Methods

Indicator

E4. Percentage of children ages 0 to 17 years living in census tracts where estimated hazardous air pollutant concentrations were greater than health benchmarks in 2005.

Summary

EPA's Office of Air Quality Planning and Standards (OAQPS) estimated census tract annual average outdoor concentrations of 181[i] hazardous air pollutants (HAPs), also known as air toxics, as part of EPA's National Air Toxics Assessment (NATA) for the calendar year 2005. EPA used a computer dispersion model, the Assessment System for Population Exposure Nationwide (ASPEN), to estimate these concentrations based on the 2005 emissions inventory of air toxics emissions from outdoor sources. The lifetime cancer risks posed by HAPs in each census tract were calculated by multiplying the ambient concentration of each HAP by the inhalation unit risk estimate (URE) of that HAP. The risk estimates for all modeled HAPs with cancer unit risk estimates then were summed together to provide a combined cancer risk estimate. The census tracts for which this value exceeded 1-in-100,000 and 1-in-10,000 were identified, producing two lists of census tracts. For each list of census tracts, the number of children ages 0 to 17 years in the identified census tracts was summed together. The resulting value then was divided by the number of children ages 0 to 17 years in all census tracts in the United States, yielding the percentage of children living in census tracts where the concentrations of carcinogenic hazardous air pollutants exceeded the two benchmark cancer risk levels. For non-cancer health benchmarks, census tracts in which the annual average concentration exceeded the reference concentration for any HAP were identified. The number of children ages 0 to 17 years in the identified census tracts was summed together. The resulting value was then divided by the number of children ages 0 to 17 years in all census tracts in the United States to yield the percentage of children living in census tracts where the concentration of one or more hazardous air pollutants exceeded the health benchmark for effects other than cancer. Table E4a provides the same set of results for the percentages of schoolchildren attending public or private elementary or secondary schools in census tracts where the concentrations of carcinogenic hazardous air pollutants exceeded the two benchmark cancer risk levels or where the concentration of one or more hazardous air pollutants exceeded the health benchmark for effects other than cancer. Table E4b provides the percentage of children living in census tracts where the cancer risk from estimated hazard air pollutant concentrations was at least one in 10,000 in 2005, by race/ethnicity and family income. Table E4c provides the percentage of children ages 0 to 17 years living in census tracts where the non-cancer risk from estimated hazardous air pollutant concentrations exceeded health benchmarks in 2005, by race/ethnicity and family income.

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[i] The NATA website reports that 177 HAPs were modeled in NATA 2005, plus diesel particulate matter. The count of HAPs considered for this indicator differs from the number reported on the NATA website as follows: rather than a single value for Polycyclic Organic Matter (POM), this analysis includes eight POM groups; rather than a single value for chromium compounds, this analysis considers three different types of chromium compounds; and this analysis excludes six individual xylene and cresol isomers.

Overview of Data Files

The following files are needed to calculate this indicator:

- Census tract annual average HAP concentrations. There is one ACCESS data table for each of the modeled HAPs. This table contains the state, county and census tract FIPS codes, the total annual average ASPEN-modeled concentration, and other information not used for these calculations. These ACCESS files were obtained from the NATA 2005 Web page: http://www.epa.gov/ttn/atw/nata2005/tables.html
  See under "2005 Tract-Level Modeled Ambient Concentrations, Exposures, and Risks."

  For the eight individual air toxics groups of Polycyclic Organic Matter (POM), the Web page provides a file with the total concentrations summed over these 8 hazardous air pollutants. We obtained the census tract annual average files for these 8 individual hazardous air pollutants directly from EPA OAQPS.[ii]

  For chromium compounds, the Web page provides a file with the total concentrations summed over 21 chromium species that were each modeled separately. We obtained the census tract annual average files for the 21 modeled chromium species directly from EPA OAQPS.[iii]

- Health effects information. This file health_effects.pdf lists the cancer unit risk estimate (URE) for all carcinogenic HAPs and lists the reference concentrations (RfC) for HAPs with non-cancer health effects. We obtained this file from the Web page: http://www.epa.gov/ttn/atw/nata2005/riskbg.html. See under "Health Effects Information (PDF)."

- American Community Survey 2005-2009 Census data. These files contain the state, county, and census tract FIPS codes, age group, sex, race/ethnicity group, income group (all, below poverty level, at or above poverty level) and average population for 2005-2009.: We obtained these data from the following url:

  http://www2.census.gov/acs2009_5yr/summaryfile/

  Example SAS programs used to extract these data were obtained from the following url:

  http://www2.census.gov/acs2009_5yr/summaryfile/UserTools/

  The populations by census tract were obtained by summing across the ages 0 to 17 years inclusive and across both sexes.

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Air Quality Data

Health effects information for the hazardous air pollutants studied in the National Air Toxics Assessment (NATA) for 2005 were obtained from the file health_effects.pdf on the Web page: http://www.epa.gov/ttn/atw/nata2005/riskbg.html. See under "Health Effects Information (PDF)." This file includes the cancer unit risk estimates (URE) and non-cancer reference concentrations (RfC) for 179 of the 181 HAPs modeled in NATA 2005, including chromium (VI) compounds. In addition, EPA OAQPS[iv] provided a file with URE and RfC values for two chromium compounds air toxics groups: chromium (III) compounds (no URE reported and no RfC reported), and chromium (VI) trioxide - chromic acid mist (no URE reported, RfC = 0.000008 mg/m^3). Some of the HAPs had no URE reported, and so were treated as having no cancer risk. Some of the HAPs had no RfC reported, and so were treated as having no non-cancer health benchmark. Several of the 181 HAPs had neither a reported URE nor a reported RfC.

Estimated census tract average annual outdoor ambient concentrations for the year 2005 were obtained from the Web page: http://www.epa.gov/ttn/atw/nata2005/tables.html. See under "2005 Tract-Level Modeled Ambient Concentrations, Exposures, and Risks."

We obtained ACCESS files with ASPEN estimated concentrations for each of 172 HAPs. One of these HAPs was named "PAHPOM." This denotes the total concentration summed over the eight individual air toxics groups of Polycyclic Organic Matter (POM). In order to apply appropriate UREs and RFCs to these 8 individual HAPs, we obtained census tract average concentration files in ACCESS format for these 8 individual HAPs directly from EPA OAQPS.[v] Another of these HAPs was named "Chromium compounds." This denotes the total concentration summed over the three air toxics groups of chromium compounds: chromium (III) compounds (5 species); chromium (VI) compounds (15 species); chromium (VI) trioxide - chromic acid mist (1 species). In order to apply appropriate UREs and RFCs to these 3 groups of chromium compounds, we obtained census tract average concentration files in ACCESS format for the 21 individual chromium species directly from EPA OAQPS[vi] and summed over the census tract average concentrations in each group. Therefore we analyzed 181 individual HAPs. The named HAP from each of these 181 census tract average concentration files matched exactly one of the HAPs listed in the health_effects.pdf file, with three exceptions: The HAP "1,2,3,4,5,6-HEXACHLOROCYCLYHEXANE (ALL STEREO ISOMERS)" was matched to the risks for "Lindane (all isomers)." The benchmarks for the two chromium compound groups chromium (III) compounds and chromium (VI) trioxide - chromic acid mist were obtained from a different file.

Census Data

Census data were obtained from the American Community Survey 5-year 2005-2009 Census data. These files contain the state, county, and census tract FIPS codes, age group, sex,

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race/ethnicity group, income group (all, below poverty level, at or above poverty level) and average population for 2005-2009. We obtained these data from the following url:

http://www2.census.gov/acs2009_5yr/summaryfile/

Example SAS programs used to extract these data were obtained from the following url:

http://www2.census.gov/acs2009_5yr/summaryfile/UserTools/

We edited and applied the example SAS code to extract census tract population data from the following tables:

- B01001. Populations by sex and age.
- B01001A to B10001I. Populations by sex, age, and race/ethnicity.
- B17001. Populations by sex, age, and known poverty status.
- B17001A to B17001I. Populations by sex, age, race/ethnicity, and known poverty status.

The populations by census tract, race/ethnicity, and poverty status (including all) were obtained by summing across the ages 0 to 17 years inclusive and across both sexes.

The race/ethnicity groups used were as follows:

- White alone
- Black alone
- American Indian / Alaska Native (AIAN) alone
- Asian alone
- Native Hawaiian And Other Pacific Islander (NHOPI) alone
- Other Races (sum of tabulated populations for Some Other Race alone and Two or More Races)
- Hispanic

The poverty status groups used were as follows:
- All (includes persons with unknown poverty status)
- Below poverty level
- At or above poverty level

Calculation of Indicator

Indicator E4 is calculated as follows. The same set of calculations is repeated for the populations of each race/ethnicity and poverty status group to give the results in Tables E4b and E4c.

1. For each census tract, the cancer risk for each carcinogenic HAP is estimated by multiplying the ASPEN estimated annual average outdoor concentration ($\mu g/m^3$) by the unit risk estimate, URE. The URE is an estimate of the excess cancer risk resulting from a lifetime of continuous

exposure to a pollutant at a concentration of one microgram per cubic meter (1 $\mu g/m^3$) in air. Thus,

> Cancer risk (census tract T, HAP H) =
> ASPEN Annual Concentration (census tract T, HAP H) × URE (HAP H)

2. The total cancer risk for each census tract is estimated by summing the cancer risks across all carcinogenic HAPs:

> Total cancer risk (census tract T) = Σ Cancer risk (census tract T, HAP H)

where this sum is across all HAPs.

3. The set of census tracts with a total cancer risk greater than 1-in-100,000 is listed. These are the affected census tracts.

4. The total population of children 0-17 living in the step 3 census tracts is summed:

> Population affected = Σ Pop (census tract T), summed over the affected census tracts only

5. The total U.S. population of children 0-17 is summed:

> U.S. Population = Σ Pop (census tracts C), summed over all census tracts in the United States

6. The percentage of affected children is calculated by dividing the population affected by the total U.S. population:

> Percentage children affected = [Population affected / U.S. Population] × 100%

The percentage affected in step 6 is the percentage of children exceeding the 1-in-100,000 cancer health benchmark.

A very similar calculation gives the percentage of children exceeding the 1-in-10,000 cancer health benchmark. The only change is to redefine the list of affected census tracts in step 3 as those census tracts exceeding the 1-in-10,000 cancer risk.

The calculation for the other health effects benchmark proceeds as follows.

1. For each HAP with a reference concentration, we list the census tracts affected by non-cancer effects from that HAP. A census tract is affected by a given HAP if the ASPEN estimated annual average outdoor concentration exceeds the reference concentration.

2. We list the affected census tracts as any census tract that is affected by non-cancer effects from one or more of the modeled HAPs.

Now repeat the cancer risk steps 4, 5, and 6 above using the new list of affected census tracts. The percentage affected is the percentage of children exceeding the non-cancer health benchmark.

Children at Schools

Table E4a provides the percentages of schoolchildren attending public or private elementary or secondary schools in census tracts where the ambient concentrations of carcinogenic hazardous air pollutants exceeded the two benchmark cancer risk levels or where the concentration of one or more hazardous air pollutants exceeded the health benchmark for effects other than cancer.

The schools data used for these calculations were obtained by EPA[vii] from the U.S. Department of Education. Data on public schools for the school year 2006-2007 were obtained from the Public Elementary/Secondary School Universe Survey Data. Data on private schools for the school year 2005-2006 were obtained from the Private School Universe Survey:

- Public Elementary/Secondary School Universe Survey Data**.** EPA selected data for the school year 2006-2007 and all public elementary and secondary schools in the database. Selected variables used for these analyses were: total students, school location latitude and longitude.

  These data were obtained from the following website:

  http://nces.ed.gov/ccd/

- Private School Universe Survey Data. EPA selected data for the school year 2005-2006 and all private elementary and secondary schools in the database. Selected variables used for these analyses were: total students, school location latitude and longitude.

  These data were obtained from the following website:

  http://nces.ed.gov/surveys/pss/pssdata.asp

This analysis also used the NATA 2005 tract annual averages files:

- Census tract annual average HAP concentrations. There is one ACCESS data table for each of the modeled HAPs. This table contains the state, county and census tract FIPS codes, the total annual average ASPEN-modeled concentration, and other information not used for these calculations. These ACCESS files were obtained from the NATA 2005 Web page: http://www.epa.gov/ttn/atw/nata2005/tables.html
  See under "2005 Tract-Level Modeled Ambient Concentrations, Exposures, and Risks."

  For the eight individual air toxics groups of Polycyclic Organic Matter (POM), the Web page provides a file with the total concentrations summed over these 8 hazardous air

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pollutants. We obtained the census tract annual average files for these 8 individual hazardous air pollutants directly from EPA OAQPS.[viii]

For chromium compounds, the Web page provides a file with the total concentrations summed over 21 chromium species that were each modeled separately. We obtained the census tract annual average files for the 21 individual modeled chromium species directly from EPA OAQPS.[ix]

Public Elementary/Secondary School Universe Survey Data.

The Common Core of Data (CCD) is a program of the U.S. Department of Education's National Center for Education Statistics that annually collects fiscal and non-fiscal data about all public schools, public school districts, and state education agencies in the United States. The data are supplied by state education agency officials and include information that describes schools and school districts, including name, address, and phone number; descriptive information about students and staff, including demographics; and fiscal data, including revenues and current expenditures.

Private School Universe Survey.

In 1988, the National Center for Education Statistics (NCES) introduced a proposal to develop a private school data collection that would improve on the sporadic collection of private school data dating back to 1890 and improve on commercially available private school sampling frames. Since 1989, the U.S. Bureau of the Census has conducted the biennial Private School Universe Survey (PSS) for NCES. The PSS is designed to generate biennial data on the total number of private schools, students, and teachers, and to build a universe of private schools in the 50 states and the District of Columbia to serve as a sampling frame of private schools for NCES sample surveys. The target population for the PSS is all schools in the 50 states and the District of Columbia that are not supported primarily by public funds, provide classroom instruction for one or more of grades kindergarten through 12 (or comparable ungraded levels), and have one or more teachers.

Calculation of Indicator

EPA compiled the public and private school data into a single database. For each school, the latitude and longitude were used to calculate the BLOCK_ID, a 15 character identifier for the census block nearest to the school, as defined by the distance between the school and the census block centroid. The first five characters of the BLOCK_ID gives the County FIPS code. The next six characters of the BLOCK_ID give the Tract FIPS code. The final four characters of the BLOCK_ID give the Block FIPS code. The school populations were summed across all county and tract combinations. Table E4a was calculated using the same methods as in the "Calculation of Measure" section, replacing census tract populations of children 0 to 17 years by total school

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populations for each county / tract, and summing over all county / tract combinations in the schools database.

Questions and Comments

Questions regarding these methods, and suggestions to improve the description of the methods, are welcome. Please use the "Contact Us" link at the bottom of any page in the America's Children and the Environment website.