | 313-67-7 | 1 | Kwn | | | | | | 1989 | 1162 | T |
| Aristolochic acid II | DTXSID00197166 | 475-80-9 | | Kwn | | | | | | 15 | 36 | |
| Aristolochic acids | DTXSID70217421 | 67123-64-2 | | Kwn | T | | | | | | 0 | |
| Arsenic | DTXSID4023886 | 7440-38-2 | 1 | Kwn | T | | T | T | T | 64758 | 699 | T |
| Arsenic acid | DTXSID1034341 | 7778-39-4 | | | | Both | T | T | T | 1692 | 12034 | T |
| Arsenic oxide (As2O3) | DTXSID0020103 | 1327-53-3 | | Kwn | | Both | T | T | | | 3288 | T |
| Arsenic(V) pentoxide | DTXSID1034343 | 1303-28-2 | | | | Both | T | | | 2078 | 596 | T |
| Asbestos | DTXSID4023888 | 1332-21-4 | | Kwn | T | | T | T | T | | | T |
| Asbestos, anthophyllite | DTXSID00108999 | 77536-67-5 | | Kwn | | | | | | | | |
| Asphalt, oxidized | DTXSID4028250 | 64742-93-4 | 2A | | | | T | T | | | | T |
| Attapulgite | DTXSID6050469 | 12174-11-7 | 2B | | T | | | | | | | |
| Auramine | DTXSID7043821 | 492-80-8 | 2B | | T | | T | | | 22133 | 1566 | T |
| Azaserine | DTXSID9020118 | 115-02-6 | 2B | | T | | | | | 27327 | 681 | T |
| Azathioprine | DTXSID4020119 | 446-86-6 | 1 | Kwn | T | | | | | 134088 | 48761 | T |
| Azobenzene | DTXSID8020123 | 103-33-3 | | | T | | T | | T | 37127 | 6278 | T |
| Basic Blue 26 | DTXSID0038889 | 2580-56-5 | | | | Both | T | T | | 20957 | 599 | T |
| Benthiavalicarb-isopropyl | DTXSID9058232 | 177406-68-7 | | | T | | | | | 6766 | 37 | T |
| Benz(a)anthracene | DTXSID5023902 | 56-55-3 | 2B | RAHC | T | Both | T | | T | 13146 | 6002 | T |
| Benz(j)aceanthrylene | DTXSID30174041 | 202-33-5 | 2B | | | | | | | 164 | 56 | |
| Benzene | DTXSID3039242 | 71-43-2 | 1 | Kwn | T | | T | T | T | 242482 | 155764 | T |
| Benzo(b)fluoranthene | DTXSID0023907 | 205-99-2 | 2B | RAHC | T | | | | T | 2150 | 3174 | T |
| Benzo(j)fluoranthene | DTXSID8052691 | 205-82-3 | 2B | RAHC | T | | | | T | 1663 | 610 | T |
| Benzo[a]pyrene | DTXSID2020139 | 50-32-8 | 1 | RAHC | T | | T | | T | 27386 | 22457 | T |
| Benzo[c]phenanthrene | DTXSID4075459 | 195-19-7 | 2B | | | | | | T | 1457 | 389 | T |
| Benzo[k]fluoranthene | DTXSID0023909 | 207-08-9 | 2B | RAHC | T | | | | T | 1993 | 3131 | T |
| Benzophenone | DTXSID0021961 | 119-61-9 | 2B | | T | | T | T | T | 160994 | 10012 | T |
| Benzotrichloride | DTXSID1020148 | 98-07-7 | | RAHC | T | | T | | T | 9211 | 390 | T |
| Benzyl Violet 4B | DTXSID7021441 | 1694-09-3 | 2B | | T | | T | | | 13155 | 47 | T |
| Benzyl chloride | DTXSID0020153 | 100-44-7 | | | T | | T | T | T | 61728 | 3710 | T |
| Beryllium | DTXSID4023913 | 7440-41-7 | 1 | Kwn | T | | T | T | T | 35119 | 2729 | T |
| Beryllium carbonate hydro | DTXSID10984600 | 66104-24-3 | | Kwn | | | | | | 2 | 0 | |
| Beryllium chloride | DTXSID10858756 | 7787-47-5 | | Kwn | | | T | | | 3565 | 359 | T |
| Beryllium hydrogen phosph | DTXSID70929198 | 13598-15-7 | | Kwn | | | | | | 20 | 20 | |
| Beryllium hydroxide | DTXSID80893932 | 13327-32-7 | | Kwn | | | T | T | | | 305 | T |
| Beryllium oxide (BeO) | DTXSID30872818 | 1304-56-9 | | Kwn | | | T | T | | 61787 | 2187 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beryllium sulfate | DTXSID0020159 | 13510-49-1 | | Kwn | | | T | T | | 2045 | 318 | T |
| Beryllium sulfate tetrahy | DTXSID3024603 | 7787-56-6 | | Kwn | | | | | | 167 | 44 | |
| Beryllium zinc orthosilic | DTXSID00948498 | 25638-88-4 | | Kwn | | | | | | 15 | 0 | |
| Bis(4-(dimethylamino)phen | DTXSID2020894 | 90-94-8 | 2B | RAHC | T | Both | T | | | 74755 | 163 | T |
| Bis(chloroethyl) ether | DTXSID9020168 | 111-44-4 | | | T | | T | T | T | 18415 | 420 | T |
| Bis-(2-chloroethyl)sulfid | DTXSID0037100 | 505-60-2 | 1 | Kwn | T | | T | | T | 12884 | 2755 | T |
| Bitumens, extracts of ste | DTXSID801046853 | 128683-24-9 | | | T | | | | | | | |
| Bleomycin | DTXSID1030862 | 11056-06-7 | 2B | | | | | | | | | |
| Bromate | DTXSID8023923 | 15541-45-4 | | | T | | | | T | 28822 | 978 | T |
| Bromkal 80 | DTXSID701016695 | 61288-13-9 | | RAHC | | | | | | | | |
| Bromochloroacetic acid | DTXSID4024642 | 5589-96-8 | 2B | RAHC | T | | | | T | 177 | 167 | T |
| Bromodichloroacetic acid | DTXSID4024644 | 71133-14-7 | | RAHC | T | | | | T | 93 | 103 | T |
| Bromodichloromethane | DTXSID1020198 | 75-27-4 | 2B | RAHC | T | | T | | T | 3883 | 950 | T |
| Bromoethane | DTXSID6020199 | 74-96-4 | | | T | | T | T | T | 74963 | 2288 | T |
| Bromoform | DTXSID1021374 | 75-25-2 | | | T | | T | | T | 26927 | 3334 | T |
| Busulfan | DTXSID3020910 | 55-98-1 | 1 | Kwn | T | | | | | 114398 | 14081 | T |
| Butyl glycidyl ether | DTXSID9024691 | 2426-08-6 | 2B | | T | | T | T | | 40210 | 253 | T |
| Butylated hydroxyanisole | DTXSID7020215 | 25013-16-5 | 2B | RAHC | T | | T | T | T | | | T |
| C.I. Acid Red 114 | DTXSID8021224 | 6459-94-5 | 2B | RAHC | T | | T | | | 585 | 46 | T |
| C.I. Azoic Diazo Componen | DTXSID2020137 | 92-87-5 | 1 | Kwn | T | | T | | T | 94774 | 7477 | T |
| C.I. Basic Red 9 monohydr | DTXSID1021247 | 569-61-9 | 2B | RAHC | T | | T | | | 1 | 414 | T |
| C.I. Basic Violet 14 | DTXSID6021246 | 632-99-5 | 2B | | | | T | | | 16815 | 8153 | T |
| C.I. Direct Black 38 | DTXSID7020184 | 1937-37-7 | | Kwn | T | Both | T | | | 1 | 74 | T |
| C.I. Direct Blue 14 | DTXSID4026268 | 72-57-1 | 2B | | T | | T | | | 87327 | 3061 | T |
| C.I. Direct Blue 15 | DTXSID7020186 | 2429-74-5 | 2B | RAHC | T | | T | | | 6 | 45 | T |
| C.I. Direct Blue 218 | DTXSID2020187 | 28407-37-6 | 2B | | T | | T | T | | | 20 | T |
| C.I. Direct Blue 6 | DTXSID2020185 | 2602-46-2 | | Kwn | T | | T | | | | 30 | T |
| C.I. Direct Brown 95 | DTXSID3020201 | 16071-86-6 | | Kwn | T | | T | | | | 27 | T |
| C.I. Direct Red 28 | DTXSID4022816 | 573-58-0 | | | | Both | T | | | 32994 | 3652 | T |
| C.I. Disperse Black 6 | DTXSID3025091 | 119-90-4 | 2B | RAHC | T | | T | | | 30535 | 3244 | T |
| C.I. Disperse Black 6 dih | DTXSID1020485 | 20325-40-0 | | | T | | T | T | | 168 | 703 | T |
| C.I. Disperse Blue 1 | DTXSID7020188 | 2475-45-8 | 2B | RAHC | T | | T | | | 4526 | 106 | T |
| C.I. Disperse Yellow 3 | DTXSID6021450 | 2832-40-8 | | | T | | T | | | 3167 | 63 | T |
| C.I. Oxidation Base 12A | DTXSID7020398 | 39156-41-7 | | RAHC | T | | T | | | 142 | 81 | T |
| C.I. Pigment Orange 5 | DTXSID6029258 | 3468-63-1 | | | T | | T | T | | 20920 | 22 | T |
| C.I. Pigment Red 104 | DTXSID9051321 | 12656-85-8 | | | | Both | T | T | | | | T |
| C.I. Pigment Red 53 | DTXSID3021229 | 5160-02-1 | | | T | | T | T | | 26377 | 36 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C.I. Pigment Yellow 34 | DTXSID8051336 | 1344-37-2 | | | | Both | T | T | | | 0 | T |
| C.I. Solvent Orange 2 | DTXSID6025808 | 2646-17-5 | 2B | | T | | T | | | 5088 | 30 | T |
| C.I. Solvent Red 80 | DTXSID6024838 | 6358-53-8 | 2B | | T | | T | | | 1447 | 25 | T |
| C.I. Solvent Yellow 1 | DTXSID6024460 | 60-09-3 | 2B | | T | Both | T | | | 26083 | 995 | T |
| C.I. Solvent Yellow 14 | DTXSID4021135 | 842-07-9 | | | T | | T | | | 4292 | 246 | T |
| C.I. Solvent Yellow 2 | DTXSID5020491 | 60-11-7 | 2B | RAHC | T | | T | | T | 7038 | 3289 | T |
| C10-12 chloroalkanes | DTXSID10872316 | 108171-26-2 | | RAHC | T | | | | | | | |
| Cadmium | DTXSID1023940 | 7440-43-9 | 1 | Kwn | T | Both | T | T | T | | | T |
| Cadmium chloride | DTXSID6020226 | 10108-64-2 | | Kwn | | Both | T | | | 22 | 20 | T |
| Cadmium dinitrate | DTXSID7044504 | 10325-94-7 | | | | Both | T | T | | 4 | 0 | T |
| Cadmium fluoride (CdF2) | DTXSID6064878 | 7790-79-6 | | | | Both | T | | | 1797 | 393 | T |
| Cadmium hydroxide (Cd(OH) | DTXSID9066671 | 21041-95-2 | | | | Both | T | T | | 4 | 450 | T |
| Cadmium oxide | DTXSID0024715 | 1306-19-0 | | | | Both | T | T | | 37551 | 2272 | T |
| Cadmium sulfate (1:1) | DTXSID1020229 | 10124-36-4 | | | | Both | T | | | 6495 | 2680 | T |
| Cadmium sulfate (1:1) hyd | DTXSID0020230 | 7790-84-3 | | | | EU | | | | 110 | 0 | |
| Cadmium sulfate–water (1 | DTXSID90934502 | 15244-35-6 | | | | EU | | | | 3 | 27 | |
| Cadmium sulfide | DTXSID30893280 | 1306-23-6 | | | | Both | T | | | 27878 | 6772 | T |
| Cadmium(II) chloride hydr | DTXSID4040183 | 7790-78-5 | | | | EU | | | | | 0 | |
| Calcium arsenate | DTXSID6058182 | 7778-44-1 | | Kwn | | Both | T | | | 5466 | 550 | T |
| Calcium monochromate | DTXSID0024717 | 13765-19-0 | | Kwn | | | T | | | 4140 | 267 | T |
| Captafol | DTXSID4020242 | 2425-06-1 | 2A | RAHC | T | | | | T | 23954 | 564 | T |
| Captan | DTXSID9020243 | 133-06-2 | | | T | | T | | T | 41381 | 2804 | T |
| Carbazole | DTXSID4020248 | 86-74-8 | 2B | | T | | T | | T | 128344 | 6874 | T |
| Carbon black | DTXSID7051216 | 1333-86-4 | 2B | | T | | T | T | | | | T |
| Carbon nanotubes | DTXSID301020377 | 308068-56-6 | 2B | | | | | | | | | |
| Carbon tetrachloride | DTXSID8020250 | 56-23-5 | 2B | RAHC | T | | T | T | T | 36125 | 44870 | T |
| Carbonic acid, cadmium sa | DTXSID60883417 | 513-78-0 | | | | Both | T | | | 2935 | 439 | T |
| Carboxymethylnitrosourea | DTXSID3020251 | 60391-92-6 | | | T | | | | | 9 | 3 | |
| Carrageenan, acid-degrade | DTXSID8020254 | 53973-98-1 | 2B | | T | | | | | | | |
| Chinomethionate | DTXSID2032342 | 2439-01-2 | | | T | | | | T | 34021 | 232 | T |
| Chloral | DTXSID7024744 | 75-87-6 | 2A | | T | | T | T | T | 36366 | 3395 | T |
| Chloral hydrate | DTXSID7020261 | 302-17-0 | 2A | | T | | T | | T | 49686 | 18512 | T |
| Chlorambucil | DTXSID7020263 | 305-03-3 | 1 | Kwn | T | | | | | 126750 | 10668 | T |
| Chloramphenicol | DTXSID7020265 | 56-75-7 | 2A | RAHC | | | T | | T | 134621 | 59298 | T |
| Chloramphenicol sodium su | DTXSID2024747 | 982-57-0 | | | T | | | | | 694 | 178 | T |
| Chlordane | DTXSID7020267 | 57-74-9 | 2B | | T | | | | T | 12895 | 4074 | T |
| Chlordimeform | DTXSID2037508 | 6164-98-3 | | | T | | | | | 16957 | 549 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chlorendic acid | DTXSID2020268 | 115-28-6 | 2B | RAHC | T | | T | | T | 10426 | 39 | T |
| Chlornaphazine | DTXSID3060087 | 494-03-1 | 1 | | T | | | | | 17394 | 135 | T |
| Chlorobenzilate | DTXSID9020299 | 510-15-6 | | | T | | T | | T | 15921 | 358 | T |
| Chloroethane | DTXSID1020302 | 75-00-3 | | | T | | T | T | T | 108095 | 3798 | T |
| Chloroform | DTXSID1020306 | 67-66-3 | 2B | RAHC | T | | T | T | T | 141399 | 159729 | T |
| Chloromethyl methyl ether | DTXSID6020307 | 107-30-2 | | Kwn | T | | T | T | | 26826 | 643 | T |
| Chloroprene | DTXSID5020316 | 126-99-8 | 2B | RAHC | T | | T | | T | 35844 | 1226 | T |
| Chlorothalonil | DTXSID0020319 | 1897-45-6 | 2B | | T | | T | | T | 130110 | 2390 | T |
| Chlorotrianisene | DTXSID1021299 | 569-57-3 | | | T | | | | | 33476 | 294 | T |
| Chlorozotocin | DTXSID9020320 | 54749-90-5 | 2A | RAHC | T | | | | | 16724 | 0 | T |
| Chromic(VI) acid | DTXSID8034455 | 7738-94-5 | | | | Both | T | T | | 13236 | 6880 | T |
| Chromium (VI) ion | DTXSID7023982 | 18540-29-9 | 1 | Kwn | T | | | | T | 44120 | 4086 | T |
| Chromium chromate (Cr2(Cr | DTXSID10894154 | 24613-89-6 | | | | Both | T | T | | 2353 | 20 | T |
| Chromium lead oxide | DTXSID201015373 | 11119-70-3 | | Kwn | | | | | | | | |
| Chromium trioxide | DTXSID0040125 | 1333-82-0 | | Kwn | | Both | T | T | | 40206 | 5280 | T |
| Chrysene | DTXSID0022432 | 218-01-9 | 2B | | T | Both | T | | T | 38289 | 6233 | T |
| Chrysotile | DTXSID0030742 | 12001-29-5 | | Kwn | | | | | | | 0 | |
| Cidofovir | DTXSID3043734 | 113852-37-2 | | | T | | | | | 30333 | 2179 | T |
| Cinnamyl anthranilate | DTXSID3020330 | 87-29-6 | | | T | | T | | | 130 | 3 | T |
| Cisplatin | DTXSID4024983 | 15663-27-1 | 2A | RAHC | T | | T | | | | | T |
| Clofibrate | DTXSID3020336 | 637-07-0 | | | T | | | | | 52079 | 8173 | T |
| Clomiphene citrate (1:1) | DTXSID8020337 | 50-41-9 | | | T | | | | | | 7963 | T |
| Coal tar | DTXSID1027683 | 8007-45-2 | 1 | Kwn | | | T | | | | | T |
| Cobalt | DTXSID1031040 | 7440-48-4 | 2B | RAHC | T | | T | T | T | 275685 | 22413 | T |
| Cobalt chloride | DTXSID9040180 | 7646-79-9 | | RAHC | | Both | T | T | | 61740 | 2243 | T |
| Cobalt oxide | DTXSID801014561 | 11104-61-3 | | RAHC | | | T | T | | | | T |
| Cobalt sulfate | DTXSID1031042 | 10124-43-3 | | RAHC | T | Both | T | T | | 40389 | 1059 | T |
| Cobalt sulfate heptahydra | DTXSID7020340 | 10026-24-1 | 2B | RAHC | T | | | T | | 2870 | 152 | T |
| Cobalt sulfide | DTXSID301015176 | 12653-56-4 | | RAHC | | | T | T | | | | T |
| Cobalt tungsten carbide | DTXSID20209477 | 60674-89-7 | | RAHC | | | | | | | 0 | |
| Cobalt(II) acetate | DTXSID6026373 | 71-48-7 | | RAHC | | Both | T | T | | 40289 | 28 | T |
| Cobalt(II) carbonate | DTXSID7052151 | 513-79-1 | | | | Both | T | T | | 15977 | 382 | T |
| Cobalt(II) nitrate | DTXSID9064970 | 10141-05-6 | | RAHC | | Both | T | T | | 42592 | 4861 | T |
| Cobalt(II) oxide | DTXSID6051649 | 1307-96-6 | | | T | | T | T | | 24528 | 6127 | T |
| Creosote | DTXSID2023987 | 8001-58-9 | 2A | | T | | T | T | T | | | T |
| Cristobalite | DTXSID5041801 | 14464-46-1 | | Kwn | | | T | T | | | | T |
| Crotonaldehyde | DTXSID8024864 | 4170-30-3 | 2B | | | | T | T | T | 12859 | 288 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cumene | DTXSID1021827 | 98-82-8 | 2B | RAHC | T | | T | T | T | 150762 | 6690 | T |
| Cupferron | DTXSID1020352 | 135-20-6 | 2B | RAHC | T | | T | | | 1678 | 56 | T |
| Cycasin | DTXSID2057574 | 14901-08-7 | 2B | | T | | | | | | 99 | |
| Cyclopenta[cd]pyrene | DTXSID7074822 | 27208-37-3 | 2A | | T | | | | T | 78 | 186 | T |
| Cyclophosphamide | DTXSID5020364 | 50-18-0 | | Kwn | T | | | | | 199306 | 119647 | T |
| Cyclophosphamide monohydr | DTXSID6024888 | 6055-19-2 | | | T | | | | | 2152 | 54077 | T |
| Cyclosporin A | DTXSID0020365 | 59865-13-3 | | Kwn | T | | | | | 152041 | 63260 | T |
| Cytembena | DTXSID5020368 | 21739-91-3 | | | T | | | | | | 32 | |
| D&C Red No. 8 | DTXSID6062173 | 2092-56-0 | | | T | | T | | | 2330 | 15 | T |
| DDT | DTXSID4020375 | 50-29-3 | 2A | RAHC | T | | T | | T | 57337 | 16796 | T |
| DE 71 | DTXSID30873481 | 117148-05-7 | | | T | | | | | | | |
| Dacarbazine | DTXSID0020369 | 4342-03-4 | 2B | RAHC | T | | | | | 133831 | 8394 | T |
| Daminozide | DTXSID9020370 | 1596-84-5 | | | T | | | | | 25668 | 593 | T |
| Danthron | DTXSID9020328 | 117-10-2 | 2B | RAHC | T | | T | | | 5852 | 896 | T |
| Daunorubicin | DTXSID7022883 | 20830-81-3 | 2B | | T | | | | | 153251 | 19185 | T |
| Di(2-ethylhexyl) phthalat | DTXSID5020607 | 117-81-7 | 2B | RAHC | T | | T | T | T | 46944 | 6680 | T |
| Diazinon | DTXSID9020407 | 333-41-5 | 2A | | | | T | | T | 66874 | 5763 | T |
| Diazoaminobenzene | DTXSID9024934 | 136-35-6 | | RAHC | T | | T | | | 6406 | 235 | T |
| Dibenz(c,h)acridine | DTXSID30176929 | 224-53-3 | 2B | | | | | | | 49 | 47 | |
| Dibenz[a,c]anthracene | DTXSID9049245 | 215-58-7 | | | T | | | | T | 1278 | 630 | T |
| Dibenz[a,h]acridine | DTXSID3059761 | 226-36-8 | 2B | RAHC | T | | | | T | 201 | 117 | T |
| Dibenz[a,h]anthracene | DTXSID9020409 | 53-70-3 | 2A | RAHC | T | | T | | T | 2576 | 2872 | T |
| Dibenz[a,j]acridine | DTXSID4059758 | 224-42-0 | 2A | RAHC | T | | | | T | 310 | 115 | T |
| Dibenz[a,j]anthracene | DTXSID8074811 | 224-41-9 | | | T | | | | | 399 | 117 | |
| Dibenzo(a,e)pyrene | DTXSID3052690 | 192-65-4 | | RAHC | T | | | | T | 594 | 167 | T |
| Dibenzo[a,h]pyrene | DTXSID4059752 | 189-64-0 | 2B | RAHC | T | | | | T | 459 | 175 | T |
| Dibenzo[a,i]pyrene | DTXSID9059751 | 189-55-9 | 2B | RAHC | T | | | | T | 370 | 190 | T |
| Dibenzo[a,l]pyrene | DTXSID9059753 | 191-30-0 | 2A | RAHC | T | | | | T | 349 | 582 | T |
| Diberyllium orthosilicate | DTXSID10929197 | 13598-00-0 | | Kwn | | | | | | 1215 | 0 | |
| Dibromoacetic acid | DTXSID1023815 | 631-64-1 | 2B | RAHC | T | | T | | T | 1853 | 327 | T |
| Dibromoacetonitrile | DTXSID3024940 | 3252-43-5 | 2B | | T | | T | | T | 270 | 154 | T |
| Dibromochloroacetic acid | DTXSID3031151 | 5278-95-5 | | RAHC | | | | | | 62 | 92 | |
| Dichloroacetic acid | DTXSID2020428 | 79-43-6 | 2B | RAHC | T | | T | | T | 55489 | 2982 | T |
| Dichloromethane | DTXSID0020868 | 75-09-2 | 2A | RAHC | T | | T | T | T | 149383 | 77642 | T |
| Dichlorvos | DTXSID5020449 | 62-73-7 | 2B | | T | | T | | T | 42009 | 3965 | T |
| Dichromic acid | DTXSID30872954 | 13530-68-2 | | | | Both | T | | | 6772 | 259 | T |
| Dieldrin | DTXSID9020453 | 60-57-1 | | | T | | | | T | 16067 | 8718 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diesel fuel, marine | DTXSID4025030 | 77650-28-3 | 2B | | | | | | | | | |
| Diethanolamine | DTXSID3021932 | 111-42-2 | 2B | | T | | T | T | T | 47679 | 5065 | T |
| Diethyl sulfate | DTXSID1024045 | 64-67-5 | 2A | RAHC | T | Both | T | T | | 49727 | 1182 | T |
| Diethylstilbestrol | DTXSID3020465 | 56-53-1 | 1 | Kwn | T | | T | | T | 55160 | 14993 | T |
| Diglycidyl resorcinol eth | DTXSID2020470 | 101-90-6 | 2B | RAHC | T | | T | T | | 15492 | 85 | T |
| Digoxin | DTXSID5022934 | 20830-75-5 | 2B | | | | T | | T | 77175 | 31032 | T |
| Dihydroxymethylfuratrizin | DTXSID401045239 | 794-93-4 | 2B | | T | | | | | | | |
| Diisononyl phthalate | DTXSID4022521 | 28553-12-0 | | | T | | T | T | T | | | T |
| Diisopropyl sulfate | DTXSID3073131 | 2973-10-6 | 2B | | T | | | | | 913 | 33 | |
| Dimethyl phosphonate | DTXSID5020493 | 868-85-9 | | | T | | T | T | | 13380 | 518 | T |
| Dimethyl sulfate | DTXSID5024055 | 77-78-1 | 2A | RAHC | T | Both | T | T | | 42200 | 5606 | T |
| Dimethylarsinic acid | DTXSID7020508 | 75-60-5 | 2B | | T | | T | | T | 14388 | 2445 | T |
| Dimethylcarbamoyl chlorid | DTXSID1020512 | 79-44-7 | 2A | RAHC | T | | T | | | 17225 | 189 | T |
| Diphenylhydantoin sodium | DTXSID2023775 | 630-93-3 | | RAHC | T | | T | | | 4185 | 13876 | T |
| Dipropyl 2,5-pyridinedica | DTXSID8032544 | 136-45-8 | | | T | | | | | 1369 | 32 | |
| Diuron | DTXSID0020446 | 330-54-1 | | | T | | T | T | T | 71096 | 9483 | T |
| Doxorubicin | DTXSID8021480 | 23214-92-8 | 2A | RAHC | | | | | | 236403 | 122238 | T |
| Elmiron | DTXSID1025229 | 37319-17-8 | 2B | | | | | | | | | |
| Epichlorohydrin | DTXSID1020566 | 106-89-8 | 2A | RAHC | T | | T | T | T | 36160 | 6363 | T |
| Erionite | DTXSID40872384 | 12510-42-8 | 1 | Kwn | T | | | | | | | |
| Estragole | DTXSID0020575 | 140-67-0 | | | T | | T | T | T | 11012 | 2070 | T |
| Estrone | DTXSID4022367 | 53-16-7 | | Kwn | T | | T | | T | 47750 | 20816 | T |
| Estropipate | DTXSID3023005 | 7280-37-7 | | | T | | | | T | 7021 | 117 | T |
| Ethanol | DTXSID9020584 | 64-17-5 | 1 | | | | T | T | T | 1198010 | 541282 | T |
| Ethoprop | DTXSID4032611 | 13194-48-4 | | | T | | | | T | 23499 | 775 | T |
| Ethyl acrylate | DTXSID4020583 | 140-88-5 | 2B | | T | | T | T | T | 43681 | 2353 | T |
| Ethyl methanesulfonate | DTXSID6025309 | 62-50-0 | 2B | RAHC | T | | T | | T | 25950 | 6466 | T |
| Ethylbenzene | DTXSID3020596 | 100-41-4 | 2B | | T | | T | T | T | 71444 | 13414 | T |
| Ethylene oxide | DTXSID0020600 | 75-21-8 | 1 | Kwn | T | | T | T | T | 146849 | 18049 | T |
| Ethylene thiourea | DTXSID5020601 | 96-45-7 | | RAHC | T | | T | T | T | 18924 | 1091 | T |
| Ethyleneimine | DTXSID8020599 | 151-56-4 | 2B | | T | | T | | | 37074 | 5558 | T |
| Etoposide | DTXSID5023035 | 33419-42-0 | 1 | | T | | | | | 164082 | 50135 | T |
| Etridiazole | DTXSID3032547 | 2593-15-9 | | | T | | | | T | 29386 | 189 | T |
| Fenoxycarb | DTXSID7032393 | 72490-01-8 | | | T | | | | T | 28211 | 537 | T |
| Fluoro-edenite fibrous am | DTXSID401335773 | 67164-60-7 | | | T | | | | | | | T |
| Folpet | DTXSID0021385 | 133-07-3 | | | T | | T | | T | 38543 | 677 | T |
| Formaldehyde | DTXSID7020637 | 50-00-0 | 1 | Kwn | T | | T | T | T | 219873 | 141838 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Formaldehyde, polymer wit | DTXSID801011036 | 25214-70-4 | | | | Both | T | | | | | T |
| Formic acid 2-[4-(5-nitro | DTXSID6020640 | 3570-75-0 | 2B | | T | | | | | 1031 | 41 | |
| Fumonisin B1 | DTXSID6020644 | 116355-83-0 | 2B | | T | | | | T | 4 | 1602 | T |
| Furaltadone | DTXSID4048016 | 139-91-3 | | | T | | | | | 1552 | 125 | |
| Furan | DTXSID6020646 | 110-00-9 | 2B | RAHC | T | Both | T | T | T | 65498 | 17619 | T |
| Furazolidone | DTXSID4041997 | 67-45-8 | | | T | | T | | | 7273 | 1361 | T |
| Furfuryl alcohol | DTXSID2025347 | 98-00-0 | 2B | | T | | T | T | T | 55638 | 4841 | T |
| Furilazole | DTXSID4041999 | 121776-33-8 | | | T | | | | | 13302 | 8 | T |
| Furmecyclox | DTXSID2024119 | 60568-05-0 | | | T | | | | T | 11900 | 31 | T |
| Fusarin C | DTXSID501020204 | 79748-81-5 | | | T | | | | | 79 | 70 | |
| Gallium arsenide | DTXSID2023779 | 1303-00-0 | | | T | | T | | | 29274 | 8722 | T |
| Ganciclovir | DTXSID8041032 | 82410-32-0 | | | T | | | | | 86110 | 10479 | T |
| Gasoline | DTXSID50105296 | 86290-81-5 | 2B | | | | | T | T | | | T |
| Gemfibrozil | DTXSID0020652 | 25812-30-0 | | | T | | | | T | 44518 | 5564 | T |
| Gentian Violet | DTXSID5020653 | 548-62-9 | 2B | | T | Both | T | | | 68384 | 28454 | T |
| Ginkgo biloba extract | DTXSID8031366 | 90045-36-6 | 2B | | | | | | | | | |
| Glass wool | DTXSID30891701 | 308066-92-4 | | RAHC | T | | | | | | | |
| Glu-P-1 | DTXSID5020657 | 67730-11-4 | 2B | | T | | | | T | 187 | 168 | T |
| Glu-P-2 | DTXSID0020658 | 67730-10-3 | 2B | | T | | | | T | 190 | 87 | T |
| Glycidaldehyde | DTXSID9020665 | 765-34-4 | 2B | | T | | | | | 2755 | 253 | T |
| Glycidol | DTXSID4020666 | 556-52-5 | 2A | RAHC | T | | T | | | 69799 | 1444 | T |
| Glycidyl methacrylate | DTXSID0025361 | 106-91-2 | 2A | | T | | T | T | | 89538 | 3057 | T |
| Glyphosate | DTXSID1024122 | 1071-83-6 | 2A | | T | | | | T | 79067 | 10668 | T |
| Griseofulvin | DTXSID8020674 | 126-07-8 | 2B | | T | | | | T | 44062 | 7553 | T |
| HC Blue 1 | DTXSID6020191 | 2784-94-3 | 2B | | T | | T | | | 730 | 32 | T |
| Heptachlor | DTXSID3020679 | 76-44-8 | 2B | | T | | | | T | 18672 | 3856 | T |
| Heptachlor epoxide B | DTXSID1024126 | 1024-57-3 | | | T | | | | T | | 149 | T |
| Hexabromobiphenyl | DTXSID3025382 | 36355-01-8 | | RAHC | | | | | | | | |
| Hexachloro-1,3-butadiene | DTXSID7020683 | 87-68-3 | | | T | | T | | T | 8799 | 1555 | T |
| Hexachlorobenzene | DTXSID2020682 | 118-74-1 | 2B | RAHC | T | | T | T | T | 36868 | 7342 | T |
| Hexachlorodibenzo-p-dioxi | DTXSID00872820 | 34465-46- 8 | | | T | | | | T | | | T |
| Hexachloroethane | DTXSID7020689 | 67-72-1 | 2B | RAHC | T | | T | T | T | 20890 | 1223 | T |
| Hexamethylphosphoramide | DTXSID6020694 | 680-31-9 | 2B | RAHC | T | | T | | T | 59098 | 3707 | T |
| Hydrazine | DTXSID3020702 | 302-01-2 | 2A | RAHC | T | Both | T | T | T | 109597 | 24430 | T |
| Hydrazine sulfate | DTXSID8020703 | 10034-93-2 | | RAHC | T | | T | | | 10655 | 3530 | T |
| Hydrochlorothiazide | DTXSID2020713 | 58-93-5 | 2B | | | | T | | T | 63505 | 18228 | T |
| Imazalil | DTXSID8024151 | 35554-44-0 | | | T | | | | T | 42807 | 1029 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Indeno[1,2,3-cd]pyrene | DTXSID8024153 | 193-39-5 | 2B | RAHC | T | | T | | T | 942 | 2224 | T |
| Indium phosphide | DTXSID3031444 | 22398-80-7 | 2A | | T | | T | | | | | T |
| Indium tin oxide | DTXSID10904045 | 71243-84-0 | | | T | | T | | | 625 | 977 | T |
| Iprovalicarb | DTXSID0047662 | 140923-17-7 | | | T | | | | | 19905 | 34 | T |
| Iron dextran | DTXSID1031464 | 9004-66-4 | 2B | RAHC | T | | | | | | | |
| Isobutyl nitrite | DTXSID3020750 | 542-56-3 | 2B | | T | | T | | | 2120 | 213 | T |
| Isoprene | DTXSID2020761 | 78-79-5 | 2B | RAHC | T | | T | T | T | 51421 | 9824 | T |
| Isopyrazam | DTXSID7058208 | 881685-58-1 | | | T | | | | | 13597 | 78 | T |
| Isoxaflutole | DTXSID5034723 | 141112-29-0 | | | T | | | | T | 23480 | 204 | T |
| Kava kava resin | DTXSID5031505 | 9000-38-8 | 2B | | | | | | | | | |
| Kepone | DTXSID1020770 | 143-50-0 | 2B | RAHC | T | | | | T | 6446 | 1598 | T |
| Kresoxim-methyl | DTXSID2032558 | 143390-89-0 | | | T | | | | T | 17414 | 451 | T |
| Lactofen | DTXSID7024160 | 77501-63-4 | | | T | | | | T | 25006 | 159 | T |
| Lasiocarpine | DTXSID1020772 | 303-34-4 | 2B | | T | | | | | 312 | 57 | |
| Lead | DTXSID2024161 | 7439-92-1 | 2B | RAHC | T | | T | T | T | 8205 | 39266 | T |
| Lead acetate | DTXSID10274073 | 15347-57-6 | | RAHC | | | | | | | | |
| Lead arsenate | DTXSID4042092 | 7784-40-9 | | Kwn | | Both | T | | | 5668 | 61 | T |
| Lead phosphate (3:2) | DTXSID5064706 | 7446-27-7 | | RAHC | T | | T | | | 261 | 52 | T |
| Lead(II) acetate | DTXSID6020773 | 301-04-2 | | | T | | T | T | | 35 | 1379 | T |
| Lead(II) arsenate (3:2) | DTXSID9074274 | 3687-31-8 | | | | Both | | | | 4 | 0 | |
| Lead(II) chromate | DTXSID1064792 | 7758-97-6 | | | | Both | T | T | | 42242 | 93 | T |
| Leucomalachite green | DTXSID7031531 | 129-73-7 | 2B | | T | | T | | | 2848 | 376 | T |
| Levofuraltadone | DTXSID6043834 | 3795-88-8 | 2B | | | | | | | | 20 | |
| Lindane | DTXSID2020686 | 58-89-9 | 1 | RAHC | T | | T | | T | 104118 | 10426 | T |
| Lomustine | DTXSID2023222 | 13010-47-4 | 2A | RAHC | T | | | | | 92047 | 4997 | T |
| Lynestrenol | DTXSID4021478 | 52-76-6 | | | T | | | | | 5706 | 1407 | T |
| MON-4660 | DTXSID0044575 | 71526-07-3 | | | T | | | | | 5721 | 22 | T |
| Malathion | DTXSID4020791 | 121-75-5 | 2A | | T | | | | T | 52709 | 9549 | T |
| Malonaldehyde, sodium sal | DTXSID4020793 | 24382-04-5 | | | T | | | | | 2 | 0 | |
| Mancozeb | DTXSID0034695 | 8018-01-7 | | | T | | | | | | | |
| Maneb | DTXSID9020794 | 12427-38-2 | | | T | | | | | 35471 | 617 | T |
| MeA-alpha-C | DTXSID5043766 | 68006-83-7 | 2B | | T | | | | T | 112 | 103 | T |
| MeIQ | DTXSID6020800 | 77094-11-2 | 2B | RAHC | T | | | | | 112 | 320 | T |
| MeIQx | DTXSID1020801 | 77500-04-0 | 2B | RAHC | T | | | | | 179 | 631 | T |
| Medroxyprogesterone aceta | DTXSID0025527 | 71-58-9 | 2B | | T | | T | | | 54459 | 11356 | T |
| Megestrol acetate | DTXSID9040683 | 595-33-5 | | | T | | | | | 92294 | 3245 | T |
| Melamine | DTXSID6020802 | 108-78-1 | 2B | | | | T | T | | 61063 | 5959 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Melphalan | DTXSID6020804 | 148-82-3 | 1 | Kwn | T | | | | | 128050 | 8336 | T |
| Mepanipyrim | DTXSID4042121 | 110235-47-7 | | | T | | | | T | 32301 | 147 | T |
| Merphalan | DTXSID9031569 | 531-76-0 | 2B | | T | | | | | 1429 | 8236 | T |
| Mestranol | DTXSID0020814 | 72-33-3 | | Kwn | T | | | | T | 13022 | 3539 | T |
| Metam-sodium | DTXSID2029167 | 137-42-8 | | | T | | | | T | 18989 | 506 | T |
| Methyl acrylate | DTXSID0024183 | 96-33-3 | 2B | | T | | T | T | T | 43077 | 5211 | T |
| Methyl carbamate | DTXSID8020834 | 598-55-0 | | | T | | T | T | T | 22180 | 825 | T |
| Methyl iodide | DTXSID0024187 | 74-88-4 | | | T | | T | T | T | 22793 | 12485 | T |
| Methyl mercury | DTXSID2031615 | 16056-34-1 | | | T | | | | T | 3187 | 14 | T |
| Methyl methanesulfonate | DTXSID7020845 | 66-27-3 | 2A | RAHC | T | | T | | T | 23115 | 3150 | T |
| Methylarsonic acid | DTXSID4020903 | 124-58-3 | 2B | | | | | | T | 4544 | 1517 | T |
| Methylazoxymethanol | DTXSID1035076 | 590-96-5 | | | T | | | | | 123 | 527 | T |
| Methylazoxymethanol aceta | DTXSID1025568 | 592-62-1 | 2B | | T | | | | | | 663 | T |
| Methyleugenol | DTXSID5025607 | 93-15-2 | 2B | RAHC | T | | T | | T | 14589 | 1767 | T |
| Methylhydrazine | DTXSID4020874 | 60-34-4 | | | T | | T | | T | 45729 | 1341 | T |
| Methylnitronitrosoguanidi | DTXSID2020846 | 70-25-7 | 2A | RAHC | T | | T | | | 17230 | 3906 | T |
| Metiram | DTXSID9034737 | 9006-42-2 | | | T | | | | T | | | T |
| Metronidazole | DTXSID2020892 | 443-48-1 | 2B | RAHC | T | | | | | 117361 | 39734 | T |
| Microcystin LR | DTXSID3031654 | 101043-37-2 | 2B | | | | | | T | 1670 | 0 | T |
| Mineral oil - includes pa | DTXSID3034743 | 8012-95-1 | | Kwn | | | T | T | T | | | T |
| Mirex | DTXSID7020895 | 2385-85-5 | 2B | RAHC | T | | | | T | 10508 | 2169 | T |
| Mitomycin C | DTXSID2020898 | 50-07-7 | 2B | | T | | T | | | 172352 | 33326 | T |
| Mitoxantrone | DTXSID4046947 | 65271-80-9 | 2B | | | | | | | 122629 | 14317 | T |
| Mitoxantrone dihydrochlor | DTXSID0045173 | 70476-82-3 | | | T | | | | | 79132 | 4572 | T |
| Molybdenum trioxide | DTXSID7020899 | 1313-27-5 | 2B | | T | | T | T | | 50745 | 8876 | T |
| Monobasic lead acetate | DTXSID1020774 | 1335-32-6 | | RAHC | T | | T | | | | | T |
| Monocrotaline | DTXSID9020902 | 315-22-0 | 2B | | T | | | | T | 3035 | 3163 | T |
| Myrcene | DTXSID6025692 | 123-35-3 | 2B | | T | | T | T | | 27601 | 4553 | T |
| N'-Nitrosonornicotine | DTXSID4021476 | 16543-55-8 | | RAHC | T | | | | T | 1602 | 505 | T |
| N,N'-Bis(2-chloroethyl)-N | DTXSID8022743 | 154-93-8 | 2A | RAHC | T | | | | | 108198 | 11831 | T |
| N,N'-Diacetylbenzidine | DTXSID9036854 | 613-35-4 | 2B | | T | | T | | | 105 | 73 | T |
| N,N,4-Trimethylaniline | DTXSID0021832 | 99-97-8 | 2B | | T | | T | T | | 28377 | 687 | T |
| N,N-Dimethyl-N'-[5-[2-(5- | DTXSID801126079 | 25962-77-0 | 2B | | | | | | | | | |
| N,N-Dimethylacetamide | DTXSID5020499 | 127-19-5 | 2B | | T | | T | T | | 53671 | 9164 | T |
| N,N-Dimethylformamide | DTXSID6020515 | 68-12-2 | 2A | | T | | T | T | | 140231 | 60584 | T |
| N-(2-Cyanoethyl)-N-methyl | DTXSID70975579 | 60153-49-3 | 2B | | T | | | | | 33 | 31 | |
| N-Amyl-N-methylnitrosamin | DTXSID30157617 | 13256-07-0 | | | T | | | | | 17 | 91 | |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N-Heptyl-N-methylnitrous | DTXSID70936822 | 16338-99-1 | | | T | | | | | | 4 | |
| N-Hexyl-N-methylnitrous a | DTXSID20951227 | 28538-70-7 | | | T | | | | | 1 | 1 | |
| N-Methyl-N-nonylnitrous a | DTXSID80997267 | 75881-19-5 | | | T | | | | | | 1 | |
| N-Methyl-N-octylnitrous a | DTXSID50955970 | 34423-54-6 | | | T | | | | | | 1 | |
| N-Methylolacrylamide | DTXSID3020885 | 924-42-5 | | | T | EU | T | T | | 97163 | 321 | T |
| N-Nitroso-N-methyl-N-dode | DTXSID4021000 | 55090-44-3 | | | T | | | | | 298 | 25 | |
| N-Nitroso-N-methyl-N-tetr | DTXSID4021004 | 75881-20-8 | | | T | | | | | | 6 | |
| N-Nitroso-N-methyldecylam | DTXSID9021005 | 75881-22-0 | | | T | | | | | 1 | 2 | |
| N-Nitroso-N-methylethylam | DTXSID6021036 | 10595-95-6 | 2B | | T | | | | T | 204 | 67 | T |
| N-Nitroso-N-methylurea | DTXSID4021006 | 684-93-5 | 2A | RAHC | T | | T | | | 7905 | 6496 | T |
| N-Nitroso-N-methylurethan | DTXSID4021472 | 615-53-2 | 2B | | T | | T | | | 679 | 394 | T |
| N-Nitrosodi-n-propylamine | DTXSID6021032 | 621-64-7 | 2B | RAHC | T | | T | | T | 1276 | 333 | T |
| N-Nitrosodibutylamine | DTXSID2021026 | 924-16-3 | 2B | RAHC | T | | T | | T | 644 | 446 | T |
| N-Nitrosodiethanolamine | DTXSID7021027 | 1116-54-7 | 2B | RAHC | T | | T | | | 542 | 351 | T |
| N-Nitrosodiethylamine | DTXSID2021028 | 55-18-5 | 2A | RAHC | T | | T | | T | 2615 | 7220 | T |
| N-Nitrosodimethylamine | DTXSID7021029 | 62-75-9 | 2A | RAHC | T | | T | | T | 7004 | 6528 | T |
| N-Nitrosodiphenylamine | DTXSID6021030 | 86-30-6 | | | T | | T | T | T | 8944 | 345 | T |
| N-Nitrosohexamethyleneimi | DTXSID0021040 | 932-83-2 | | | T | | | | | 75 | 40 | |
| N-Nitrosomethyl-N-propyla | DTXSID90238991 | 924-46-9 | | | T | | | | | 13 | 6 | |
| N-Nitrosomethylvinylamine | DTXSID3042211 | 4549-40-0 | 2B | RAHC | T | | | | | | 0 | |
| N-Nitrosomorpholine | DTXSID4021056 | 59-89-2 | 2B | RAHC | T | | | | T | 979 | 1013 | T |
| N-Nitrosopiperidine | DTXSID8021060 | 100-75-4 | 2B | RAHC | T | | T | | T | 961 | 511 | T |
| N-Nitrosopyrrolidine | DTXSID8021062 | 930-55-2 | 2B | RAHC | T | | T | | T | 896 | 641 | T |
| N-Nitrososarcosine | DTXSID9074309 | 13256-22-9 | 2B | RAHC | T | | | | | 350 | 120 | |
| N-[4-(5-Nitro-2-furyl)-2- | DTXSID9020952 | 531-82-8 | 2B | | T | | | | | 349 | 44 | |
| Nafenopin | DTXSID8020911 | 3771-19-5 | 2B | | T | | | | | 577 | 583 | T |
| Nalidixic acid | DTXSID3020912 | 389-08-2 | | | T | | | | | 37656 | 12281 | T |
| Naphthalene | DTXSID8020913 | 91-20-3 | 2B | RAHC | T | | T | T | T | 78694 | 34015 | T |
| Nickel | DTXSID2020925 | 7440-02-0 | 2B | RAHC | T | | T | T | T | 591386 | 26453 | T |
| Nickel (II) oxide | DTXSID7025710 | 1313-99-1 | | Kwn | T | | T | T | | | 649 | T |
| Nickel carbonate | DTXSID3025708 | 3333-67-3 | | | T | | T | T | | | | T |
| Nickel carbonyl | DTXSID0024212 | 13463-39-3 | | | T | | T | | T | 6 | 1446 | T |
| Nickel hydroxide (Ni(OH)2 | DTXSID90274011 | 12054-48-7 | | Kwn | T | | T | T | | 37378 | 106 | T |
| Nickel subsulfide | DTXSID2025711 | 12035-72-2 | | Kwn | T | | T | T | | | | T |
| Nickel sulfate | DTXSID6023787 | 7786-81-4 | | Kwn | | | T | T | | 72521 | 6057 | T |
| Nickel sulfide | DTXSID801014466 | 11113-75-0 | | Kwn | | | T | T | | | | T |
| Nickel(II) acetate | DTXSID7020926 | 373-02-4 | | Kwn | T | | T | T | | 32350 | 49 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nickelocene | DTXSID8025709 | 1271-28-9 | | | T | | T | | | | 287 | T |
| Nifuradene | DTXSID2020973 | 555-84-0 | 2B | | T | | | | | 1299 | 25 | |
| Niridazole | DTXSID6045244 | 61-57-4 | 2B | | T | | | | | 3178 | 788 | T |
| Nitrapyrin | DTXSID0024216 | 1929-82-4 | | | T | | T | T | | 14054 | 768 | T |
| Nitrilotriacetic acid | DTXSID6020939 | 139-13-9 | 2B | RAHC | T | | T | T | T | 121944 | 4905 | T |
| Nitrilotriacetic acid tri | DTXSID5020940 | 18662-53-8 | | | T | | | | | 977 | 36 | |
| Nitrobenzene | DTXSID3020964 | 98-95-3 | 2B | RAHC | T | | T | T | T | 117874 | 16032 | T |
| Nitrofen | DTXSID7020970 | 1836-75-5 | 2B | RAHC | T | | T | | T | 12704 | 967 | T |
| Nitrofurazone | DTXSID5020944 | 59-87-0 | | | T | | T | T | | 3908 | 252 | T |
| Nitrogen mustard | DTXSID2020975 | 51-75-2 | 2A | | T | | T | | | 102630 | 7997 | T |
| Nitrogen mustard N-oxide | DTXSID7020976 | 126-85-2 | 2B | | T | | | | | 4268 | 5672 | T |
| Nitrogen mustard hydrochl | DTXSID8025757 | 55-86-7 | | RAHC | T | | | | | 22951 | 5809 | T |
| Nitrogen mustard oxide | DTXSID0023375 | 302-70-5 | | | T | | | | | 24324 | 5662 | T |
| Nitromethane | DTXSID2020977 | 75-52-5 | 2B | RAHC | T | | T | T | T | 50287 | 7517 | T |
| Nitroso-2,6-dimethylmorph | DTXSID4021470 | 1456-28-6 | | | T | | | | | 18 | 88 | |
| Nitrosomethyl-N-butylamin | DTXSID20220960 | 7068-83-9 | | | T | | | | | 452 | 25 | |
| Nitrosomethylundecylamine | DTXSID9021055 | 68107-26-6 | | | T | | | | | | 3 | |
| Norethindrone | DTXSID9023380 | 68-22-4 | | RAHC | T | | | | T | 43524 | 8369 | T |
| Norethynodrel | DTXSID3021069 | 68-23-5 | | | T | | | | | 9141 | 1067 | T |
| Ochratoxin A | DTXSID7021073 | 303-47-9 | 2B | RAHC | T | | | | | 2582 | 6496 | T |
| Oryzalin | DTXSID8024238 | 19044-88-3 | | | T | | | | T | 23015 | 1280 | T |
| Oxadiazon | DTXSID3024239 | 19666-30-9 | | | T | | | | T | 27954 | 356 | T |
| Oxazepam | DTXSID1021087 | 604-75-1 | 2B | | T | | | | T | 31498 | 5470 | T |
| Oxymetholone | DTXSID5023794 | 434-07-1 | | RAHC | T | | | | | 5877 | 943 | T |
| Parathion | DTXSID7021100 | 56-38-2 | 2B | | T | | | | T | 44073 | 7950 | T |
| Pentachlorophenol | DTXSID7021106 | 87-86-5 | 1 | RAHC | T | | T | T | T | 74940 | 8693 | T |
| Pentaerythritol dibromide | DTXSID9020164 | 3296-90-0 | 2B | RAHC | T | EU | T | T | | 1062 | 74 | T |
| Pentazinc chromate octahy | DTXSID30197957 | 49663-84-5 | | | | Both | | | | 2 | 0 | |
| Pentosan polysulfate sodi | DTXSID70102623 | 140207-93-8 | | | T | | | | | | | T |
| Perfluorooctanesulfonic a | DTXSID3031864 | 1763-23-1 | | | T | | T | | T | 26669 | 3356 | T |
| Perfluorooctanoic acid | DTXSID8031865 | 335-67-1 | 2B | | T | | T | | T | 23464 | 4336 | T |
| Phenacetin | DTXSID1021116 | 62-44-2 | 1 | RAHC | T | | T | T | T | 29377 | 7087 | T |
| Phenazopyridine | DTXSID1023445 | 94-78-0 | | | T | | | | T | 20885 | 902 | T |
| Phenazopyridine hydrochlo | DTXSID1021118 | 136-40-3 | 2B | RAHC | T | | | | | 7530 | 765 | T |
| Phenesterin | DTXSID6021119 | 3546-10-9 | | | T | | | | | 23597 | 35 | T |
| Phenobarbital | DTXSID5021122 | 50-06-6 | 2B | | T | | | | T | 147350 | 41672 | T |
| Phenolphthalein | DTXSID0021125 | 77-09-8 | 2B | RAHC | T | Both | T | | | 86632 | 16225 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phenoxybenzamine | DTXSID0023458 | 59-96-1 | | | T | | | | | 13428 | 9404 | T |
| Phenoxybenzamine hydrochl | DTXSID0021127 | 63-92-3 | 2B | RAHC | T | | | | | 1788 | 5402 | T |
| Phenyl glycidyl ether | DTXSID8021145 | 122-60-1 | 2B | | T | | T | T | | 51345 | 723 | T |
| Phenylhydrazine | DTXSID8021147 | 100-63-0 | | | T | | T | | | 52396 | 7854 | T |
| Pioglitazone | DTXSID3037129 | 111025-46-8 | 2A | | T | | | | T | 74776 | 4456 | T |
| Pirimicarb | DTXSID1032569 | 23103-98-2 | | | T | | | | T | 32192 | 957 | T |
| Pitch, coal tar, high-tem | DTXSID1028285 | 65996-93-2 | 1 | Kwn | T | Both | T | T | | | | T |
| Plutonium | DTXSID4064682 | 7440-07-5 | 1 | | | | | | | 31171 | 3680 | T |
| Polybrominated biphenyls | DTXSID5021174 | 59536-65-1 | 2A | RAHC | T | | | | T | | | T |
| Polychlorinated biphenyls | DTXSID5024267 | 1336-36-3 | 1 | RAHC | T | | T | | T | | | T |
| Polycyclic aromatic hydro | DTXSID3044043 | 130498-29-2 | | RAHC | | | | T | T | | | T |
| Ponceau 3R | DTXSID7021231 | 3564-09-8 | 2B | | T | | | | | 258 | 32 | |
| Potassium N-methyldithioc | DTXSID1034424 | 137-41-7 | | | T | | | | T | 3958 | 149 | T |
| Potassium arsenite anhydr | DTXSID10274159 | 13464-35-2 | | Kwn | | | | | | 4 | 82 | |
| Potassium bromate | DTXSID6020195 | 7758-01-2 | 2B | | T | | T | | | 11701 | 2523 | T |
| Potassium chromate(VI) | DTXSID8064858 | 7789-00-6 | | Kwn | | Both | T | | | 10310 | 2536 | T |
| Potassium dichromate | DTXSID5025948 | 7778-50-9 | | Kwn | | Both | T | | | 40647 | 15954 | T |
| Premarin | DTXSID9021186 | 12126-59-9 | | Kwn | | | | | | | | |
| Primidone | DTXSID7023510 | 125-33-7 | 2B | | T | | | | T | 21937 | 5165 | T |
| Procarbazine | DTXSID4021189 | 671-16-9 | | RAHC | T | | | | | 133053 | 8706 | T |
| Procarbazine hydrochlorid | DTXSID3021190 | 366-70-1 | 2A | RAHC | T | | | | | 24535 | 3444 | T |
| Procymidone | DTXSID9033923 | 32809-16-8 | | | T | | | | T | 19068 | 755 | T |
| Progesterone | DTXSID3022370 | 57-83-0 | | RAHC | T | | T | | T | 115933 | 123256 | T |
| Propachlor | DTXSID4024274 | 1918-16-7 | | | T | | | | T | 29406 | 450 | T |
| Propargite | DTXSID4024276 | 2312-35-8 | | | T | | | | T | 29783 | 466 | T |
| Propoxur | DTXSID7021948 | 114-26-1 | | | T | | | | T | 39359 | 2022 | T |
| Propyleneimine | DTXSID8024286 | 75-55-8 | 2B | RAHC | T | | T | T | | 10917 | 169 | T |
| Propyzamide | DTXSID2020420 | 23950-58-5 | | | T | | | | T | 21198 | 577 | T |
| Pymetrozine | DTXSID2032637 | 123312-89-0 | | | T | | | | T | 12739 | 353 | T |
| Pyridine | DTXSID9021924 | 110-86-1 | 2B | | T | | T | T | T | 178813 | 80334 | T |
| Quartz (SiO2) | DTXSID3032040 | 14808-60-7 | 1 | Kwn | T | | T | T | | | | T |
| Quinoline | DTXSID1021798 | 91-22-5 | 2B | | T | | T | T | T | 235320 | 15414 | T |
| R-(+)-Pulegone | DTXSID2025975 | 89-82-7 | 2B | | T | | T | | | 8069 | 505 | T |
| Radium-224 | DTXSID50912341 | 13233-32-4 | 1 | | | | | | T | 503 | 159 | T |
| Radium-226 | DTXSID3051202 | 13982-63-3 | 1 | | | | | | T | 1904 | 165 | T |
| Radium-228 | DTXSID6050415 | 15262-20-1 | 1 | | | | | | T | 249 | 43 | T |
| Radon | DTXSID701015778 | 10043-92-2 | 1 | Kwn | | | | | T | 42893 | 6555 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Refractories, fibers, alu | DTXSID90891702 | 142844-00-6 | 2B | | T | Both | | T | | | | T |
| Reserpine | DTXSID7021237 | 50-55-5 | | RAHC | T | | T | | | 201285 | 28228 | T |
| Resmethrin | DTXSID7022253 | 10453-86-8 | | | T | | | | T | 14870 | 427 | T |
| Rhodamine B | DTXSID6042369 | 81-88-9 | | | T | | T | | | 181293 | 13925 | T |
| Riddelliine | DTXSID4026006 | 23246-96-0 | 2B | RAHC | T | | | | | 4 | 72 | |
| Riebeckite | DTXSID5030743 | 12001-28-4 | | Kwn | | | | | T | | | T |
| Safrole | DTXSID0021254 | 94-59-7 | 2B | RAHC | T | | T | | T | 18387 | 1956 | T |
| Sedaxane | DTXSID2058207 | 874967-67-6 | | | T | | | | T | 14302 | 60 | T |
| Selenium sulfide (SeS) | DTXSID9021265 | 7446-34-6 | | RAHC | T | | | | | 10751 | 742 | T |
| Semustine | DTXSID8031603 | 13909-09-6 | 1 | Kwn | T | | | | | 41318 | 1004 | T |
| Shale oils | DTXSID7028435 | 68308-34-9 | 1 | | T | | T | | | | | T |
| Silicon carbide | DTXSID5052751 | 409-21-2 | 2A | | T | | T | T | | 170678 | 7975 | T |
| Silicon carbide, fibrous | DTXSID701020379 | 308076-74-6 | 2B | | | | | | | | | |
| Sodium 2-phenylphenate | DTXSID2021153 | 132-27-4 | 2B | | T | | T | | | 8929 | 357 | T |
| Sodium arsenate | DTXSID5020102 | 7631-89-2 | | Kwn | | | T | | | | | T |
| Sodium arsenite | DTXSID5020104 | 7784-46-5 | | Kwn | | | T | | | 18323 | 3161 | T |
| Sodium chromate | DTXSID7032056 | 7775-11-3 | | Kwn | | Both | T | | | 10080 | 1441 | T |
| Sodium dichromate | DTXSID8021274 | 10588-01-9 | | Kwn | | Both | T | T | | 20057 | 1021 | T |
| Sodium pentachlorophenate | DTXSID4040264 | 131-52-2 | | RAHC | | | T | | | 11099 | 2350 | T |
| Spirodiclofen | DTXSID6034928 | 148477-71-8 | | | T | | | | T | 24470 | 195 | T |
| Spironolactone | DTXSID6034186 | 52-01-7 | | | T | | | | | 60269 | 21554 | T |
| Stanozolol | DTXSID3044128 | 10418-03-8 | | | T | | | | | 8003 | 1550 | T |
| Sterigmatocystin | DTXSID2021280 | 10048-13-2 | 2B | | T | | | | | 506 | 1234 | T |
| Streptozotocin | DTXSID2021282 | 18883-66-4 | 2B | RAHC | T | | | | | 96389 | 19175 | T |
| Strontium chromate | DTXSID70872832 | 7789-06-2 | | Kwn | | Both | T | T | | 10850 | 239 | T |
| Styrene | DTXSID2021284 | 100-42-5 | 2A | RAHC | T | | T | T | T | 309037 | 38045 | T |
| Styrene oxide | DTXSID2021286 | 96-09-3 | 2A | RAHC | T | | T | | | 73762 | 2422 | T |
| Sulfallate | DTXSID7021289 | 95-06-7 | 2B | RAHC | T | | | | T | 9381 | 96 | T |
| Sulfasalazine | DTXSID0021256 | 599-79-1 | 2B | | T | | | | | 98963 | 8438 | T |
| Sulfuric acid | DTXSID5029683 | 7664-93-9 | | Kwn | | | T | T | T | 334467 | 122647 | T |
| Talc | DTXSID5032109 | 14807-96-6 | 2B | | T | | T | T | T | | | T |
| Tamoxifen | DTXSID1034187 | 10540-29-1 | 1 | Kwn | T | | | | T | 127664 | 47356 | T |
| Teniposide | DTXSID8023638 | 29767-20-2 | 2A | | | | | | | 93396 | 3043 | T |
| Teriparatide | DTXSID001027900 | 52232-67-4 | | | T | | | | | | | |
| Testosterone | DTXSID8022371 | 58-22-0 | | | T | | T | | T | 94121 | 135724 | T |
| Tetrachloroethylene | DTXSID2021319 | 127-18-4 | 2A | RAHC | T | | T | T | T | 56538 | 7992 | T |
| Tetraethyl lead | DTXSID7023801 | 78-00-2 | | RAHC | | | T | T | T | 11519 | 1832 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tetrafluoroethylene | DTXSID6021325 | 116-14-3 | 2A | RAHC | T | | T | T | | 48648 | 2986 | T |
| Tetrahydrofuran | DTXSID1021328 | 109-99-9 | 2B | | T | | T | T | T | 198206 | 46843 | T |
| Tetranitromethane | DTXSID5021334 | 509-14-8 | 2B | RAHC | T | | T | | | 10594 | 1480 | T |
| Thioacetamide | DTXSID9021340 | 62-55-5 | 2B | RAHC | T | | T | | | 18385 | 5414 | T |
| Thiodicarb | DTXSID0032578 | 59669-26-0 | | | T | | | | T | 142 | 113 | T |
| Thiotepa | DTXSID0021339 | 52-24-4 | 1 | Kwn | T | | | | | 132998 | 7436 | T |
| Thiouracil | DTXSID4021347 | 141-90-2 | 2B | | T | | T | | | 47267 | 4128 | T |
| Thiourea | DTXSID9021348 | 62-56-6 | | RAHC | T | | T | T | | 36477 | 29607 | T |
| Thorium | DTXSID6049800 | 7440-29-1 | 1 | | | | T | | T | 63012 | 147 | T |
| Thorium(IV) oxide | DTXSID0051657 | 1314-20-1 | | Kwn | T | | T | | | 32451 | 3427 | T |
| Titanium dioxide | DTXSID3021352 | 13463-67-7 | 2B | | T | | T | T | | | | T |
| Toluene 2,4-diisocyanate | DTXSID7026156 | 584-84-9 | | RAHC | | | T | T | T | 100258 | 3527 | T |
| Toluene diisocyanate | DTXSID0024341 | 26471-62-5 | 2B | RAHC | T | | T | T | | | | T |
| Toluene-2,6-diisocyanate | DTXSID2026157 | 91-08-7 | | RAHC | | | T | T | T | 57372 | 286 | T |
| Toxaphene | DTXSID7021368 | 8001-35-2 | 2B | RAHC | T | | | | T | | | T |
| Tremolite asbestos | DTXSID701026177 | 77536-68-6 | | Kwn | | | | | | | | |
| Treosulfan | DTXSID0026173 | 299-75-2 | 1 | | T | | | | | 11539 | 148 | T |
| Triamterene | DTXSID6021373 | 396-01-0 | 2B | | T | | | | T | 33615 | 4021 | T |
| Tribromoacetic acid | DTXSID6021668 | 75-96-7 | | RAHC | | | T | | | 1914 | 163 | T |
| Tribromoneopentyl alcohol | DTXSID40893054 | 36483-57-5 | | | | EU | T | T | | | | T |
| Tribufos | DTXSID1024174 | 78-48-8 | | | T | | T | T | T | 7277 | 446 | T |
| Trichlormethine | DTXSID6074835 | 817-09-4 | 2B | | T | | | | | 215 | 78 | |
| Trichloroacetic acid | DTXSID1021378 | 76-03-9 | 2B | | T | | T | | T | 8644 | 42054 | T |
| Trichloroethylene | DTXSID0021383 | 79-01-6 | 1 | Kwn | T | Both | T | T | T | 56309 | 17227 | T |
| Tridymite | DTXSID6049563 | 15468-32-3 | | Kwn | | | | | | | | |
| Triethyl arsenate | DTXSID20166036 | 15606-95-8 | | | | Both | | | | 149 | 3 | |
| Trim VX | DTXSID701052685 | 1204332-00-2 | | | T | | | | | | | T |
| Trimethyl orthophosphate | DTXSID1021403 | 512-56-1 | | | T | | T | T | | 67999 | 913 | T |
| Trimethylolpropane triacr | DTXSID0027773 | 15625-89-5 | 2B | | T | | T | T | | 45319 | 605 | T |
| Triphenyltin hydroxide | DTXSID1021409 | 76-87-9 | | | T | | T | T | | 21418 | 335 | T |
| Tris(1,3-dichloro-2-propy | DTXSID9026261 | 13674-87-8 | | | T | | T | T | T | 4732 | 325 | T |
| Tris(2,3-dibromopropyl) p | DTXSID5021413 | 126-72-7 | 2A | RAHC | T | | T | | T | 11314 | 369 | T |
| Tris(2-chloroethyl) phosp | DTXSID5021411 | 115-96-8 | | | T | | T | | T | 19483 | 510 | T |
| Trp-P-1 | DTXSID0043767 | 62450-06-0 | 2B | | T | | | | T | 483 | 300 | T |
| Trp-P-2 | DTXSID5043768 | 62450-07-1 | 2B | | T | | | | T | 703 | 331 | T |
| Uracil mustard | DTXSID8026270 | 66-75-1 | 2B | | T | | | | | 65211 | 251 | T |
| Urethane | DTXSID9021427 | 51-79-6 | 2A | RAHC | T | | T | | | 173756 | 25913 | T |

**Return to:** Section 2.1.1. Continued, next page...

**Table E1:** Complete list of candidate carcinogens

| Chemical Name | DTXSID | CAS | IARC | ROC | Prop65 | SVHC | TSCA Active | CDR 2020 | MMDBV1 | Pat. Count | Lit. Count | Ubiq. Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vanadium oxide (V2O5) | DTXSID2023806 | 1314-62-1 | 2B | | T | | T | T | | | | T |
| Vinclozolin | DTXSID4022361 | 50471-44-8 | | | T | | | | T | 39037 | 1394 | T |
| Vincristine-prednisone-ni | DTXSID701045240 | 113803-47-7 | | | T | | | | | | | |
| Vinyl acetate | DTXSID3021431 | 108-05-4 | 2B | | | | T | T | T | 107263 | 7107 | T |
| Vinyl bromide | DTXSID8021432 | 593-60-2 | 2A | RAHC | T | | T | | T | 38132 | 852 | T |
| Vinyl chloride | DTXSID8021434 | 75-01-4 | 1 | Kwn | T | | T | T | T | 96428 | 10265 | T |
| Vinyl fluoride | DTXSID3021435 | 75-02-5 | 2A | RAHC | T | | T | T | | 128091 | 1033 | T |
| Z-Tetrachlorvinphos | DTXSID1032648 | 22248-79-9 | 2B | | T | | | | T | 30515 | 144 | T |
| Zileuton | DTXSID9023752 | 111406-87-2 | | | T | | | | | 17395 | 1671 | T |
| Zinc chromate | DTXSID7047485 | 13530-65-9 | | Kwn | | | T | T | | 15302 | 544 | T |
| Zinc potassium chromate | DTXSID2026313 | 11103-86-9 | | | | Both | T | T | | | 20 | T |
| alpha,alpha-bis[4-(Dimeth | DTXSID4064474 | 6786-83-0 | | | | Both | T | | | 18 | 0 | T |
| alpha-1,2,3,4,5,6-Hexachl | DTXSID2020684 | 319-84-6 | | RAHC | | | T | | T | 104118 | 10426 | T |
| alpha-Methylstyrene | DTXSID9025661 | 98-83-9 | 2B | | T | | T | T | | 38793 | 1821 | T |
| beta-Butyrolactone | DTXSID1020223 | 3068-88-0 | 2B | | T | | T | | | 15557 | 201 | T |
| beta-Hexachlorocyclohexan | DTXSID7020685 | 319-85-7 | | RAHC | | | T | | T | 104118 | 10426 | T |
| beta-Propiolactone | DTXSID8021197 | 57-57-8 | 2B | RAHC | T | | T | | | 49583 | 1530 | T |
| bis(2-Chloro-1-methylethy | DTXSID4020167 | 108-60-1 | | | T | | T | | T | 3221 | 84 | T |
| bis(Chloromethyl) ether | DTXSID8020173 | 542-88-1 | | Kwn | T | | T | | T | 3468 | 369 | T |
| o-Aminoazotoluene | DTXSID1020069 | 97-56-3 | 2B | RAHC | T | Both | T | | | 1341 | 286 | T |
| p,p'-DDD | DTXSID4020373 | 72-54-8 | | | T | | | | T | 1351 | 1885 | T |
| p,p'-DDE | DTXSID9020374 | 72-55-9 | | | T | | | | T | 955 | 5481 | T |
| p-Nitroanisole | DTXSID9059208 | 100-17-4 | 2B | | T | | T | | | 3860 | 793 | T |
| trans-2-[(Dimethylamino)m | DTXSID7020502 | 55738-54-0 | | | T | | | | | | 0 | |

**Return to:** Section 2.1.1.