

Methods

Indicator

E7. Estimated percentage of children ages 0 to 17 years served by community water systems that did not meet all applicable health-based drinking water standards, 1993–2009.

E8. Estimated percentage of children ages 0 to 17 years served by community water systems with violations of drinking water monitoring and reporting requirements, 1993–2009.

Summary

EPA's Safe Drinking Water Information System Federal Version (SDWIS/FED) includes information on populations served and violations of maximum contaminant levels or required treatment techniques by the nation's 160,000 public water systems. For each calendar year, SDWIS/FED violation data for the nation's 50,000 community water systems were obtained from EPA Office of Ground Water and Drinking Water (OGWDW), listing all violations that occurred during part or all of that year. For Indicator E7, health-based violations were grouped into different types based on the violation code and chemical contaminant code. For Indicator E8, violations of monitoring and reporting requirements were grouped into different types based on the violation code. For each state and type of violation, the fraction of the population served by violating systems was estimated as the total population served by community water systems with one or more violations divided by the total population served by all community water systems. For each state and type of violation, the number of children served by violating systems was estimated as the fraction of the population served by violating systems multiplied by the total population of children ages 17 years and under in the state. Indicators E7 and E8 are the percentages of children served by violating systems in relation to all children served by community water systems, estimated by summing the numbers of children served by violating systems across all states and dividing this total by the national total population of children ages 17 years and under.

Overview of Data Files

The following files are needed to calculate this indicator:

- SDWIS/FED violation data. This file contains the public water system identification code (PWSID), violation code, contaminant code, contaminant type, state (primary state served by the water system), population served, and calendar year. The SDWIS/FED database records the PWSID and start and end date of each violation. This file has one row for each calendar year and violation where the violation starts on or before December 31 and ends on or after January 1. This file only contains violations by Community Water

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Systems (as defined by OGWDW).ⁱ The population served is the current (fourth quarter 2009) estimate of the population served by that water system. This file was obtained directly from OGWDW staff.

- SDWIS/FED inventory data. This file contains the total population served by all community water systems in each state and year. The data for 2009, fourth quarter, frozen as of January 2010, were used for these analyses. This file was obtained directly from OGWDW staff.
- Census data. This file contains the state FIPS codes, year, and children's population. For 1993-1999, we obtained this information from the U.S. Census Bureau files:

“Estimates of the Population of Counties by Age and Sex: 1990-1999,” August 30, 2000, .

For 2000-2009, we obtained this information from the bridged-race Vintage 2009 postcensal population files:

National Center for Health Statistics. Postcensal estimates of the resident population of the United States for July 1, 2000-July 1, 2009, by year, county, age, bridged race, Hispanic origin, and sex (Vintage 2009). Prepared under a collaborative arrangement with the U.S. Census Bureau; released June 20, 2010. Available from: http://www.cdc.gov/nchs/nvss/bridged_race.htm as of July 23, 2010.

The children's populations by year and state were obtained by summing across all counties and across the ages 0 to 17 years inclusive.

Drinking Water Standards Violation Data

Drinking water standards violation data from the EPA Safe Drinking Water Information System Federal Version (SDWIS/FED) were obtained directly from OGWDWⁱⁱ. The file was extracted from SDWIS/FED in November 2010. This file contains the public water system identification code (PWSID), violation code, contaminant code, state (primary state served by the water system), population served, and calendar year. The SDWIS database records the PWSID and start and end date of each violation. This file has one row for each calendar year and violation where the violation starts on or before December 31 and ends on or after January 1. Violations that start and end in different calendar years are included for each of the calendar years that intersect the violation period. This file only contains violations by Community Water Systems. The population served is the current (fourth quarter 2009) estimate of the population served by that water system. Violations by systems not assigned to one of the 50 U.S. States or Washington DC were excluded. Therefore, we did not include violations in Puerto Rico and other U.S.

ⁱ Community Water Systems have at least 15 service connections or serve 25 or more of the same population year-round.

ⁱⁱ<http://water.epa.gov/drink/contact.cfm>

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territories that are not states. We also excluded violations on tribal lands which are assigned to the EPA regions. Finally, we excluded a single SWTR TT for PWSID CA1910067 determined to be invalid by OGWDW staff.

For Indicator E7, health-based violations were grouped into the following violation types using the violation and contaminant codes:

- All health-based: Violation codes 20, 48 (Ground water rule), 40 (Filter backwash recycling rule), or any of the following violations
- Lead and copper: Violation codes 57, 58, 59, 63, 64, 65
- Total coliforms: Violation codes 21 and 22 with all contaminant codes. Violation codes 1 and 2 with contaminant code 3000 (Coliform pre-TCR) only
- Chemical and radionuclide: Violation codes 1, 2 and 7 with all applicable contaminant codes*
- Surface water treatment: Violation codes 33, 41-44 and 47 with all contaminant codes. Violation code 37 with contaminant code 0300 only
- Nitrate/nitrite: Violation codes 1 and 2 with contaminant codes 1038, 1040, and 1041
- Disinfectants and disinfection byproducts: Violation codes 11, 12, 13, and 46 with all contaminant codes. Violation code 2 with contaminant codes 1009, 1011, 2456, 2941, 2942, 2943, 2944 and 2950. Violation code 37 with contaminant code 0400.

* The applicable contaminant codes for Chemical and radionuclide are as follows:

Volatile organic chemicals: 2378, 2380, 2955, 2964, 2968, 2969, 2976, 2977, 2979, 2980, 2981, 2982, 2983, 2984, 2985, 2987, 2989, 2990, 2991, 2992, 2996

Synthetic organic contaminants: 2005, 2010, 2015, 2020, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2039, 2040, 2041, 2042, 2046, 2050, 2051, 2063, 2065, 2067, 2105, 2110, 2274, 2298, 2306, 2326, 2383, 2388, 2390, 2392, 2394, 2396, 2400, 2931, 2946, 2959

Inorganic chemicals: 1005, 1010, 1015, 1020, 1024, 1025, 1035, 1045, 1074, 1075, 1085, 1094

Radiological contaminants: 4000, 4006, 4010, 4100, 4101, 4102

For Indicator E8, monitoring and reporting violations were grouped into the following violation types using the violation codes:

- Any violation: Violation codes 19, 34 (Ground water rule), 39 (Filter backwash recycling rule), or any of the following violations
- Lead and copper: Violation codes 51, 52, 53, 56, and 66
- Total coliforms: Violation codes 23, 24, 25, and 26
- Chemical and radionuclide: Violation codes 3 and 4
- Surface water treatment: Violation codes 29, 31, 32, 36 and 38 with all contaminant codes. Violation code 37 with contaminant code 0800 only
- Disinfectants and disinfection byproducts: Violation codes 27, 30, and 35.

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In a calendar year, a PWSID may have one or more violations of a given violation type. Only the first such violation is selected. For each violation type, state, and calendar year, the total population served by all violating PWSIDs was calculated by summing across the PWSIDs, counting each violating PWSID once only.

For each state, the total population served by community water systems was obtained from the SDWIS/FED inventory files. OGWDW staff provided this summary file. The data for 2009, fourth quarter, frozen as of January 2010, were used for these analyses. Only the 50 U.S. States or Washington DC, identified by their postal code abbreviations, were included.

Census Data

We obtained children's populations by state for each year from 1993-2009.

For 1993-1999, the source was U.S. Census Bureau files:

“Estimates of the Population of Counties by Age and Sex: 1990-1999,” August 30, 2000. The file headers are “(C0-99-9) Population Estimates for Counties by Age and Sex: Annual Time Series July 1, 1990 to July 1, 1999.”

These files give county populations by age and sex for 1990 to 1999. We summed these populations by year and state across all counties in the state, all ages 17 years and under, and both sexes.

For 2000-2009, we used the bridged-race Vintage 2009 postcensal populations files obtained from the CDC website:

National Center for Health Statistics. Postcensal estimates of the resident population of the United States for July 1, 2000-July 1, 2009, by year, county, age, bridged race, Hispanic origin, and sex (Vintage 2009). Prepared under a collaborative arrangement with the U.S. Census Bureau; released June 20, 2010. Available from: http://www.cdc.gov/nchs/nvss/bridged_race.htm as of July 23, 2010.

The bridged Vintage 2009 postcensal population files contain estimates of the resident population of the United States as of July 1, 2000, July 1, 2001, July 1, 2002, July 1, 2003, July 1, 2004, July 1, 2005, July 1, 2006, July 1, 2007, July 1, 2008, and July 1, 2009 by county, single-year of age (0, 1, 2,..., 85 years and over), bridged-race category (White, Black or African American, American Indian or Alaska Native, Asian or Pacific Islander), Hispanic origin (not Hispanic or Latino, Hispanic or Latino), and sex. There is one file for each year. Files are available in SAS dataset and text formats; we used the SAS dataset format for these analyses.

We extracted the variables: state, county, age, racesex, hisp, and pop. The racesex variable is a single coded value for each combination of race and sex, e.g., racesex = 1 denotes White males. The value pop gives the population as of July 1 of the calendar year for a given state, county, age, racesex combination, and ethnicity. The state children's populations for each year 2000-

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2009 were obtained by summing the variable pop over all counties in a state, ages ≤ 17 , all values of “racesex” and all values of “hispanic.”

Calculation of Indicator

Indicators E7 and E8 are calculated as follows.

Using the water quality violation data, the PWSIDs violating a given type of violation during each calendar year were listed. For each type of violation and calendar year, only the first violation by a PWSID was selected.

1. For each state, type of violation, and year, the populations served by violating systems were obtained by summing the populations served across the violating PWSIDs:

$$\text{Violating population (state, violation type, year)} = \Sigma \text{Population served}$$

where this sum is taken over all violating community water systems in the state for the given calendar year.

2. The fractions of the populations served by violating systems were obtained by dividing the violating population in the state for that year by the total population served by all community water systems in the state. The total populations served by community water systems in each state were obtained from the SDWIS/FED inventory data:

$$\begin{aligned} \text{State population fraction affected (state, violation type, year)} = \\ \text{Violating population (state, violation type, year)} / \\ \text{Total population served (state)} \end{aligned}$$

3. The number of affected children in each state was estimated by multiplying the state population fraction affected by the state children’s population. This estimate assumes an even geographic distribution over water systems of individuals under the age of 18 in each state for each year. This estimate also assumes that all children are served by community water systems; see below for a discussion of this assumption. This estimate also makes no adjustment for children in one state that are served by water systems that primarily serve another state:

$$\begin{aligned} \text{State children affected (state, violation type, year)} = \\ \text{State population fraction affected (state, violation type, year)} \times \\ \text{Children 0-17 (state, year)} \end{aligned}$$

4. The national number of children served by violating systems was obtained by summing the state numbers of children served by violating systems:

$$\begin{aligned} \text{National children affected (violation type, year)} = \\ \Sigma \text{State children affected (state, violation type, year)} \end{aligned}$$

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5. The percentage of children served by violating water systems was obtained by dividing the national number of children served by violating water systems by the total number of children in the 50 U.S. states and Washington DC:

$$\begin{aligned} \text{Percentage children affected (violation type, year)} = \\ \text{[National children affected (violation type, year) /} \\ \Sigma \text{ Children 0-17 (state, year)]} \times 100\% \end{aligned}$$

where the sum is across all states.

In Step 3, an assumption is made that all children ages 0 to 17 years are served by community water systems. In fact, some of the U.S. population, and hence some children ages 0 to 17 years, are not served by community water systems, so this assumption is unrealistic. To address this issue, suppose instead that a fraction g of children are served by community water systems, where g is approximately the same for every state, but could vary by year. In Step 3, the number of children affected in a given state is given by:

$$\begin{aligned} \text{State children affected (state, violation type, year)} = \\ \text{State population fraction affected (state, violation type, year)} \times \\ \text{Children 0-17 (state, year)} \times g(\text{year}), \end{aligned}$$

since there are $\text{Children 0-17 (state, year)} \times g(\text{year})$ children ages 0 to 17 years that are served by community water systems in that state and year, Step 4 is unchanged. In Step 5, the percentage of children served by violating systems in relation to the children served by community water systems is obtained by dividing the national number of children served by violating water systems by the total number of children served by community water systems:

$$\begin{aligned} \text{Percentage children affected (violation type, year)} = \\ \text{[National children affected (violation type, year) /} \\ \Sigma \text{ Children 0-17 (state, year)} \times g(\text{year})] \times 100\%. \end{aligned}$$

Because the same fraction $g(\text{year})$ appears in both the numerator and denominator, it cancels out. Therefore, even though not all children are served by community water systems, Indicators E7 and E8 estimate the percentage of children served by violating systems in relation to the children served by community water systems.

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.