Cotinine

Environmental tobacco smoke (ETS), commonly referred to as secondhand smoke, is a complex mixture of gases and particles and includes smoke from burning cigarettes, cigars, and pipe tobacco (sidestream smoke), as well as exhaled mainstream smoke.[1] There are at least 250 chemicals in ETS that are known to be toxic or carcinogenic, including acrolein, ammonia, benzene, carbon monoxide, formaldehyde, hydrogen cyanide, nicotine, nitrogen oxides, and sulfur dioxide.[1,2] In 1992, EPA classified ETS as a known human carcinogen.[3] Children can be exposed to ETS in their homes or in places where people are allowed to smoke, such as some restaurants in some locations throughout the United States.

According to the U.S. Surgeon General, there is no safe level of exposure to ETS, and breathing even a small amount can be harmful to human health.[1] The Surgeon General has concluded that exposure to ETS causes sudden infant death syndrome (SIDS), acute lower respiratory infection, ear problems, and more severe asthma in children. Smoking by parents causes respiratory symptoms and slows lung growth in their children.[1] Young children appear to be more susceptible to the respiratory effects of ETS than are older children.[3-5] It is also possible that early-life exposures to ETS may lead to adverse health effects in adulthood. Exposure to ETS in childhood has been reported to be associated with early emphysema in adulthood among nonsmokers.[6]

The exposure of a pregnant woman to ETS can also be harmful to her developing fetus. The Surgeon General has determined that exposure of pregnant women to ETS causes a small reduction in mean birth weight and the evidence is suggestive (but not sufficient to infer causation) of a relationship between maternal exposure to environmental tobacco smoke during pregnancy and preterm delivery.[1] In addition, the Surgeon General concluded the evidence is suggestive but not sufficient to infer a causal relationship between prenatal and postnatal exposure to ETS and childhood cancer.[1]

Exposure to ETS in the home is influenced by adult behaviors, including the decisions to smoke at home and to allow visitors to smoke inside the home. Children living in homes with smoking bans have significantly lower levels of cotinine (a biological marker of exposure to ETS) in urine than children living in homes without smoking bans.[7] Household smoking bans can significantly decrease children's exposures to ETS, but do not completely eliminate them.[8]

In recent years there has been a significant decline in children's exposures to ETS.[9] This reduction is in part attributable to a decline in the percentage of adults who smoke. In 2010, an estimated 19.3% of adults were current smokers, down from 24.7% in 1997.[10,11] In addition, the prevalence of smoke-free households increased from 43% of U.S. homes in 1992–1993 to 72% in 2003.[12] However, despite the increasing numbers of adults disallowing smoking in the home, approximately 34% of children live in a home with at least one smoker as of 2009.[13] The enactment of smoking bans in restaurants, bars, and other public places has led to a decrease in ETS exposure for both children and adults.[14] Recent studies suggest that smoking bans can

reduce the number of asthma-related emergency room visits and hospitalizations and reduce asthmatic symptoms, including persistent wheeze, wheeze-medication use, and chronic night cough in children.[15-18]

Cotinine is considered the best biomarker of exposure to tobacco smoke for both active smokers and those exposed to ETS.[19] The two indicators that follow use the best nationally representative data currently available on blood cotinine levels over time for women of child-bearing age and children. Indicator B4 presents median and 95th percentile blood serum levels of cotinine for children ages 3 to 17 years. Indicator B5 presents median and 95th percentile blood serum levels of cotinine for women ages 16 to 49 years.

Indicator B4: Cotinine in nonsmoking children ages 3 to 17 years: Median and 95th percentile concentrations in blood serum, 1988–2010

Indicator B5: Cotinine in nonsmoking women ages 16 to 49 years: Median and 95th percentile concentrations in blood serum, 1988–2010

> **About the Indicators:** Indicators B4 and B5 present concentrations of cotinine in blood serum of U.S. children ages 3 to 17 years and women ages 16 to 49 years. Cotinine is a marker of exposure to environmental tobacco smoke (ETS). The data are from a national survey that collects blood specimens from a representative sample of the population every two years, and then measures the concentration of cotinine in the blood serum. Indicator B4 presents concentrations of cotinine in children's blood serum over time and Indicator B5 presents concentrations of cotinine in women's blood serum over time. The focus on both children and women of child-bearing age is based on concern for potential adverse effects in children exposed to ETS and in children born to women who have been exposed to ETS.

NHANES

The National Health and Nutrition Examination Survey (NHANES) provides nationally representative biomonitoring data for cotinine. NHANES is designed to assess the health and nutritional status of the civilian noninstitutionalized U.S. population and is conducted by the National Center for Health Statistics, part of the Centers for Disease Control and Prevention (CDC). Interviews and physical examinations are conducted with approximately 10,000 people in each two-year survey cycle. CDC's National Center for Environmental Health measures concentrations of environmental chemicals in blood and urine samples collected from NHANES participants. Summaries of the measured values for more than 200 chemicals are provided in the *Fourth National Report on Human Exposure to Environmental Chemicals*.[19]

Environmental Tobacco Smoke (ETS) and Cotinine

Indicators B4 and B5 present blood serum levels of cotinine as a marker of exposure to ETS. Nicotine is a distinctive component of tobacco that is found in large amounts in tobacco smoke, including ETS. Once nicotine enters the body, it is rapidly broken down in a matter of a few hours into other chemicals. Cotinine is a primary breakdown product of nicotine, and has a longer half-life. This characteristic makes cotinine a better indicator than nicotine of an individual's exposure to ETS.[20-22]

Measurement of cotinine in blood serum is a marker for exposure to ETS in the previous few days.[23] Some studies have shown that, given the same exposure to tobacco smoke, cotinine levels may differ by race/ethnicity and sex, and there may be genetic differences in the rate at which cotinine is removed from the body.[1,24-28]

These indicators present cotinine levels for non-tobacco-users only. Children and women who were active smokers, as indicated by a relatively high serum cotinine level, were excluded from these statistics. For these analyses, individuals with a serum cotinine level greater than 10 nanograms of cotinine per milliliter of serum (ng/mL) are considered active smokers, and all individuals with cotinine levels below 10 ng/mL are considered nonsmokers.[19] Active smokers will almost always have serum cotinine levels above 10 ng/mL, and sometimes those levels will be higher than 500 ng/mL.[19,29] Nonsmokers who are exposed to typical levels of ETS have serum cotinine levels of less than 1 ng/mL, whereas those nonsmokers with heavy exposure to ETS will have serum cotinine levels between 1 and 10 ng/mL.[19]

Concentrations of cotinine in blood serum have been measured in NHANES participants ages 4 years and older for the 1988–1991 and 1991–1994 survey cycles, and then for ages 3 years and older beginning with the 1999–2000 survey cycle.

For 2009–2010, NHANES collected cotinine biomonitoring data for 6,678 nonsmoking individuals ages 3 years and older, including 2,191 children ages 3 to 17 years and 1,395 women ages 16 to 49 years. Cotinine was detected in about 67% of all nonsmoking individuals sampled. The frequency of cotinine detection was 71% in children ages 3 to 17 years and 66% in women ages 16 to 49 years.[i] The median blood serum cotinine level for all nonsmoking NHANES participants in 2009–2010 was 0.03 ng/mL and the 95th percentile was 1.3 ng/mL.

Birth Rate Adjustment

Indicator B5 uses measurements of cotinine in blood serum of women ages 16 to 49 years to represent the distribution of ETS exposures to women who are pregnant or may become pregnant. For example, in 2003–2004, women aged 27 years had a 12% annual probability of giving birth, and women aged 37 years had a 4% annual probability of giving birth.[30] A birth rate-adjusted distribution of women's cotinine levels is used in calculating this indicator,[ii] meaning that the data are weighted using the age-specific probability of a woman giving birth.[31]

Data Presented in the Indicators

Indicator B4 presents median and 95th percentile concentrations of cotinine in blood serum over time as a marker of exposure to ETS among non-smoking children ages 3 to 17 years, using NHANES data from 1988–2010.

Indicator B5 presents median and 95th percentile concentrations of cotinine in blood serum over time as a marker of exposure to ETS among non-smoking women ages 16 to 49 years, using NHANES data from 1988–2010.

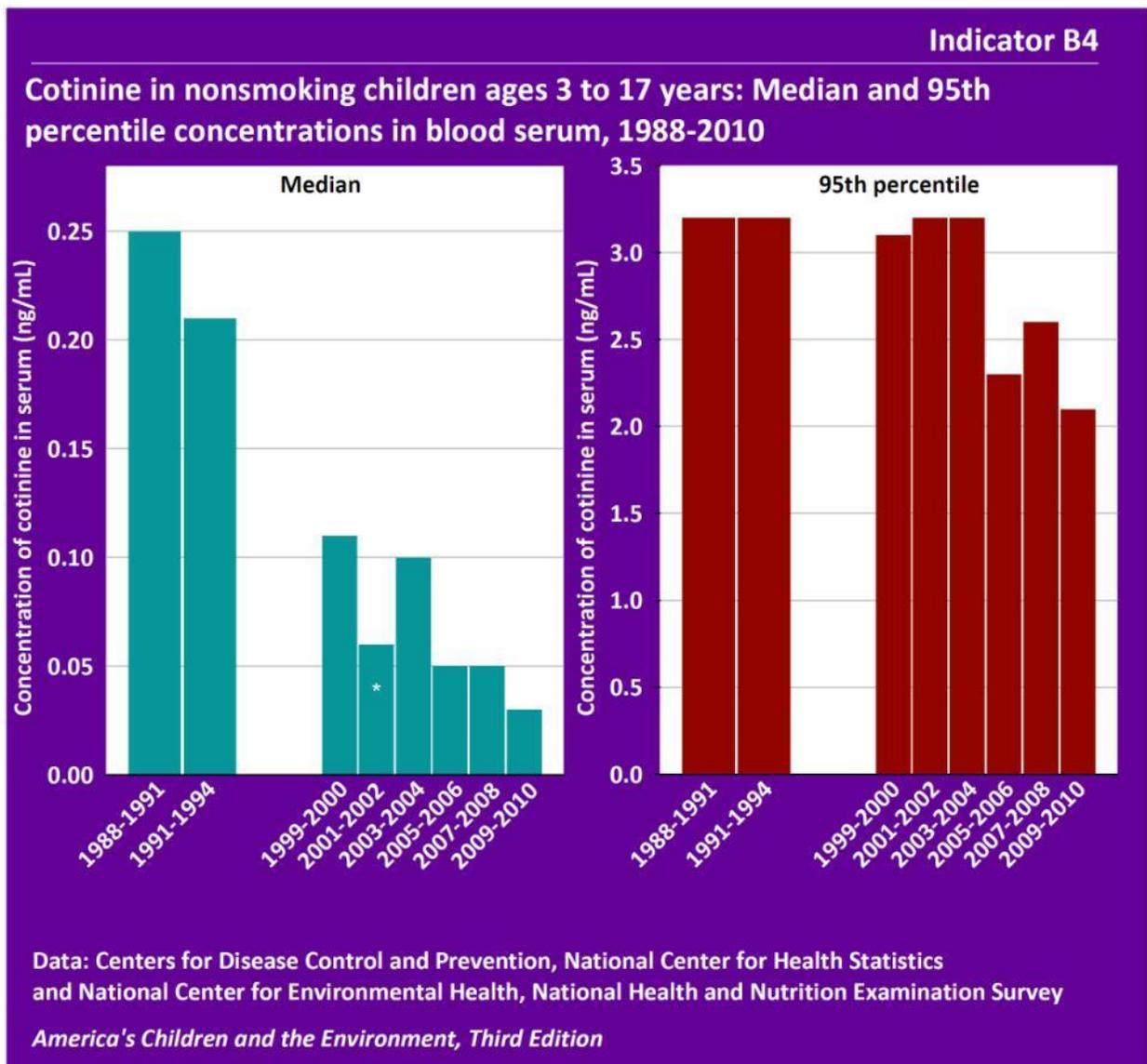[i] The percentage for women ages 16 to 49 years is calculated with the birth rate adjustment described below.
[ii] There may be multiple ways to implement an adjustment to the data that accounts for birth rates by age. The National Center for Health Statistics has not fully evaluated the method used in ACE, or any other method intended to accomplish the same purpose, and has not used any such method in its publications. NCHS and EPA are working together to further evaluate the birth rate adjustment method used in ACE and alternative methods.

Although the sensitivity of measurement techniques has improved over the years spanned by Indicators B4 and B5, allowing increased detection of lower serum cotinine levels over time, these improvements do not affect the comparability of the median or 95th percentiles over time since the majority of children and women have had detectable levels of cotinine in each NHANES cycle.

Additional information showing how median and 95th percentile blood serum levels of cotinine vary by race/ethnicity, family income, and age for children ages 3 to 17 years is presented in the supplemental data tables for these indicators. Data tables also show how median and 95th percentile blood serum levels of cotinine vary by race/ethnicity and family income for women ages 16 to 49 years.

NHANES does not provide cotinine measurements for children under the age of 3 years (or under age 4 years prior to 1999), who may be especially sensitive to the effects of ETS exposure.

Please see the Introduction to the Biomonitoring section for an explanation of the terms "median" and "95th percentile," a description of the race/ethnicity and income groups used in the ACE3 biomonitoring indicators, and information on the statistical significance testing applied to these indicators.

Indicator B4

Cotinine in nonsmoking children ages 3 to 17 years: Median and 95th percentile concentrations in blood serum, 1988-2010

Data: Centers for Disease Control and Prevention, National Center for Health Statistics and National Center for Environmental Health, National Health and Nutrition Examination Survey

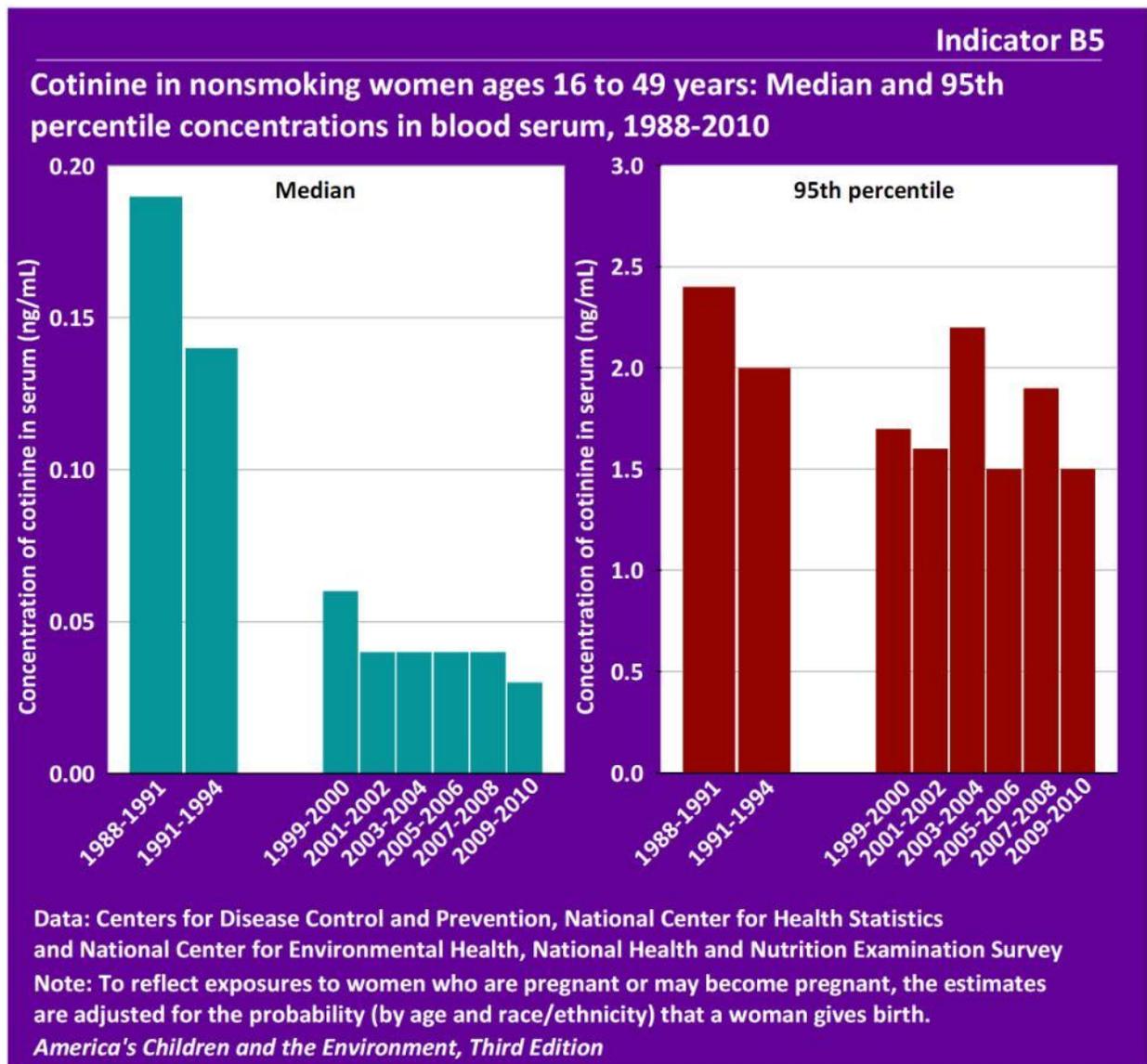*America's Children and the Environment, Third Edition*

*The estimate should be interpreted with caution because the standard error of the estimate is relatively large: the relative standard error, RSE, is at least 30% but is less than 40% (RSE = standard error divided by the estimate), or the RSE may be underestimated.

Data characterization
-   Data for this indicator are obtained from an ongoing continuous survey conducted by the National Center for Health Statistics.
-   Survey data are representative of the U.S. civilian noninstitutionalized population.
-   Cotinine is measured in blood samples obtained from individual survey participants.

■ The median level of cotinine measured in blood serum of nonsmoking children ages 3 to 17 years dropped from 0.25 ng/mL in 1988–1991 to 0.03 ng/mL in 2009–2010, a decrease of 88%. This decreasing trend was statistically significant.

- Cotinine values at the 95th percentile decreased by 34% from 1988–1991 to 2009–2010. This trend was also statistically significant.

- Children at the 95th percentile of cotinine levels had much higher levels than those at the median. In 1988–1991, the 95th percentile cotinine level (3.2 ng/mL) was 13 times the median level (0.25 ng/mL); in 2009–2010, the 95th percentile cotinine level (2.1 ng/mL) was 70 times the median level (0.03 ng/mL).

- In every time period measured, children at the 95th percentile had higher levels of cotinine in their blood than women at corresponding levels. (Compare with Indicator B5.)

- Eighty-seven percent of nonsmoking children ages 4 to 17 years had detectable levels (at or above 0.05 ng/mL) of cotinine in 1988–1991. Forty percent of nonsmoking children ages 3 to 17 years had levels at or above 0.05 ng/mL of cotinine in 2009–2010, although improvements in laboratory methods made it possible to detect cotinine at lower concentrations starting with the 2001–2002 survey cycle. (Data not shown.)

- In 2007–2010, median concentrations of cotinine in blood for nonsmokers were approximately 0.11 ng/mL for Black non-Hispanic children, 0.04 ng/mL for White non-Hispanic children, and 0.02 ng/mL for Mexican-American children. The differences between these race/ethnicity groups were statistically significant. (See Table B4a.)

- In 2007–2010, the median concentration of cotinine in blood serum for nonsmoking children living below the poverty level (0.14 ng/mL) was about 5 times the median for nonsmoking children living at or above the poverty level (0.03 ng/mL). The differences between income groups were statistically significant. (See Table B4a.)

- In 2007–2010, 95th percentile concentrations of cotinine in blood for nonsmokers were 2.9 ng/mL for White non-Hispanic children and 2.6 ng/mL for Black non-Hispanic children, while Mexican-American children had levels that were more than 3 times lower (0.8 ng/mL). (See Table B4b.)

  - The differences between levels for Mexican-American children and both White non-Hispanic and Black non-Hispanic children were statistically significant.

- For the years 2007–2010, median levels of cotinine in younger nonsmoking children ages 3 to 5 years and 6 to 10 years were 0.06 and 0.05 ng/mL, respectively, compared with 0.03 and 0.04 ng/mL in older nonsmoking children ages 11 to 15 years and 16 to 17 years, respectively. (See Table B4c.)

  - The differences between the levels for the four age groups were not statistically significant.

Indicator B5

Cotinine in nonsmoking women ages 16 to 49 years: Median and 95th percentile concentrations in blood serum, 1988-2010

Data: Centers for Disease Control and Prevention, National Center for Health Statistics and National Center for Environmental Health, National Health and Nutrition Examination Survey

Note: To reflect exposures to women who are pregnant or may become pregnant, the estimates are adjusted for the probability (by age and race/ethnicity) that a woman gives birth.

America's Children and the Environment, Third Edition

Data characterization
- Data for this indicator are obtained from an ongoing continuous survey conducted by the National Center for Health Statistics.
- Survey data are representative of the U.S. civilian noninstitutionalized population.
- Cotinine is measured in blood samples obtained from individual survey participants.

■ The median level of cotinine measured in blood serum of nonsmoking women of child-bearing age dropped from 3.2 ng/mL in 1988–1991 to 2.1 ng/mL in 2009–2010, a decrease of 86%. This decreasing trend was statistically significant.

■ Cotinine values at the 95th percentile decreased by 35% from 1988–1991 to 2009–2010. This trend was also statistically significant.

- Women at the 95th percentile cotinine levels had much higher levels than those at the median. In 1988–1991, the 95th percentile cotinine level (2.3 ng/mL) was 11 times the median level (0.21 ng/mL); in 2009–2010, the 95th percentile cotinine level (1.5 ng/mL) was 50 times the median level (0.03 ng/mL).

- In 2007–2010, median concentrations of cotinine in blood for nonsmoking women were approximately 0.1 ng/mL for Black non-Hispanic women and 0.03 ng/mL for White non-Hispanic women and Mexican-American women. (See Table B5a.)

  - The difference between Black non-Hispanic women and Mexican-American women was statistically significant. The difference between Black non-Hispanic and White non-Hispanic women was not statistically significant after adjusting for age and income differences.

- Cotinine values at the 95th percentile were more than twice as high for nonsmoking women living below the poverty level (3.5 ng/mL) as for nonsmoking women living at or above the poverty level (1.4 ng/mL) in 2007–2010. The differences between income groups were statistically significant. (See Table B5b.)

Biomonitoring

Cotinine

1. U.S. Department of Health and Human Services. 2006. *The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. http://www.surgeongeneral.gov/library/reports/secondhandsmoke/fullreport.pdf.

2. National Toxicology Program. 2011. *Report on Carcinogens, 12th Edition*. Research Triangle Park, NC: U.S. Department of Health and Human Services, National Toxicology Program. http://ntp.niehs.nih.gov/ntp/roc/twelfth/roc12.pdf.

3. U.S. Environmental Protection Agency. 1992. *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders*. Washington, DC: EPA Office of Research and Development. http://cfpub.epa.gov/ncea/cfm/ets/etsindex.cfm.

4. Gergen, P.J., J.A. Fowler, K.R. Maurer, W.W. Davis, and M.D. Overpeck. 1998. The burden of environmental tobacco smoke exposure on the respiratory health of children 2 months through 5 years of age in the United States: Third National Health and Nutrition Examination Survey, 1988 to 1994. *Pediatrics* 101 (2):E8.

5. Institute of Medicine. 2000. *Clearing the Air: Asthma and Indoor Air Exposures*. Washington, DC: National Academy Press. http://books.nap.edu/catalog/9610.html.

6. Lovasi, G.S., A.V. Diez Roux, E.A. Hoffman, S.M. Kawut, D.R. Jacobs, Jr., and R.G. Barr. Association of environmental tobacco smoke exposure in childhood with early emphysema in adulthood among nonsmokers: the MESA-lung study. *American Journal of Epidemiology* 171 (1):54-62.

7. Yousey, Y.K. 2006. Household characteristics, smoking bans, and passive smoke exposure in young children. *Journal of Pediatric Health Care* 20 (2):98-105.

8. Wamboldt, F.S., R.C. Balkissoon, A.E. Rankin, S.J. Szefler, S.K. Hammond, R.E. Glasgow, and W.P. Dickinson. 2008. Correlates of household smoking bans in low-income families of children with and without asthma. *Family Process* 47 (1):81-94.

9. Pirkle, J.L., J.T. Bernert, S.P. Caudill, C.S. Sosnoff, and T.F. Pechacek. 2006. Trends in the exposure of nonsmokers in the U.S. population to secondhand smoke: 1988-2002. *Environmental Health Perspectives* 114 (6):853-8.

10. Centers for Disease Control and Prevention. 2007. Cigarette smoking among adults—United States, 2006. *Morbidity and Mortality Weekly Report* 56 (44):1157-1161.

11. Centers for Disease Control and Prevention. 2011. Vital Signs: Current Cigarette Smoking Among Adults Aged ≥18 Years --- United States, 2005--2010. *Morbidity and Mortality Weekly Report* 60 (35):1207-12.

12. Centers for Disease Control and Prevention. 2007. State-specific prevalence of smoke-free home rules - United States, 1992-2003. *Morbidity and Mortality Weekly Report* 56 (20):501-504.

13. King, K., M. Martynenko, M.H. Bergman, Y.-H. Liu, J.P. Winickoff, and M. Weitzman. 2009. Family Composition and Children's Exposure to Adult Smokers in Their Homes. *Pediatrics* 123 (4):559-64.

14. Centers for Disease Control and Prevention. 2011. *Smoke-Free Policies Reduce Secondhand Smoke Exposure* CDC, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Retrieved May 24, 2011 from http://www.cdc.gov/tobacco/data_statistics/fact_sheets/secondhand_smoke/protection/shs_exposure/index.htm.

15. Dove, M.S., D.W. Dockery, and G.N. Connolly. 2010. Smoke-free air laws and secondhand smoke exposure among nonsmoking youth. *Pediatrics* 126 (1):80-7.

16. Dove, M.S., D.W. Dockery, and G.N. Connolly. 2011. Smoke-free air laws and asthma prevalence, symptoms, and severity among nonsmoking youth. *Pediatrics* 127 (1):102-9.

17. Mackay, D., S. Haw, J.G. Ayres, C. Fischbacher, and J.P. Pell. 2010. Smoke-free legislation and hospitalizations for childhood asthma. *New England Journal of Medicine* 363 (12):1139-45.

18. Rayens, M.K., P.V. Burkhart, M. Zhang, S. Lee, D.K. Moser, D. Mannino, and E.J. Hahn. 2008. Reduction in asthma-related emergency department visits after implementation of a smoke-free law. *Journal of Allergy and Clinical Immunology* 122 (3):537-41 e3.

19. Centers for Disease Control and Prevention. 2009. *Fourth National Report on Human Exposure to Environmental Chemicals* Atlanta (GA): CDC. http://www.cdc.gov/exposurereport/.

20. Jarvis, M.J., H. Tunstall-Pedoe, C. Feyerabend, C. Vesey, and Y. Saloojee. 1987. Comparison of tests used to distinguish smokers from nonsmokers. *American Journal of Public Health* 77 (11):1435-8.

21. Watts, R.R., J.J. Langone, G.J. Knight, and J. Lewtas. 1990. Cotinine analytical workshop report: consideration of analytical methods for determining cotinine in human body fluids as a measure of passive exposure to tobacco smoke. *Environmental Health Perspectives* 84:173-82.

22. Benowitz, N.L. 1999. Biomarkers of environmental tobacco smoke exposure. *Environmental Health Perspectives* 107 Suppl 2:349-55.

23. Benowitz, N.L. 1996. Cotinine as a biomarker of environmental tobacco smoke exposure. *Epidemiologic Reviews* 18 (2):188-204.

Cotinine (continued)

24. Wagenknecht, L.E., G.R. Cutter, N.J. Haley, S. Sidney, T.A. Manolio, G.H. Hughes, and D.R. Jacobs. 1990. Racial differences in serum cotinine levels among smokers in the Coronary Artery Risk Development in (Young) Adults study. *American Journal of Public Health* 80 (9):1053-6.

25. Caraballo, R.S., G.A. Giovino, T.F. Pechacek, P.D. Mowery, P.A. Richter, W.J. Strauss, D.J. Sharp, M.P. Eriksen, J.L. Pirkle, and K.R. Maurer. 1998. Racial and ethnic differences in serum cotinine levels of cigarette smokers: Third National Health and Nutrition Examination Survey, 1988-1991. *Journal of the American Medical Association* 280 (2):135-9.

26. Perez-Stable, E.J., B. Herrera, P. Jacob, 3rd, and N.L. Benowitz. 1998. Nicotine metabolism and intake in black and white smokers. *Journal of the American Medical Association* 280 (2):152-6.

27. Benowitz, N.L., E.J. Perez-Stable, I. Fong, G. Modin, B. Herrera, and P. Jacob, 3rd. 1999. Ethnic differences in N-glucuronidation of nicotine and cotinine. *Journal of Pharmacology and Experimental Therapeutics* 291 (3):1196-203.

28. Benowitz, N.L., E.J. Perez-Stable, B. Herrera, and P. Jacob, 3rd. 2002. Slower metabolism and reduced intake of nicotine from cigarette smoking in Chinese-Americans. *Journal of the National Cancer Institute* 94 (2):108-15.

29. Pirkle, J.L., K.M. Flegal, J.T. Bernert, D.J. Brody, R.A. Etzel, and K.R. Maurer. 1996. Exposure of the US population to environmental tobacco smoke: the Third National Health and Nutrition Examination Survey, 1988 to 1991. *Journal of the American Medical Association* 275 (16):1233-40.

30. National Center for Health Statistics. *Vital Statistics Natality Birth Data*. Retrieved June 15, 2009 from http://www.cdc.gov/nchs/data_access/Vitalstatsonline.htm. .

31. Axelrad, D.A., and J. Cohen. 2011. Calculating summary statistics for population chemical biomonitoring in women of childbearing age with adjustment for age-specific natality. *Environmental Research* 111 (1):149-155.

Cotinine

Table B4: Cotinine in nonsmoking children ages 3 to 17 years: Median and 95th percentile concentrations in blood serum, 1988-2010

	Concentration of cotinine in serum (ng/mL)							
	1988-1991	1991-1994	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010
Median	0.25	0.21	0.11	0.06*	0.10	0.05	0.05	0.03
95th percentile	3.2	3.2	3.1	3.2	3.2	2.3	2.6	2.1

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics and National Center for Environmental Health, National Health and Nutrition Examination Survey

NOTE: Based on children ages 3 to 17 years with serum cotinine $\leq$ 10 ng/mL (ages 4 to 17 years for 1988-1991 and 1991-1994).

*The estimate should be interpreted with caution because the standard error of the estimate is relatively large: the relative standard error, RSE, is at least 30% but is less than 40% (RSE = standard error divided by the estimate), or the RSE may be underestimated.

Table B4a. Cotinine in nonsmoking children ages 3 to 17 years: Median concentrations in blood serum, by race/ethnicity and family income, 2007-2010

	Median concentration of cotinine in serum (ng/mL)		
Race / Ethnicity	**All Incomes‡** *(n=4,284)*	**< Poverty Level** *(n=1,323)*	**≥ Poverty Level** *(n=2,648)*
All Races/Ethnicities *(n=4,284)*	0.04	0.14	0.03
White non-Hispanic *(n=1,310)*	0.04	NA**	0.04
Black non-Hispanic *(n=955)*	0.11	0.38	0.06
Mexican-American *(n=1,229)*	0.02	0.03	0.02
All Other Races/Ethnicities† *(n=790)*	0.03	0.09	0.02

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics and National Center for Environmental Health, National Health and Nutrition Examination Survey

NOTE: Based on children ages 3 to 17 years with serum cotinine $\leq$ 10 ng/mL.

† The "All Other Races/Ethnicities" category includes all other races or ethnicities not specified, together with those individuals who report more than one race.

‡ Includes sampled individuals for whom income information is missing.

** Not available. The estimate is not reported because it has large uncertainty: the relative standard error, RSE, is 40% or greater (RSE = standard error divided by the estimate), or the RSE cannot be reliably estimated.

Table B4b. Cotinine in nonsmoking children ages 3 to 17 years: 95th percentile concentrations in blood serum, by race/ethnicity and family income, 2007-2010

Race / Ethnicity	95th percentile concentration of cotinine in serum (ng/mL)		
	All Incomes‡ (n=4,284)	< Poverty Level (n=1,323)	≥ Poverty Level (n=2,648)
All Races/Ethnicities (n=4,284)	2.5	4.1	2.0
White non-Hispanic (n=1,310)	2.9	5.8	2.3
Black non-Hispanic (n=955)	2.6	3.0	2.3
Mexican-American (n=1,229)	0.8	0.9*	0.7*
All Other Races/Ethnicities† (n=790)	1.5	NA**	0.7*

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics and National Center for Environmental Health, National Health and Nutrition Examination Survey

NOTE: Based on children ages 3 to 17 years with serum cotinine ≤ 10 ng/mL.

† The "All Other Races/Ethnicities" category includes all other races or ethnicities not specified, together with those individuals who report more than one race.

‡ Includes sampled individuals for whom income information is missing.

*The estimate should be interpreted with caution because the standard error of the estimate is relatively large: the relative standard error, RSE, is at least 30% but is less than 40% (RSE = standard error divided by the estimate), or the RSE may be underestimated.

** Not available. The estimate is not reported because it has large uncertainty: the relative standard error, RSE, is 40% or greater (RSE = standard error divided by the estimate), or the RSE cannot be reliably estimated.

Table B4c: Cotinine in nonsmoking children ages 3 to 17 years: Median and 95th percentile concentrations in blood serum, by age group, 2007-2010

	Concentration of cotinine in serum (ng/mL)				
	Ages 3 to 17 years	Ages 3 to 5 years	Ages 6 to 10 years	Ages 11 to 15 years	Ages 16 to 17 years
Median	0.04	0.06	0.05	0.03	0.04
95th percentile	2.5	2.9	2.5	2.3	2.9

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics and National Center for Environmental Health, National Health and Nutrition Examination Survey

Table B5: Cotinine in nonsmoking women ages 16 to 49 years: Median and 95th percentile concentrations in blood serum, 1988-2010

	Concentration of cotinine in serum (ng/mL)							
	1988-1991	1991-1994	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010
Median	0.21	0.15	0.06	0.04	0.04	0.04	0.04	0.03
95th percentile	2.3	2.1	1.7	1.6	2.2	1.5	1.9	1.5

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics and National Center for Environmental Health, National Health and Nutrition Examination Survey

NOTES:

- Based on women ages 16 to 49 years with serum cotinine ≤ 10 ng/mL.

- To reflect exposures to women who are pregnant or may become pregnant, the estimates are adjusted for the probability (by age and race/ethnicity) that a woman gives birth. The intent of this adjustment is to approximate the distribution of exposure to pregnant women. Results will therefore differ from a characterization of exposure to adult women without consideration of birth rates.

Table B5a. Cotinine in nonsmoking women ages 16 to 49 years: Median concentrations in blood serum, by race/ethnicity and family income, 2007-2010

	Median concentration of cotinine in serum (ng/mL)		
Race / Ethnicity	All Incomes‡ (n=2,601)	< Poverty Level (n=583)	≥ Poverty Level (n=1,781)
All Races/Ethnicities (n=2,601)	0.03	0.05	0.03
White non-Hispanic (n=949)	0.03	NA**	0.03
Black non-Hispanic (n=475)	0.10	0.33	0.06
Mexican-American (n=654)	0.03	0.04	0.02
All Other Races/Ethnicities† (n=523)	0.03	0.03*	0.03

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics and National Center for Environmental Health, National Health and Nutrition Examination Survey

NOTES:

- Based on women ages 16 to 49 years with serum cotinine ≤ 10 ng/mL.

- To reflect exposures to women who are pregnant or may become pregnant, the estimates are adjusted for the probability (by age and race/ethnicity) that a woman gives birth. The intent of this adjustment is to approximate the distribution of exposure to pregnant women. Results will therefore differ from a characterization of exposure to adult women without consideration of birth rates.

† The "All Other Races/Ethnicities" category includes all other races or ethnicities not specified, together with those individuals who report more than one race.

‡ Includes sampled individuals for whom income information is missing.

*The estimate should be interpreted with caution because the standard error of the estimate is relatively large: the relative standard error, RSE, is at least 30% but is less than 40% (RSE = standard error divided by the estimate), or the RSE may be underestimated.

Table B5b. Cotinine in nonsmoking women ages 16 to 49 years: 95th percentile concentrations in blood serum, by race/ethnicity and family income, 2007-2010

Race / Ethnicity	95th percentile concentration of cotinine in serum (ng/mL)		
	All Incomes‡ (n=2,601)	< Poverty Level (n=583)	≥ Poverty Level (n=1,781)
All Races/Ethnicities (n=2,601)	1.6	3.5	1.4
White non-Hispanic (n=949)	1.4	3.7*	1.0
Black non-Hispanic (n=475)	3.4	8.3	3.0
Mexican-American (n=654)	1.6*	2.5	NA**
All Other Races/Ethnicities† (n=523)	NA**	NA**	NA**

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics and National Center for Environmental Health, National Health and Nutrition Examination Survey

NOTES:

- Based on women ages 16 to 49 years with serum cotinine ≤ 10 ng/mL.

- To reflect exposures to women who are pregnant or may become pregnant, the estimates are adjusted for the probability (by age and race/ethnicity) that a woman gives birth. The intent of this adjustment is to approximate the distribution of exposure to pregnant women. Results will therefore differ from a characterization of exposure to adult women without consideration of birth rates.

† The "All Other Races/Ethnicities" category includes all other races or ethnicities not specified, together with those individuals who report more than one race.

‡ Includes sampled individuals for whom income information is missing.

*The estimate should be interpreted with caution because the standard error of the estimate is relatively large: the relative standard error, RSE, is at least 30% but is less than 40% (RSE = standard error divided by the estimate), or the RSE may be underestimated.

** Not available. The estimate is not reported because it has large uncertainty: the relative standard error, RSE, is 40% or greater (RSE = standard error divided by the estimate), or the RSE cannot be reliably estimated.