America's Children and the Environment, Third Edition

DRAFT Indicators

Health: Respiratory Diseases

EPA is preparing the third edition of *America's Children and the Environment* (ACE3), following the previous editions published in December 2000 and February 2003. ACE is EPA's compilation of children's environmental health indicators and related information, drawing on the best national data sources available for characterizing important aspects of the relationship between environmental contaminants and children's health. ACE includes four sections: Environments and Contaminants, Biomonitoring, Health, and Special Features.

EPA has prepared draft indicator documents for ACE3 representing 23 children's environmental health topics and presenting a total of 42 proposed children's environmental health indicators. This document presents the draft text, indicators, and documentation for the respiratory diseases topic in the Health section.

For more information on America's Children and the Environment, please visit www.epa.gov/ace. For instructions on how to submit comments on the draft ACE3 indicators, please visit www.epa.gov/ace/ace3drafts/.

Respiratory Diseases in Children

Respiratory diseases and illness, such as asthma, bronchitis, pneumonia, and other respiratory infections, can greatly impair a child's ability to function and are an important cause of missed school days and limitations of activities. Symptoms associated with both mild and more severe manifestations of these respiratory conditions, such as cough, wheeze, congestion, chest pain, shortness of breath, and respiratory distress, are responsible for substantial morbidity and a large cost burden to families and society.

Environmental contaminants—both outdoor and indoor—can cause or exacerbate existing respiratory conditions.[1-7] In particular, studies have shown that outdoor and indoor air pollution can cause respiratory symptoms and increase the frequency or severity of asthma attacks in children.[1,8,9] Some studies suggest that environmental contaminants can cause the onset of asthma in children, although studies relating to the exacerbation of pre-existing asthma are more prevalent because they are easier to conduct.[10,11]

Most of the six common air pollutants for which EPA sets ambient air quality standards[12] have been linked to respiratory diseases in children. These pollutants, referred to as criteria air pollutants, are particulate matter, ground-level ozone, nitrogen oxides, sulfur oxides, carbon monoxide, and lead.

Particulate matter (PM) is associated with significant respiratory problems in children, including aggravated asthma, exacerbation of allergic symptoms, reduced growth of lung function, and increased hospital admissions, emergency room visits, and doctor visits for respiratory diseases, especially in children with lung diseases such as asthma.[6]

Short-term exposure to ground-level ozone can cause a variety of respiratory health effects, including inflammation of the lining of the lungs, reduced lung function, and respiratory symptoms such as cough, wheezing, chest pain, burning in the chest, and shortness of breath.[3,13,14] Ozone exposure may also decrease the capacity to perform exercise.[3] Exposure to ambient concentrations of ozone has been associated with the aggravation of respiratory illnesses such as asthma, emphysema, and bronchitis, leading to increased use of medication, absences from school, doctor and emergency department visits, and hospital admissions. Exposure to ozone can increase susceptibility to respiratory infection; long-term exposure can permanently damage lung tissue, and short-term exposure is associated with increased mortality.[3]

Nitrogen dioxide (NO_2) is an odorless gas that can irritate the eyes, nose, and throat, and can cause shortness of breath. EPA has concluded that exposure to NO_2 can lead to increased respiratory illnesses and symptoms, more severe asthma symptoms, and an increase in the number of emergency department visits and hospital admissions for respiratory causes, especially asthma.[4] Exposure to NO_2 may lead to the development of new childhood asthma cases.[15] In people with asthma, exposure to low levels of NO_2 may cause increased bronchial reactivity and make young children more susceptible to respiratory infections.[16] Furthermore, children's exposure to NO_2 can increase the risk of bronchiolitis, a condition associated with

respiratory viral infection that causes inflammation and mucus accumulation in the smallest air passages in the lungs.[17]

Short-term exposures of asthmatic individuals to elevated levels of sulfur dioxide (SO_2) while exercising at a moderate level may result in breathing difficulties, accompanied by symptoms such as wheezing, chest tightness, or shortness of breath. Studies also provide consistent evidence of an association between short-term SO_2 exposure and increased respiratory symptoms in children, especially those with asthma or chronic respiratory symptoms. Short-term exposures to SO_2 have also been associated with respiratory-related emergency department visits and hospital admissions, particularly for children.[5]

Exposure to carbon monoxide (CO) reduces the capacity of the blood to carry oxygen, thereby decreasing the supply of oxygen to tissues and organs such as the heart. Short-term exposure can cause effects such as a reduction in exercise performance.[7] Research suggests correlations between CO exposure and the exacerbation of asthma, and EPA has concluded that across the published studies there are consistent, positive associations between short-term exposure to CO and respiratory symptoms in individuals with asthma, while acknowledging that the mechanism by which CO causes these effects is unclear.[7,9,18]

Pollution from traffic-related sources, a mix of criteria air pollutants and hazardous air pollutants such as benzene, appears to pose particular threats to a child's respiratory system. Many studies have found a correlation between proximity to traffic (or to traffic-related pollutants) and occurrence of new asthma cases or exacerbation of existing asthma and other respiratory symptoms, including deceased lung function.[15,19-22] A report by the Health Effects Institute concluded that living close to busy roads appears to be an independent risk factor for the onset of childhood asthma. The same report also concluded that the evidence was "sufficient" to infer a causal association between exposure to traffic-related pollution and exacerbations of asthma in children.[23]

Regarding indoor air pollution, the Institute of Medicine concluded that exposure to dust mites causes asthma in susceptible children, and exposure to cockroaches and environmental tobacco smoke (ETS) are likely to cause asthma in young children.[1] Indoor allergens and irritants can also play a significant role in triggering asthma attacks. Some of the most common indoor asthma triggers include ETS, dust mites, mold, cockroaches and other pests, household pets, and combustion byproducts. ETS can also increase the severity of asthma attacks, and is linked to lower respiratory infections, bronchitis, pneumonia, and impaired lung function.[2,24-26] Children receiving high doses of ETS, such as those with parents who smoke indoors or in cars, face the greatest relative risk of experiencing damaging health effects.[2,27] NO_2 is also considered an indoor irritant as it can be a byproduct of fuel-burning appliances, such as gas stoves, gas or oil furnaces, fireplaces, wood stoves, and unvented kerosene or gas space heaters. Formaldehyde is another common indoor air pollutant released from particle board, insulation, carpet, and furniture. A recent systematic review of seven studies concluded that there is a significant association between formaldehyde exposure and self-reported or diagnosed asthma in children.[28]

Air pollutants can enter the bloodstream of pregnant women and cross the placenta to reach the developing fetus; thus the period of fetal development may be a period of special vulnerability for respiratory effects of some air pollutants. Studies indicate that prenatal exposure to ETS may increase the risk of developing asthma during childhood and/or lead to impaired lung function, especially among children with asthma.[29-31] Limited studies of prenatal exposure to criteria air pollutants have found that exposure to PM, CO, and oxides of nitrogen and sulfur may increase the risk of developing asthma as well as worsen respiratory outcomes among those children that do develop asthma.[32-34] However, it is difficult to distinguish the effects of prenatal and early childhood exposure because exposure to air pollutants is often very similar during both time periods.

Asthma

Asthma is a chronic inflammatory disease of the airways. When children with asthma are exposed to an asthma trigger, airway walls become inflamed, secrete more mucus, and the muscles around the airways tighten, all of which causes the air passageway to become narrower and allows less air flow into the lungs. These physiologic changes can result in wheezing, coughing, difficulty in breathing, chest tightness, and pain.

Asthma is one of the most common chronic diseases among children: in the year 2008, it affected 7.0 million (or about 10% of) children in the United States.[35] It is costly in both human and monetary terms: estimated national annual costs in 2010 are more than $20 billion.[36] The percentage of children with asthma increased substantially from 1980–1996 and remains high.[37] Researchers do not completely understand why children develop asthma or why the prevalence has increased. The tendency to develop asthma can be inherited, but genetic factors alone are unlikely to explain the significant increases that occurred since 1980.[1]

The percentage of children reported to have current asthma differs by age, racial and ethnic group, and family income. Children of color and children of lower-income families are more likely to be diagnosed with asthma. These children may experience different exposures and other risk factors. They may also face barriers to medical care, have less access to routine medical care and instructions for asthma management, or may be less likely to use asthma control medications than other children do.[38-40] These factors and others, such as poor housing conditions, cockroach and house dust mite allergens, and ETS, can increase the severity and impact of the illness.[41-45] While some research has suggested that variations in asthma prevalence between racial groups can be explained by socioeconomic factors,[46] another study suggested that the difference persists even after accounting for economic factors.[47]

Children living in poverty are more likely to have poorly maintained housing, which can present additional risks for asthma. The Institute of Medicine concluded that exposure to dust mites causes asthma in susceptible children.[1] As noted above, cockroaches and ETS are likely to cause asthma in young children.[1] Research suggests that lower-income children are more likely to live in homes with higher exposure to cockroach allergens.[41,48,49] The first nationally representative survey of allergens in U.S. housing reported higher levels of dust mite allergen in bedding from lower-income families.[50] Household mouse allergen was also found at higher concentrations in low-income homes, mobile homes, and older homes.[51] In addition, total dust weight itself was

found to contribute to respiratory symptoms, including asthma and wheeze. Households with lower income, older homes, household pets, a smoker in the house, and less frequent cleaning are more likely to have higher dust weight levels.[52]

Indicators D1 and D2 focus on the prevalence of asthma among children. Indicator D1 shows two measures of asthma prevalence by year among of children ages 0 to 17 years, from 1997–2008: current asthma prevalence and asthma attack prevalence (those with ongoing or uncontrolled symptoms). Indicator D2 shows the prevalence of current asthma among children 0-17 years by race/ethnicity and poverty status for the years 2005–2008.[i]

Emergency Room Visits and Hospitalizations for Respiratory Diseases

Children who visit emergency rooms or are hospitalized for respiratory diseases (such as asthma, upper respiratory infections, and bronchiolitis) usually represent the most severe cases of respiratory effects. Although only a fraction of children with respiratory diseases are admitted to the hospital, asthma is the third leading cause of hospitalization for children in the United States.[53]

Emergency room visits and hospital admissions for respiratory diseases can be related to a number of factors. Besides indoor and outdoor air pollution, these factors include lack of access to primary health care, lack of or inadequate insurance, inadequate instructions for asthma management, or inadequate compliance with given instructions. Changes in emergency room visits and hospital admissions over time may also reflect changes in medical practices, asthma therapy, and access to and use of care.[54,55]

For children with existing respiratory conditions, exposure to air pollution from indoor and outdoor sources can trigger the onset of symptoms and lead to difficulty in breathing, increased use of medication, school absenteeism, visits to the doctor's office, and respiratory-related hospitalizations and trips to the emergency room.[3-6]

Studies have suggested that exacerbation of asthma from exposure to air pollution can be more severe among people with low income compared with other populations,[56,57] and that the gap between Black and White children in both hospitalizations and deaths from asthma appears to be growing.[58-60] The asthma death rate among Black non-Hispanic children with asthma was 4.9 times higher than the rate for White non-Hispanic children with asthma in 2004–2005.[58] Asthma is the leading cause of emergency room visits, hospitalizations, and missed school days in New York City's poorest neighborhoods.[61] In Maryland, the rate of children's emergency room visits for asthma is twice as high for Baltimore City (an area with a relatively high percentage of lower income and Black children) than for any other jurisdiction.[62]

The third indicator in this section (D3) provides information on emergency room visits for asthma and other respiratory illnesses for the years 1996–2008, and hospital admissions for asthma and other respiratory illnesses for the years 1996–2008. This indicator highlights the most severe cases of respiratory illness among children ages 0 to 17 years.

[i] State-specific asthma information can be found in the CDC report, *The State of Childhood Asthma, United States, 1980–2005*, located at http://www.cdc.gov/nchs/data/ad/ad381.pdf.

Indicator D1: Percentage of children ages 0 to 17 years with asthma, 1997–2008

Indicator D2: Percentage of children ages 0 to 17 years reported to have current asthma, by race/ethnicity and family income, 2005–2008

Overview

Indicators D1 and D2 present the percentage of children ages 0 to 17 years with asthma. The data are from a national survey that collects health information from a representative sample of the population. Indicator D1 shows how children's asthma rates have changed over time. Indicator D2 shows how children's asthma rates vary by race/ethnicity and family income level.

National Health Interview Survey

The National Health Interview Survey (NHIS) is a large-scale household interview survey of a representative sample of the civilian noninstitutionalized U.S. population, conducted by the Centers for Disease Control and Prevention (CDC). From 1997–2005, interviews were conducted for approximately 12,000–14,000 children annually. Since 2006, interviews have been conducted for approximately 9,000–10,000 children per year. With a major survey redesign implemented in 1997, the measurement of asthma prevalence in NHIS was changed to reporting the percentage of children ever diagnosed with asthma (lifetime asthma prevalence) and children ever diagnosed with asthma that also had an asthma attack in the previous 12 months (asthma attack prevalence). NHIS also began to report the percentage of children who currently have asthma (current asthma prevalence) beginning in 2001. The NHIS is conducted throughout the year to ensure that there is no seasonal bias in reporting.[63]

Data Presented in the Indicators

Indicator D1 presents two different measures of asthma prevalence using data from the NHIS: current asthma and asthma attack prevalence. Indicator D1 uses NHIS data for all children 0 to 17 years of age for the years 1997–2008. Indicator D2 reports on the percentage of children ages 0 to 17 years reported to have current asthma, by race/ethnicity and family income, in 2005–2008. NHIS is also the source of data for this indicator. The 2005, 2006, 2007, and 2008 data are combined for this indicator in order to increase the statistical reliability of the estimates for each race/ethnicity and income group.

NHIS asks parents, "Has a doctor or other health professional ever told you that your child has asthma?" If the parent answers YES to this question, they are then asked (1) "Does your child still have asthma?" (shown in the D1 graph with the "Current asthma prevalence" line) and (2) "during the past 12 months, has your child had an episode of asthma or an asthma attack?"

(shown in the D1 graph with the "Asthma attack prevalence" line). The question "Does your child still have asthma?" was introduced in 2001 and identifies children who were previously diagnosed with asthma and who currently have asthma. Some children may have asthma when they are young and experience fewer symptoms as they get older, or their asthma may be well controlled through medication and by avoiding triggers of asthma attacks. In such cases, children may currently have asthma but may not have experienced any attacks in the previous year.

For Indicator D2, five race/ethnicity groups are presented: White non-Hispanic, Black non-Hispanic, Asian non-Hispanic, Hispanic, and "Other." The "Other" race/ethnicity category includes non-Hispanic respondents whose race is neither White, Black, nor Asian, or who report multiple races. The data are also tabulated across three income categories: all incomes, below the poverty level, and greater than or equal to the poverty level.

In addition to the data shown in Indicator D1, a supplemental table shows data for the percentage of children who had asthma in the past 12 months, (asthma period prevalence), for the years 1980–1996. Estimates for asthma period prevalence are not directly comparable to any of the three prevalence estimates collected since 1997 because of changes in the NHIS survey questions. The data table for Indicator D2 shows the prevalence of current asthma for an expanded set of race/ethnicity categories, including Mexican-American and Puerto Rican.

Other Estimates of Asthma Prevalence

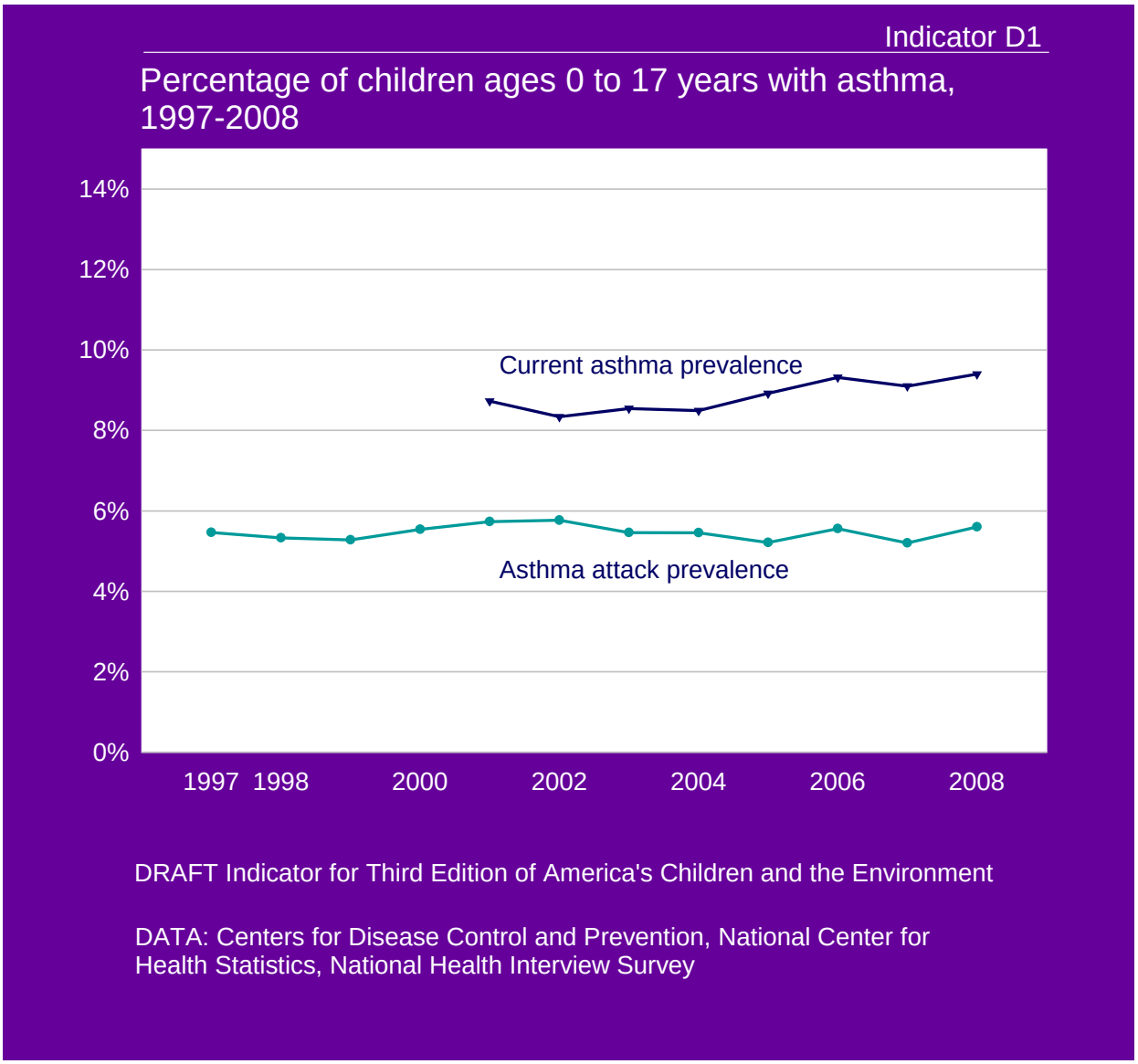
In addition to NHIS, other CDC surveys provide data on asthma prevalence. A survey conducted in 2007 by CDC along with state and local governments found that 11% of high school students currently had asthma.[64] The 2007 National Survey of Children's Health (NSCH) found that nationwide 9.0% of children ages 0 to 17 years currently had asthma, which is very similar to the estimate from NHIS for 2007. The 2007 NSCH also provides information at the state level: South Dakota has the lowest asthma rates, with only 5.2% of children currently having asthma. The District of Columbia has the highest asthma rates, with 14.4% of children currently having asthma.[65]

Statistical Testing

Statistical analysis has been applied to the indicators to determine whether any changes in prevalence over time, or any differences in prevalence between demographic groups, are statistically significant. These analyses use a 5% significance level ($p \leq 0.05$), meaning that a conclusion of statistical significance is made only when there is no more than a 5% chance that the observed change over time or difference between demographic groups occurred randomly. It should be noted that when statistical testing is conducted for differences among multiple demographic groups (e.g., considering both race/ethnicity and income level), the large number of comparisons involved increases the probability that some differences identified as statistically significant may actually have occurred randomly.

A finding of statistical significance for a health indicator depends not only on the numerical difference in the value of a reported statistic between two groups, but also on the number of observations in the survey and various aspects of the survey design. For example, if the prevalence of a health effect is different between two groups, the statistical test is more likely to

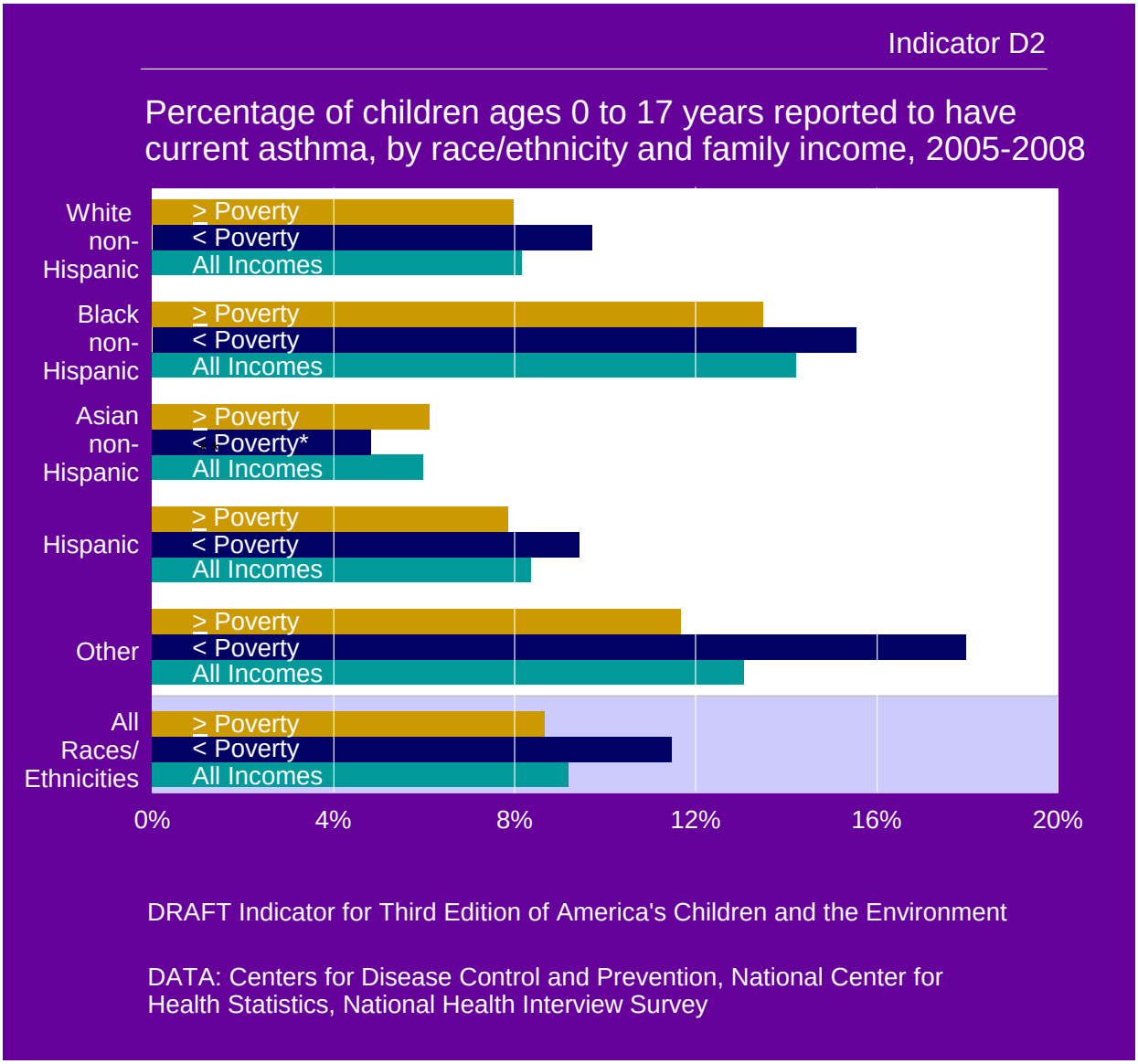
detect a difference when data have been obtained from a larger number of people in those groups. A finding that there is or is not a statistically significant difference in prevalence between two groups or in prevalence over time is not the only information that should be considered when determining the public health implications of those differences.



- The percentage of children reported to currently have asthma has increased in recent years. In 2001, an estimated 8.7% of children were reported to currently have asthma; in 2008, an estimated 9.4% of children were reported to currently have asthma. The increase from 2001 to 2008 was statistically significant.
    - Statistical note: The increase in current asthma among all children from 2001–2008 was statistically significant. There was also a statistically significant trend in current asthma for boys (but not girls); and for Hispanic and Black non-Hispanic children (but not for the remaining races/ethnicities).

- In 2008, an estimated 6% of all children had one or more asthma attacks in the previous 12 months. There was little change in this rate between 1997 and 2008. About 3 children out of 5 who currently have asthma have ongoing asthma symptoms.

- Between 1980 and 1995 the percentage of children who had asthma in the past 12 months increased from an estimated 4% in 1980 to approximately 8% in 1995. Methods for measurement of childhood asthma changed in 1997, so earlier data cannot be compared to the data from 1997–2008. (See Table D1.)



* 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).

- In 2005–2008, 9% of all children were reported to currently have asthma.

- Eleven percent of children living in families with incomes below the poverty level were reported to currently have asthma. An estimated 9% of children living in families with incomes at the poverty level and higher were reported to currently have asthma. This difference was statistically significant.

- Fourteen percent of Black non-Hispanic and 13% of children of "Other" race/ethnicity were reported to currently have asthma, compared with 8% of White non-Hispanic, 8% of Hispanic children, and 6% of Asian non-Hispanic children.
    - Statistical Note: The differences in current asthma prevalence among Black or "Other" children, compared with current asthma prevalence among Hispanic, White non-Hispanic, or Asian non-Hispanic children, were statistically significant. These differences by race/ethnicity also hold true when considering only children below poverty level and only children at or above poverty level.

- Puerto Rican children have the highest levels of reported current asthma. About 1 in 4 Puerto Rican children (24%) living in families with incomes below the poverty level were reported to currently have asthma. The rate of reported current asthma for Mexican-American children living in families with incomes below the poverty level is 7%, demonstrating a difference with Puerto Rican children that is statistically significant. (See Table D2).

- About 11% of boys were reported to have current asthma compared with 8% of girls. This difference was statistically significant. (See Table D2b).

- About 7% of children ages 0 to 5 years were reported to have current asthma compared with 10% of children ages 6 to 10 years and 10% of children ages 11 to 17 years. This difference was statistically significant. (See Table D2b).

Indicator D3: Children's emergency room visits and hospital admissions for asthma and other respiratory causes, ages 0 to 17 years, 1996-2008

Overview

Indicator D3 presents information about the number of children's emergency room visits and hospital admissions for asthma and other respiratory causes. The data are from two national surveys that collect information from hospitals. Indicator D3 shows how the rates of children's emergency room visits and hospitalizations for respiratory causes have changed over time.

National Hospital Ambulatory Medical Care Survey and National Hospital Discharge Survey

The sources of data for this indicator are the National Hospital Ambulatory Medical Care Survey (NHAMCS) and the National Hospital Discharge Survey (NHDS), conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention. The NHAMCS has collected data for physician diagnoses for visits to hospital emergency rooms and outpatient departments beginning in the year 1992, while the NHDS reports physician diagnoses for discharges from hospitals beginning in the year 1965. Both surveys exclude federal and military hospitals and report patient demographic information.

Data Presented in the Indicators

Indicator D3 displays emergency room visits and hospitalizations for asthma and other respiratory conditions including bronchitis, pneumonia, and influenza. The top line in each graph represents the total number of children's emergency room visits or hospitalizations for asthma and all other respiratory causes, followed by lines for asthma and for all respiratory causes other than asthma. Indicator D3 presents survey results from 1996–2008.

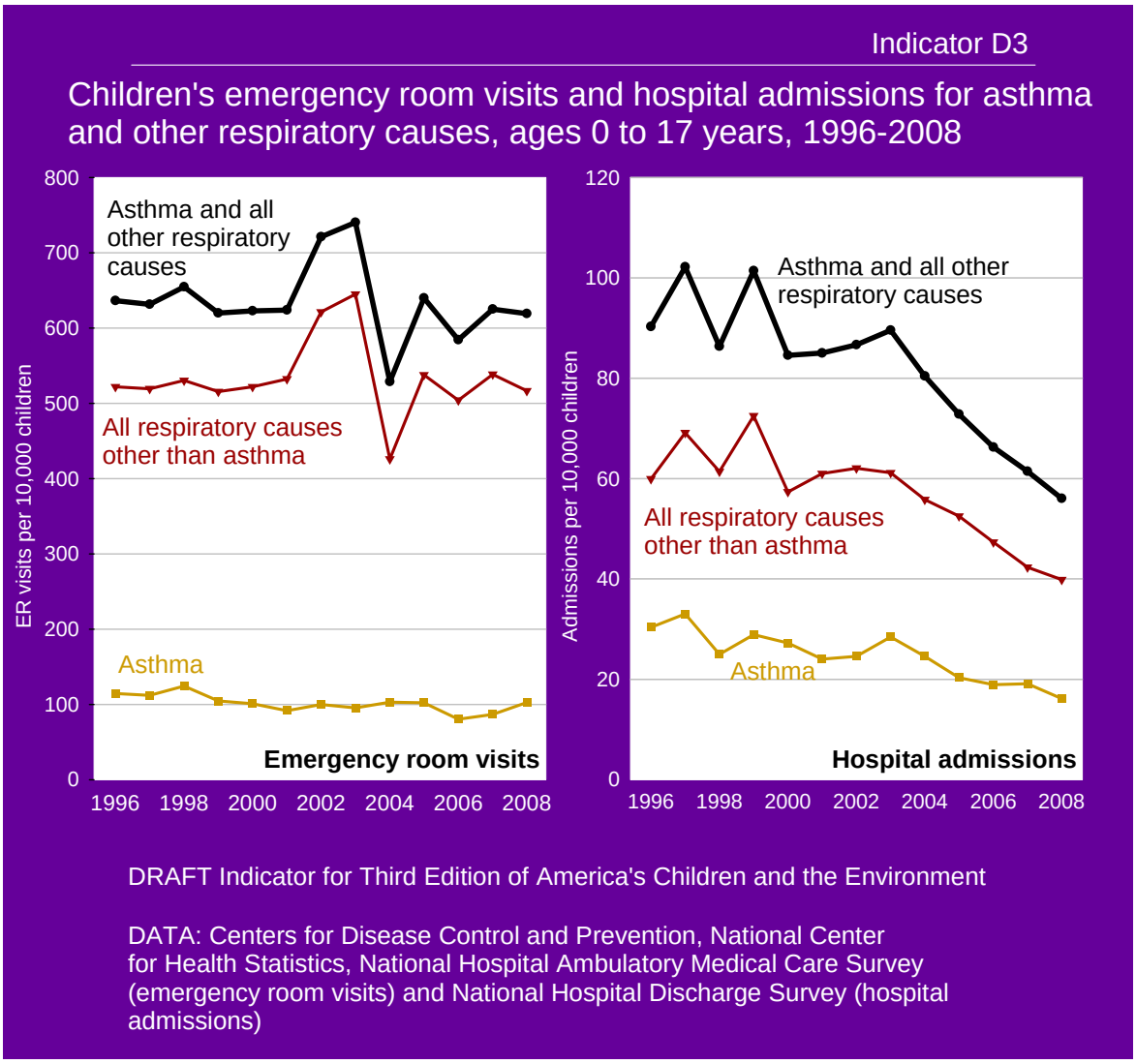
In addition to the data shown in the Indicator D3 graph, supplemental tables show the annual average rates of children's emergency room visits and hospital admissions for asthma and all other respiratory causes, asthma, and all respiratory causes other than asthma (composed of the following subcategories: upper respiratory conditions, pneumonia or influenza, and other lower respiratory conditions besides asthma) by age and race/ethnicity for the years 2005–2008. The supplemental tables do not include income data, since neither of these surveys includes the patient's income or family income.

Statistical Testing

Statistical analysis has been applied to the indicators to determine whether any changes in prevalence over time, or any differences in prevalence between demographic groups, are statistically significant. These analyses use a 5% significance level ($p \leq 0.05$), meaning that a conclusion of statistical significance is made only when there is no more than a 5% chance that

the observed change over time or difference between demographic groups occurred randomly. It should be noted that when statistical testing is conducted for differences among multiple demographic groups (e.g., considering both race/ethnicity and income level), the large number of comparisons involved increases the probability that some differences identified as statistically significant may actually have occurred randomly.

A finding of statistical significance for a health indicator depends not only on the numerical difference in the value of a reported statistic between two groups, but also on the number of observations in the survey and various aspects of the survey design. For example, if the prevalence of a health effect is different between two groups, the statistical test is more likely to detect a difference when data have been obtained from a larger number of people in those groups. A finding that there is or is not a statistically significant difference in prevalence between two groups or in prevalence over time is not the only information that should be considered when determining the public health implications of those differences.



Emergency Room Visits

- In 2008, the rate of emergency room visits for asthma and all other respiratory causes was 619 visits per 10,000 children. The rate of emergency room visits for asthma alone was 103 visits per 10,000 children, and the rate for all respiratory causes other than asthma was 517 visits per 10,000 children.

- The rate of asthma emergency room visits decreased from 114 visits per 10,000 children in 1996 to 103 visits per 10,000 children in 2008. This decrease was statistically significant.

- Children's emergency room visits for asthma and all other respiratory causes vary widely by race/ethnicity. For the years 2005–2008, Black non-Hispanic children had a rate of 1,240 emergency room visits per 10,000 children, while Hispanic children had a rate of 672 emergency room visits per 10,000 children, American Indian/Alaska Native non-Hispanic

children had a rate of 536 emergency room visits per 10,000 children, White non-Hispanic children had a rate of 487 emergency room visits per 10,000 children, and Asian and Pacific Islander non-Hispanic children had a rate of 371 emergency room visits per 10,000 children. (See Table D3a.)

- Statistical Note: The difference in rates of emergency room visits between Black non-Hispanic children and emergency room visits for each of the other race/ethnicity groups was statistically significant.

- Children's emergency room visits for asthma and all other respiratory causes vary widely by age. For the years 2005–2008, infants less than 12 months of age had a rate of 2,142 emergency room visits per 10,000 children, while children 16 to 17 years of age had a rate of 338 emergency room visits per 10,000 children. The differences between age groups were statistically significant. (See Table D3c.)

Hospital Admissions

- In 2008, the rate of hospital admissions for asthma and all other respiratory causes was 56 hospital admissions per 10,000 children. The rate of hospital admissions for asthma alone was 16 hospital admissions per 10,000 children, and the rate for all respiratory causes other than asthma was 40 hospital admissions per 10,000 children. Between 1996 and 2008, hospital admissions for asthma and for all other respiratory causes decreased. These decreases were statistically significant.

- Children's hospital admissions for asthma and all other respiratory causes vary widely by race. For the years 2005–2008, Black children had a rate of 84 hospital admissions per 10,000 children, while White children had a rate of 52 hospital admissions per 10,000 children, American Indian/Alaska Native children had a rate of 36 hospital admissions per 10,000 children, and Asian and Pacific Islander children had a rate of 28 hospital admissions per 10,000 children. (See Table D3b.)
  - Statistical Note: There were statistically significant differences between the rates for all racial groups, after adjustment for age and sex, with the exception of the difference between Asian and Pacific Islander and American Indian/Alaska Native children.

- Children's hospital admissions for asthma and all other respiratory causes vary widely by age. For the years 2005–2008, infants less than 12 months of age had a rate of 396 hospital admissions per 10,000 children, while children 16 to 17 years of age had a rate of 13 hospital admissions per 10,000 children. The differences between age groups were statistically significant (See Table D3d.)

Data Tables

Table D1: Percentage of children ages 0 to 17 years with asthma, 1997-2008

1997-2003							
	1997	1998	1999	2000	2001	2002	2003
Asthma attack prevalence	5.5%	5.3%	5.3%	5.5%	5.7%	5.8%	5.5%
Current asthma prevalence‡					8.7%	8.3%	8.5%

2004-2008					
	2004	2005	2006	2007	2008
Asthma attack prevalence	5.5%	5.2%	5.6%	5.2%	5.6%
Current asthma prevalence‡	8.5%	8.9%	9.3%	9.1%	9.4%

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey

‡ This survey question was first asked in 2001.

Table D1a: Percentage of children ages 0 to 17 years with asthma, 1980-1996†

1980-1987								
	1980	1981	1982	1983	1984	1985	1986	1987
Asthma in the past 12 months	3.6%	3.7%	4.1%	4.5%	4.3%	4.8%	5.1%	5.3%

1988-1996									
	1988	1989	1990	1991	1992	1993	1994	1995	1996
Asthma in the past 12 months	5.0%	6.1%	5.8%	6.4%	6.3%	7.2%	6.9%	7.5%	6.2%

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey

† Note: The survey questions for asthma changed in 1997; data before 1997 cannot be directly compared to data in 1997 and later, and are thus shown in this separate table.

Table D2: Percentage of children ages 0 to 17 years reported to have current asthma by race/ethnicity and family income, 2005-2008

Race / Ethnicity	All	< Poverty Level	≥Poverty Level	≥ Poverty Level Detail	
				100-200% of Poverty Level	≥ 200% of Poverty Level
All	9.2	11.5	8.7	9.5	8.3
White non-Hispanic	8.2	9.7	8.0	9.0	7.7
Black or African-American non-Hispanic	14.2	15.5	13.5	13.4	13.6
Asian non-Hispanic	6.0	4.8*	6.1	4.4*	6.7
Hispanic	8.4	9.4	7.9	7.5	8.2
Mexican	7.1	6.7	7.3	6.8	7.8
Puerto Rican	18.8	24.3	15.5	18.1	14.0
Other†	13.1	18.0	11.7	16.6	9.2
American Indian or Alaska Native non-Hispanic	14.3	15.6*	13.5	17.7*	NA**

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey

† "Other" includes non-Hispanic respondents whose race is neither White, Black, or Asian or who report multiple races.

* 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).

** The estimate is not reported because it has large uncertainty: the relative standard error, RSE, is at least 40% (RSE = standard error divided by the estimate).

Table D2a: Percentage of children ages 0 to 17 years reported to have current asthma by age and sex, 2005-2008

	All	Boys	Girls
0-17 years	9.2	10.5	7.8
0-5 years	7.1	8.9	5.3
6-10 years	10.1	12.3	7.9
11-17 years	10.3	10.8	9.8

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey

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Table D3: Children's emergency room visits and hospitalizations for asthma and other respiratory causes, ages 0 to 17 years, 1996-2008

1996-1999				
	Rate per 10,000 children			
	1996	1997	1998	1999
Emergency Room Visits				
Asthma and all other respiratory causes	636.4	631.5	654.7	619.9
All respiratory causes other than asthma	521.9	519.4	530.3	515.4
Upper respiratory	408.4	409.3	426.0	403.0
Pneumonia or influenza	56.3	52.0	58.0	58.8
Other lower respiratory	57.2	58.0	46.3	53.6
Asthma	114.4	112.1	124.4	104.5
Hospital Admissions				
Asthma and all other respiratory causes	90.3	102.2	86.3	101.4
All respiratory causes other than asthma	59.9	69.1	61.4	72.5
Upper respiratory	28.9	37.2	27.6	39.5
Pneumonia or influenza	29.6	30.6	33.1	32.0
Other lower respiratory	1.4	1.3	0.7	1.0
Asthma	30.4	33.1	25.0	28.9
2000-2003				
	Rate per 10,000 children			
	2000	2001	2002	2003
Emergency Room Visits				
Asthma and all other respiratory causes	622.7	624.0	721.1	740.2
All respiratory causes other than asthma	521.8	532.3	621.3	644.8
Upper respiratory	428.1	426.8	494.4	499.1
Pneumonia or influenza	54.1	63.3	79.8	94.3
Other lower respiratory	39.7	42.2	47.1	51.5
Asthma	100.9	91.7	99.9	95.4
Hospital Admissions				
Asthma and all other respiratory causes	84.6	85.0	86.7	89.6
All respiratory causes other than asthma	57.3	61.0	62.1	61.1
Upper respiratory	32.5	33.7	33.6	29.8

Pneumonia or influenza	23.9	26.6	27.8	30.2
Other lower respiratory	1.0	NA**	0.6	1.2
Asthma	27.2	24.0	24.6	28.4
2004-2007				
	Rate per 10,000 children			
	2004	**2005**	**2006**	**2007**
Emergency Room Visits				
Asthma and all other respiratory causes	528.8	639.8	584.3	625.1
All respiratory causes other than asthma	426.0	537.8	504.1	538.5
Upper respiratory	331.6	441.3	396.9	416.2
Pneumonia or influenza	56.9	62.6	61.1	87.6
Other lower respiratory	37.4	33.9	46.1	34.6
Asthma	102.8	102.1	80.2	86.6
Hospital Admissions				
Asthma and all other respiratory causes	80.4	72.8	66.3	61.4
All respiratory causes other than asthma	55.8	52.5	47.3	42.3
Upper respiratory	30.5	25.8	23.5	23.1
Pneumonia or influenza	24.2	26.4	22.9	18.9
Other lower respiratory	1.1	0.4*	0.9	NA**
Asthma	24.6	20.3	18.9	19.1
2008				
	Rate per 10,000 children			
	2008			
Emergency Room Visits				
Asthma and all other respiratory causes	619.1			
All respiratory causes other than asthma	516.6			
Upper respiratory	388.2			
Pneumonia or influenza	91.3			
Other lower respiratory	37.1			
Asthma	102.6			
Hospital Admissions				
Asthma and all other respiratory causes	56.0			
All respiratory causes other than asthma	39.9			
Upper respiratory	19.1			
Pneumonia or influenza	20.3			

Other lower respiratory	NA**			
Asthma	16.2			

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Hospital Ambulatory Medical Care Survey and National Hospital Discharge Survey.

* 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).

** The estimate is not reported because it has large uncertainty: the relative standard error, RSE, exceeds 40% (RSE = standard error divided by the estimate) or there are less than 30 sampled hospitalizations.

Table D3a: Children's emergency room visits for asthma and other respiratory causes, by race/ethnicity, 2005-2007, ages 0 to 17 years , 2005-2008

	Rate per 10,000 children				
	2005	**2006**	**2007**	**2008**	**2005-2008**
All	639.8	584.3	625.1	619.1	617.1
White non-Hispanic	484.8	442.3	518.8	500.9	486.6
Black non-Hispanic	1,242.7	1,276.0	1,183.5	1,258.0	1,240.1
American Indian/Alaska Native non-Hispanic	NA**	NA**	NA**	NA**	536.2
Asian and Pacific Islander non-Hispanic	409.4*	404.7	341.8*	333.1*	371.4
Hispanic	788.9	600.4	656.4	646.7	671.5

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Hospital Ambulatory Medical Care Survey.

* 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).

** The estimate is not reported because it has large uncertainty: the relative standard error, RSE, exceeds 40% (RSE = standard error divided by the estimate) or there are fewer than 30 sampled emergency room visits.

Table D3b: Children's hospital admissions for asthma and other respiratory causes, by race,† 2005-2008, ages 0 to 17 years, 2005-2008

	Rate per 10,000 children				
	2005	**2006**	**2007**	**2008**	**2005-2008**
All	72.8	66.3	61.4	56.0	64.1
White	61.7	56.5	47.7	42.7	52.1

	Rate per 10,000 children				
	2005	2006	2007	2008	2005-2008
Black	94.1	91.6	78.0	72.3	84.0
American Indian/Alaska Native	NA**	NA**	NA**	NA**	36.0
Asian and Pacific Islander	NA**	36.9	24.2	NA**	27.6

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Hospital Discharge Survey.

† Estimates for ethnicity not available. Race categories include children of Hispanic ethnicity.

** The estimate is not reported because it has large uncertainty: the relative standard error, RSE, exceeds 40% (RSE = standard error divided by the estimate) or there are fewer than 30 sampled hospitalizations.

Table D3c: Children's emergency room visits for asthma and other respiratory causes, by age, 2005-2008

	Rate per 10,000 children				
	2005	2006	2007	2008	2005-2008
< 18 years	639.8	584.3	625.1	619.1	617.1
< 12 months	2,344.8	2,040.5	2,098.3	2,090.4	2,142.1
1 to < 2 years	1,884.3	1,696.4	1,823.1	1,727.5	1,782.3
2 to < 3 years	1,081.9	957.2	1,015.0	972.7	1,006.3
3 to < 6 years	778.4	668.1	719.8	751.9	729.5
6 to < 11 years	391.6	384.1	389.5	382.7	387.0
11 to < 16 years	252.6	251.0	276.7	268.3	262.0
16 to < 18 years	333.2	310.2	362.9	346.1	338.2

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Hospital Ambulatory Medical Care Survey.

Table D3d: Children's hospital admissions for asthma and other respiratory causes, by age, 2005-2008

	Rate per 10,000 children				
	2005	2006	2007	2008	2005-2007
< 18 years	72.8	66.3	61.4	56.0	64.1
< 12 months	477.2	399.6	364.8	344.3	395.5
1 to < 2 years	232.7	211.9	173.5	152.2	191.9
2 to < 3 years	115.9	112.2	117.9	89.7	108.8

	Rate per 10,000 children				
	2005	**2006**	**2007**	**2008**	**2005-2007**
3 to < 6 years	70.1	68.2	53.9	53.3	61.3
6 to < 11 years	33.0	28.8	29.0	27.6	29.6
11 to < 16 years	15.3	13.8	17.2	13.1	14.9
16 to < 18 years	8.7	15.0	13.9	14.1	12.9

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Hospital Discharge Survey.

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Metadata

Metadata for	National Health Interview Survey (NHIS)
Brief description of the data set	The National Health Interview Survey (NHIS) collects data on a broad range of health topics through personal household interviews. The results of NHIS provide data to track health status, health care access, and progress toward achieving national health objectives.
Who provides the data set?	Centers for Disease Control and Prevention, National Center for Health Statistics.
How are the data gathered?	Data are obtained using a health questionnaire through a personal household interview. Interviewers obtain information on health history and demographic characteristics, including age, household income, and race and ethnicity from respondents, or from a knowledgeable household adult for children age 17 years and younger.
What documentation is available describing data collection procedures?	See http://www.cdc.gov/nchs/nhis.htm for detailed survey documentation by survey year.
What types of data relevant for children's environmental health indicators are available from this database?	Health history (e.g., asthma, mental health, childhood illnesses). Smoking in residences (for selected years). Demographic information. Health care use and access information.
What is the spatial representation of the database (national or other)?	NHIS sampling procedures provide nationally representative data, and may also be analyzed by four broad geographic regions: North, Midwest, South and West. Analysis of data for any other smaller geographic areas (state, etc.) is possible only by special arrangement with the NCHS Research Data Center.
Are raw data (individual measurements or survey responses) available?	Data for each year of the NHIS are available for download and analysis (http://www.cdc.gov/nchs/nhis/nhis_questionnaires.htm). Annual reports from the NHIS are also available (http://www.cdc.gov/nchs/nhis/nhis_products.htm) as are interactive data tables (http://www.cdc.gov/nchs/hdi.htm). The files available for download generally contain individual responses to the survey questions; however, for some questions the responses are categorized Some survey responses are not publicly released.
How are database files obtained?	Raw data: http://www.cdc.gov/nchs/nhis.htm
Are there any known data quality or data analysis concerns?	Data are self-reported, or (for individuals age 17 years and younger) reported by a knowledgeable household adult, usually a parent. Responses to some demographic questions (race/ethnicity, income) are statistically imputed for survey participants lacking a reported response.
What documentation is available describing QA procedures?	http://www.cdc.gov/nchs/data/series/sr_02/sr02_130.pdf provides a summary of QA procedures.
For what years are data available?	Data from the NHIS are available from 1957–present. Availability of data addressing particular issues varies based on when questions were added to the NHIS. The survey is redesigned on a regular basis; many questions of interest for children's environmental health indicators were modified or first asked with the redesign that was implemented in 1997. For environmental tobacco smoke (regular smoking in the home), comparable

Metadata for	National Health Interview Survey (NHIS)
	data are available for 1994 and 2005.
What is the frequency of data collection?	Continuous throughout the year.
What is the frequency of data release?	Annually.
Are the data comparable across time and space?	Survey design and administration are consistent across locations and from year to year. Many questions were revised or added in 1997, so data for prior years may not be comparable to data from 1997 to present.
Can the data be stratified by race/ethnicity, income, and location (region, state, county or other geographic unit)?	Race, ethnicity, income. Region (four regions only).

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Metadata for	National Hospital Ambulatory Medical Care Survey (NHAMCS)
Brief description of the data set	The National Hospital Ambulatory Medical Care Survey (NHAMCS) is designed to collect information on the services provided in hospital emergency and outpatient departments and in ambulatory surgery centers.
Who provides the data set?	Centers for Disease Control and Prevention, National Center for Health Statistics.
How are the data gathered?	Sampled hospitals are noninstitutional general and short-stay hospitals located in all states and Washington DC, but exclude federal, military, and Veteran's Administration hospitals. Data from sampled visits are obtained on the demographic characteristics, expected source(s) of payments, patients' complaints, physician's diagnoses, diagnostic and screening services, procedures, types of health care professionals seen, and causes of injury.
What documentation is available describing data collection procedures?	See http://www.cdc.gov/nchs/ahcd/ahcd_data_collection.htm#nhamcs_collection for data collection documentation.
What types of data relevant for children's environmental health indicators are available from this database?	Physicians' diagnoses for ambulatory visits to hospital emergency rooms and outpatient departments. Demographic information.
What is the spatial representation of the database (national or other)?	NHAMCS sampling procedures provide nationally representative data, and may also be analyzed by four broad geographic regions: North, Midwest, South and West. In addition the database identifies whether or not the hospital is in an MSA. Analysis of data for any other geographic area (state, patient or facility zip code) is possible only by special arrangement with the NCHS Research Data Center.
Are raw data (individual measurements or survey responses) available?	Data for each year of the NHAMCS are available for download and analysis (http://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm). Annual reports from the NHAMCS are also available (http://www.cdc.gov/nchs/ahcd/ahcd_products.htm) as are interactive data tables (http://www.cdc.gov/nchs/hdi.htm).
How are database files obtained?	http://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm
Are there any known data quality or data analysis	Responses to some demographic and other questions (birth year, sex, race, ethnicity, immediacy of being seen) are statistically imputed for survey

Metadata for	National Hospital Ambulatory Medical Care Survey (NHAMCS)
concerns?	participants lacking a reported response.
What documentation is available describing QA procedures?	http://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm summarizes the QA procedures.
For what years are data available?	1992–present.
What is the frequency of data collection?	Continuously throughout the year.
What is the frequency of data release?	Annually.
Are the data comparable across time and space?	Changes to some survey questions or to the set of possible responses make their responses non-comparable for different time periods (e.g., reason for visit). Some diagnosis codes are not comparable from year to year due to annual revisions to the International Classification of Diseases (ICD-9).
Can the data be stratified by race/ethnicity, income, and location (region, state, county or other geographic unit)?	Race, ethnicity. Region (four regions only). For 2006 and later: Median income, % below poverty, % with college degree or higher level of education, and urban/rural classification for patient's zip code (the zip code itself is not included in the public release version).

1
2

Metadata for	National Hospital Discharge Survey (NHDS)
Brief description of the data set	The National Hospital Discharge Survey (NHDS) is an annual probability survey that collects information on the characteristics of inpatients discharged from non-federal short-stay hospitals in the United States.
Who provides the data set?	Centers for Disease Control and Prevention, National Center for Health Statistics.
How are the data gathered?	Sampled hospitals are short-stay general or children's general hospitals located in all states and Washington DC, with an average length of stay of fewer than 30 days and six or more beds staffed for patients use. Federal, military, and Veteran's Administration hospitals are excluded, as are hospital units of institutions. Data from sampled hospital discharges are obtained on the demographic characteristics and physician's diagnoses.
What documentation is available describing data collection procedures?	See http://www.cdc.gov/nchs/nhds/nhds_collection.htm for data collection documentation.
What types of data relevant for children's environmental health indicators are available from this database?	Physician's diagnoses for discharges from hospitals. Demographic information.
What is the spatial representation of the database (national or other)?	NHDS sampling procedures provide nationally representative data, and may also be analyzed by four broad geographic regions: North, Midwest, South and West. Analysis of data for any other geographic area (state, patient zip code) is possible only by special arrangement with the NCHS Research Data Center.
Are raw data (individual measurements or survey responses) available?	Individual hospital discharge data are available. Some survey responses are not publicly released.

Metadata for	National Hospital Discharge Survey (NHDS)
How are database files obtained?	http://www.cdc.gov/nchs/nhds/nhds_questionnaires.htm
Are there any known data quality or data analysis concerns?	The survey is designed to represent in-patient discharges to short-stay general or children's general hospitals, excluding federal and military hospitals. Data are obtained from a detailed complex survey sampling scheme including samplings of hospitals and discharges within hospitals. Survey responses must be appropriately weighted using the provided analysis weights to obtain national estimates. The public release version includes coefficients for variance estimation equations for approximate variance estimation. The available data are for discharges and not admissions. Some age and sex values were imputed.
What documentation is available describing QA procedures?	http://www.cdc.gov/nchs/data/series/sr_01/sr01_039.pdf includes a description of the QA procedures since 1988.
For what years are data available?	1965–present.
What is the frequency of data collection?	Continuously throughout the year.
What is the frequency of data release?	Annually.
Are the data comparable across time and space?	Some diagnosis codes are not comparable from year to year due to annual revisions to the International Classification of Diseases (ICD-9).
Can the data be stratified by race/ethnicity, income, and location (region, state, county or other geographic unit)?	Race. Region (four regions only). NHDS does not release information on Hispanic ethnicity or income of patients due to high nonresponse rates for this item. Although race is reported, there are also high non-response rates for race.

1
2

Methods (D1 and D2)

Indicator

D1. Percentage of children ages 0 to 17 years with asthma, 1997-2008.
D2. Percentage of children ages 0 to 17 years with current asthma, by race/ethnicity and family income, 2005-2008.

Summary

Since 1957, the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention, has conducted the National Health Interview Survey (NHIS), a series of annual U.S. national surveys of the health status of the noninstitutionalized civilian population. These indicators use responses to questions on asthma for children ages 0 to 17 years from the NHIS 1997 to 2008 surveys; these questions have changed over time. Indicator D1 gives the percentages of children ever diagnosed with asthma that also had an asthma attack in the previous 12 months (1997-2008), and of children that currently have asthma (2001-2008). Indicator D2 uses responses to questions on asthma from children ages 0 to 17 years from the NHIS 2005 to 2008 surveys. Indicator D2 gives the percentages of children that currently have asthma, stratified both by race/ethnicity (using NHIS information on race and Hispanic origin) and family income (using reported or imputed NHIS poverty-income ratio data for each respondent). Table D1a gives the percentages of children with asthma in the previous 12 months for 1980 to 1996. Table D2a gives the percentages of children that currently have asthma, stratified both by age group and sex. Percentages are calculated by combining positive responses to the relevant questions with the survey weights for each respondent. The survey weights are the annual numbers of children in the noninstitutionalized civilian population represented by each respondent.

Data Summary

Indicator	D1. Percentage of children ages 0 to 17 years with asthma, 1997-2008. D2. Percentage of children ages 0 to 17 years with current asthma, by race/ethnicity and family income, 2005-2008.					
Time Period	1997-2008					
Data	Asthma prevalence in children ages 0 to 17 years.					
Years (1997-2002)	1997	1998	1999	2000	2001	2002
Asthma attack non-missing responses	14,242	13,608	12,685	13,350	13,556	12,492
Asthma attack missing responses	48	37	25	26	23	32

Indicator	D1. Percentage of children ages 0 to 17 years with asthma, 1997-2008. D2. Percentage of children ages 0 to 17 years with current asthma, by race/ethnicity and family income, 2005-2008.					
Current asthma non-missing responses*					13,534	12,475
Current asthma missing responses					45	49
Years (2003-2008)	2003	2004	2005	2006	2007	2008
Asthma attack non-missing responses	12,224	12,395	12,500	9,810	9,401	8,798
Asthma attack missing responses	25	29	23	27	16	17
Current asthma non-missing responses	12,207	12,386	12,496	9,797	9,394	8,793
Current asthma missing responses	42	38	27	40	23	22

* This survey question was first asked in 2001.

Overview of Data Files

The following files are needed to calculate this indicator. All these files together with the survey documentation and SAS programs for reading in the data are available at the NHIS website: http://www.cdc.gov/nchs/nhis.htm.

- NHIS 1997-2008: Sample Child file samchild.dat. Person file personsx.dat, Family file familyxx.dat, Imputed Income files 2005-2008: incmimp1.dat, incmimp2.dat, incmimp3.dat, incmimp4.dat, and incmimp5.dat. The Sample Child file is an ASCII file containing interview data for children ages 17 years and under. Demographic data is obtained from the Person and Family files. The demographic variables needed for this indicator are the sample child survey weight (WTFA_SC), age (AGE_P), sex (SEX), the pseudo-stratum (STRATUM), the pseudo-PSU (PSU), the race (RACERPI2, using the 1997 OMB definitions), the Hispanic origin (ORIGIN_I), and the detailed Hispanic origin HISPAN_I. The pseudo-stratum and pseudo-PSU variables provide an approximation to the exact sample design variables, and were created by CDC by combining stratum information in a manner to protect the confidentiality of the publicly released data. From each of the imputed income files we need the imputed poverty income ratio (RAT_CATI), which gives the poverty income ratio category calculated from the reported exact family income, if available, or else gives the imputed category

randomly generated by multiple imputation using regression models. The files are sorted and merged using the identifiers HHX, FMX, and FPX. The questionnaire variables needed for these analyses are the responses to the following questions: "Has a doctor or other health professional ever told you that <child's name> had asthma?" (CASHMEV) and if yes, "During the past 12 months, has <child's name> had an episode of asthma or an asthma attack?" (CASHYR). For 2001-2008 another needed variable is the response to the question: "Does <child's name> still have asthma?" (CASSTILL).

- NHIS 1980-1996. Condition file conditon.dat. This file is an ASCII file that contains the age (AGE), condition number (CNUM), survey weight (WTFA), and the parent's response to "Did <child's name> have this condition in the past 12 months?" (CPAST12). Data for children ages 17 and under and for the asthma condition were extracted. Used only for Table D1a.

National Health Interview Survey (NHIS)

Since 1957, the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention, has conducted the National Health Interview Survey (NHIS), a series of annual U.S. national surveys of the health status of the noninstitutionalized civilian population. This indicator uses responses to asthma prevalence questions in children ages 0 to 17 years for the surveys from 1980 to 2008. The NHIS data were obtained from the NHIS website: http://www.cdc.gov/nchs/nhis.htm.

For 1997-2008, the first asthma question was: "Has a doctor or other health professional ever told you that <child's name> had asthma?" (CASHMEV). If the response was Yes, then the second question "During the past 12 months, has <child's name> had an episode of asthma or an asthma attack?" was asked (CASHYR). For 2001-2008, Yes responders to the CASHMEV question were also asked "Does <child's name> still have asthma?" (CASSTILL). For all three questions, responses other than Yes or No were treated as missing data. For the CASHYR and CASSTILL questions, responders who said No to the CASHMEV question were, for these analyses, treated as also responding No to the CASHYR and CASSTILL questions, even though they were not asked those questions. For 1980 to 1996, the asthma survey question was "Did <child's name> have asthma in the past 12 months?"

The NHIS uses a complex multi-stage, stratified, clustered sampling design. Certain demographic groups have been deliberately over-sampled. Oversampling is performed to increase the reliability and precision of estimates of health status indicators for these population subgroups. From 1997 to 2005, Blacks and Hispanics were over-sampled. From 2006, Blacks, Hispanics, and Asians were over-sampled. The publicly released data include survey weights to adjust for the over-sampling, non-response, and non-coverage. The statistical analyses used the sample child survey weights (WTFA_SC, 1997 and later) to re-adjust the responses to represent the national population.

The sample design was changed in 2006. New strata were defined and PSUs were selected from these new strata. For example, pseudo-stratum 1 for 1997-2005 is unrelated to pseudo-stratum 1

for 2006-2008. To properly treat the 2006-2008 data as independent from the 2005 data, 1,000 was added to each of the year 2006, 2007, and 2008 pseudo-stratum numbers for these statistical analyses.[ii]

Race/Ethnicity and Family Income

For Indicator D2, the prevalence percentages were calculated for demographic strata defined by the combination of race/ethnicity and family income.

The family income was characterized based on the RAT_CATI variable, which gives the level of the ratio of the family income to the poverty level. The National Center for Health Statistics obtained the family income for the respondent's family during the family interview. The U.S. Census Bureau defines annual poverty level money thresholds varying by family size and composition. The poverty income ratio (PIR) is the family income divided by the poverty level for that family. The public release variable RAT_CATI gives the value of the PIR for various ranges, Under 0.5, 0.5-0.74, 0.75 to 0.99, …, 4.50-4.99, 5.00 and Over.

Family income was stratified into the following groups:

- Below Poverty Level: PIR < 1, i.e., RAT_CATI = 1, 2, or 3.
- Between 100% and 200% of Poverty Level: 1 ≤ PIR < 2, i.e., RAT_CATI = 4, 5, 6, or 7.
- Above 200% of Poverty level: PIR ≥ 2, i.e., RAT_CATI = 8, 9, 10, 11, 12, 13 or 14.
- Above Poverty Level: PIR ≥ 1 (combines the previous two groups).
- Unknown Income: PIR is missing ("undefinable"), i.e., RAT_CATI = 96.[iii]

Approximately 30% of families did not report their exact family income. From 1997 to 2006, the majority of these families either reported their income by selecting from two categories (above or below $20,000) or from 44 categories. For 2007 and later, the income questions were revised, so that families not reporting an exact income were first asked to report their income as the two categories above or below $50,000, and were then asked appropriate additional questions to refine the income range as either 0-$34,999, $35,000-$49,999, $50,000-74,999, $75,000-$99,999, or $100,000 and above. In 2007 and 2008, 92% of families either gave the exact income or a categorical response.

NCHS reports[iv] evidence that the non-response to the income question is related to person-level or family-level characteristics, including items pertaining to health. Therefore treating the missing responses as being randomly missing would lead to biased estimates. To address this problem, NCHS applied a statistical method called "multiple imputation" to estimate or "impute"

[ii] The addition of 1,000 was chosen to make the stratum numbers for 2005 and earlier distinct from the stratum numbers for 2006 and later. This follows the recommendations in Appendix III of the survey description document "2008 National Health Interview Survey (NHIS) Public Use Data Release NHIS Survey Description," CDC, June 2009, http://www.cdc.gov/nchs/nhis/quest_data_related_1997_forward.htm

[iii] Although missing values of family income were statistically imputed for the vast majority of respondents, there were a few respondents that still had an unknown income after the income imputation.

[iv] "Multiple imputation of family income and personal earnings in the National Health Interview Survey: methods and examples," http://www.cdc.gov/nchs/nhis/2008imputedincome.htm, August, 2009.

the family income based on the available family income and personal earnings information and on responses to other survey equations. A series of regression models was used to predict the exact family income from the available responses. Five sets of simulated family income values were generated for each family that did not report their exact family income. In this manner, NCHS generated five data sets, each containing a complete set of family income values (either the reported or the imputed values). The poverty income ratio categories were calculated from the income values and the family size and composition variables. An estimated prevalence percentage was computed for each of the five data sets. The overall estimated prevalence percentage is the arithmetic mean of the five estimates.

Race was characterized using the race variable for the 1997 OMB standards,[v] RACERPI2. The possible values of this variable are:

- 1. White only
- 2. Black / African American only
- 3. American Indian Alaska Native (AIAN) only
- 4. Asian only
- 5. Race group not releasable
- 6. Multiple race

The Native Hawaiian or Other Pacific Islander (NHOPI) race group is not specified in the public release version due to confidentiality concerns. Respondents with the single race NHOPI have RACERPI2 = 5 and respondents of multiple races including NHOPI have RACERPI2 = 6.

The ORIGIN_I variable indicates whether or not the ethnicity is Hispanic or Latino. ORIGIN_I = 1 if the respondent is Hispanic or Latino. ORIGIN_I = 2 if the respondent is not Hispanic or Latino.

The HISPAN_I variable indicates the specific Hispanic origin or ancestry.

- 00 Multiple Hispanic
- 01 Puerto Rico
- 02 Mexican
- 03 Mexican-American
- 04 Cuban/Cuban American
- 05 Dominican (Republic)
- 06 Central or South American
- 07 Other Latin American, type not specified
- 08 Other Spanish
- 09 Hispanic/Latino/Spanish, non-specific type

[v] Revised race standards were issued by the Office of Management and Budget in 1997 and were to be fully implemented across the federal statistical system by January 2003. Under the new standards, the minimum available race categories include: White, Black, AIAN, Asian, and Native Hawaiian or Other Pacific Islander (NHOPI). A very important change was that under the new standards, respondents may select more than one race category.

- 10 Hispanic/Latino/Spanish, type refused
- 11 Hispanic/Latino/Spanish, type not ascertained
- 12 Not Hispanic/Spanish origin

The race/ethnicity was defined based on RACERPI2, ORIGIN_I, and HISPAN_I:

Race/ethnicity:

- White non-Hispanic: RACERPI2 =1, ORIGIN_I = 2
- Black or African-American, Non Hispanic: RACERPI2 = 2, ORIGIN_I = 2
- Asian non-Hispanic: RACERPI2 = 4, ORIGIN_I = 2
- Hispanic: ORIGIN_I = 1
    - Mexican: ORIGIN_I = 1 and HISPAN_I = 02, 03
    - Puerto Rican: ORIGIN_I = 1 and HISPAN_I = 01
- Other: RACERPI2 = 3, 5 or 6, ORIGIN_I = 2
    - American Indian, Alaska Native, Non-Hispanic: RACERPI2 = 3, ORIGIN_I = 2

The "Other" category includes non-Hispanic respondents reporting multiple races, or reporting a single race that is neither White, Black, African-American, or Asian.

Some respondents gave missing or incomplete answers to the race/ethnicity questions. In those cases NCHS applied a statistical method called "hot-deck imputation" to estimate or "impute" the race or ethnicity based on the race/ethnicity responses for other household members, if available, or otherwise based on information from other households. The NHIS variables ORIGIN_I , HISPAN_I, and RACERPI2 use imputed responses if the original answer was missing or incomplete.

Calculation of Indicator

Indicator D1 is the percentage of children ages 17 years or under for whom the response was Yes to the asthma attack in the last 12 months or current asthma questions, as detailed in the section "National Health Interview Survey (NHIS)." Indicator D2 is the percentage of children ages 17 years or under for whom the response was Yes to the current asthma question, stratified by race/ethnicity and family income. Table D2a is the percentage of children ages 17 years or under for whom the response was Yes to the current asthma question, stratified by age and sex.

To simply demonstrate the calculations, we will describe the calculations for the indicator D2, and will use the NHIS 2005-2008 responses to the CASSTILL question asking if the child still had asthma for White non-Hispanic children of all incomes. This question was only asked if the response was Yes to the CASHMEV question about whether the child was ever diagnosed with asthma. As described above, the question of interest is whether the child was ever diagnosed with asthma and still had asthma. We shall call this combined question the current asthma question. This question is answered Yes if CASHMEV = 1 (Yes) and CASSTILL = 1 (Yes). This question is answered No if either CASHMEV = 1 (Yes) and CASSTILL = 2 (No), or if

CASHMEV = 2 (No). Otherwise the response is missing. We have rounded all the numbers to make the calculations easier:

We begin with all the non-missing responses to the current asthma question in the NHIS 2005-2008 surveys for White non-Hispanic children ages 0 to 17 years. Assume for the sake of simplicity that Yes or No responses were available for every sampled child. Each sampled child has an associated survey weight that estimates the total number of U.S. White non-Hispanic children in 2005-2008 represented by that sampled child. For example, the first response for a White non-Hispanic child aged 17 years or under was No with a survey weight of 9,000, and so represents 9,000 White non-Hispanic children ages 17 years or under. A second White non-Hispanic child aged 17 years or under responded Yes with a survey weight of 4,000, and so represents 4,000 White non-Hispanic children ages 17 years or under. A third White non-Hispanic child aged 17 years or under responded No with a survey weight of 9,000, and so represents 9,000 White non-Hispanic children ages 17 years or under. The total of the survey weights for the sampled White non-Hispanic children equals 180 million, the total U.S. population of White non-Hispanic children ages 17 years or under summed over all four years; thus the annual population is about 45 million.

To calculate the proportion of White non-Hispanic children with current asthma, we can use the survey weights to expand the data to the total four-year U.S. White non-Hispanic population of 180 million White non-Hispanic children ages 0 to 17 years. We have 9,000 No responses from the first child, 4,000 Yes responses from the second child, 9,000 Yes responses from the third child, and so on. Of these 180 million responses, a total of 14 million responses are Yes and the remaining 166 million are No. Thus 14 million of the 180 million White non-Hispanic children have current asthma, giving a proportion of about 8%.

In reality, the calculations need to take into account that Yes or No responses were not reported for every respondent, and to use exact rather than rounded numbers. There were non-missing responses for 18,687 of the 18,748 sampled White non-Hispanic children ages 0 to 17 years over the four-year period. ("Don't know" responses or refusals to answer are treated as missing). The survey weights for all 18,748 sampled children add up to 169.0 million, the total four-year U.S. population of White non-Hispanic children ages 0 to 17 years. The survey weights for the 18,687 sampled White non-Hispanic children with non-missing responses add up to 168.5 million. Thus the available data represent 168.5 million children, which is more than 99%, but not all, of the four-year U.S. population of White non-Hispanic children ages 0 to 17 years. The survey weights for the Yes responses add up to 13.7 million, which is 8.2% of the population with responses (13.7 million/168.5 million = 8.2%). Thus we divide the sum of the weights for participants with Yes responses by the sum of the weights for participants with non-missing responses. These calculations assume that the sampled children with non-missing responses are representative of the children with missing responses.

For calculation of prevalence by income group, we use the five sets of imputed income values, which each give different results. Suppose we wish to estimate the proportion of White non-Hispanic children below the poverty level with current asthma. Using the above calculation method applied for White non-Hispanic children below the poverty level, the proportions for the five sets of imputed values are: 9.6%, 9.8%, 9.4%, 9.9%, and 9.9%. The estimated proportion of

White non-Hispanic children below the poverty level with current asthma is given by the average of the five estimates, (9.6 + 9.8 + 9.4 + 9.9 + 9.9) /5 = 9.7%.

Equations

The following equations give the mathematical calculations for the example of White non-Hispanic children below the poverty level. Let w(i) denote the survey weight for the i'th surveyed White non-Hispanic child of ages 0 to 17 years. Exclude any surveyed children with a response other than Yes or No. For the current asthma question, let the response indicator c(i) = 1 if the i'th surveyed White non-Hispanic child had a Yes response and let c(i) = 0 if the i'th surveyed White non-Hispanic child had a No response. Let the income indicator d(i, j) = 1 if the i'th surveyed White non-Hispanic child was below the poverty level according to the j'th set of imputed values and let d(i, j) = 0 if the i'th surveyed White non-Hispanic child was not below the poverty level according to the j'th set of imputed values.

1. Fix j = 1, 2, 3, 4 or 5. Sum (over i) all the survey weights multiplied by the income indicators to get the total weight W(j) for set j:

$$W(j) = \Sigma\, w(i) \times d(i, j)$$

2. Fix j = 1, 2, 3, 4 or 5. Sum (over i) all the survey weights multiplied by the response indicators and multiplied by the income indicators to get the total weight D(j) for set j for White non-Hispanic children below the poverty level with a Yes response:

$$D(j) = \Sigma\, w(i) \times c(i) \times d(i, j)$$

3. Divide D(j) by W(j) to get the percentage of children with asthma in set j:

$$\text{Percentage (j)} = (D(j) / W(j)) \times 100\%$$

4. Average the percentages across the 5 sets to get the estimated percentage of children with current asthma:

$$\text{Percentage} = [\text{Percentage (1)} + \text{Percentage (2)} + \text{Percentage (3)} + \text{Percentage (4)} + \text{Percentage (5)}] / 5$$

If the demographic group of interest includes all incomes, then the percentages will be equal for all five sets of imputed values, so the calculation in steps 1 to 3 need only be done for j =1, and step 4 is not required.

Relative Standard Error

The uncertainties of the percentages were calculated using SUDAAN® (Research Triangle Institute, Research Triangle Park, NC 27709) statistical survey software. SUDAAN was used to

calculate the estimated percentages and the standard errors of the estimated percentages. The standard error is the estimated standard deviation of the percentage, and this depends upon the survey design. The standard error calculation also incorporates the extra uncertainty due to the multiple imputations of the income variables (based on the variation between the estimated percentages from each of the five sets of imputations). For this purpose, the public release version of NHIS includes the variables STRATUM and PSU, which are the Masked Variance Unit pseudo-stratum and pseudo-primary sampling unit (pseudo-PSU). For approximate variance estimation, the survey design can be approximated as being a stratified random sample with replacement of the pseudo-PSUs from each pseudo-stratum; the true stratum and PSU variables are not provided in the public release version to protect confidentiality.

The sample design was changed in 2006. New strata were defined and PSUs were selected from these new strata. For example, pseudo-stratum 1 for 2005 is unrelated to pseudo-stratum 1 for 2006-2008. To properly treat the 2006-2008 data as independent from the 2005 data, 1,000 was added to each of the year 2006, 2007, and 2008 pseudo-stratum numbers for these statistical analyses.

The relative standard error is the standard error divided by the estimated percentage:

$$\text{Relative Error (\%)} = [\text{Standard Error (Percentage)} / \text{Percentage}] \times 100\%$$

Percentages with a relative error less than 30% were treated as being reliable and were tabulated. Percentages with a relative error greater than or equal to 30% but less than 40% were treated as being unstable; these values were tabulated but were flagged to be interpreted with caution. Percentages with a relative standard error greater than or equal to 40%, or without an estimated relative standard error, were treated as being unreliable; these values were not tabulated and were flagged as having a large uncertainty.

Statistical Comparisons

Statistical analyses of the percentages of children with a positive response to the question of interest were used to determine whether the differences between percentages for different demographic groups were statistically significant. Using a logistic regression model, the logarithm of the odds that a given child has a positive response is assumed to be the sum of explanatory terms for the child's age group, sex, income group and/or race/ethnicity. The odds of a positive response are the probability of a positive response divided by the probability of a negative response. Thus if two demographic groups have similar (or equal) probabilities of a positive response, then they will also have similar (or equal) values for the logarithm of the odds. Using this model, the difference in the percentage between different demographic groups is statistically significant if the difference between the corresponding sums of explanatory terms is statistically significantly different from zero. The uncertainties of the regression coefficients were calculated using SUDAAN® (Research Triangle Institute, Research Triangle Park, NC 27709) statistical survey software to account for the survey weighting and design. A p-value at or

below 0.05 implies that the difference is statistically significant at the 5% significance level. No adjustment is made for multiple comparisons.

For these statistical analyses we used two income groups, below poverty level, and at or above poverty level. The small number of children with unknown (and unimputed) incomes were included in the at or above poverty level group. For the main analyses we also used five race/ethnicity groups: White non-Hispanic; Black non-Hispanic; Asian non-Hispanic; Hispanic; Other. In addition, for specific comparisons between the Mexican and Puerto Rican subgroups, we applied a similar statistical analysis using three ethnicity groups: Mexican; Puerto Rican; Other Hispanic or Non-Hispanic. We also used three age groups: 0-5, 6-10, and 11-17.

For each type of comparison, we present unadjusted and adjusted analyses. The unadjusted analyses directly compare a percentage between different demographic groups. The adjusted analyses add other demographic explanatory variables to the statistical model and use the statistical model to account for the possible confounding effects of these other demographic variables. For example, the unadjusted race/ethnicity comparisons use and compare the percentages between different race/ethnicity pairs. The adjusted analyses add age, sex, and income terms to the statistical model and compare the percentages between different race/ethnicity pairs after accounting for the effects of the other demographic variables. For example, if White non-Hispanics tend to have higher family incomes than Black non-Hispanics, and if the prevalence of a disease strongly depends on family income only, then the unadjusted differences between these two race/ethnicity groups would be significant but the adjusted difference (taking into account income) would not be significant.

Comparisons of the prevalence of current asthma in children ages 0 to 17 years between pairs of race/ethnicity groups are shown in Table 1. For the unadjusted "All incomes" comparisons, the only explanatory variables are terms for each race/ethnicity group. For these unadjusted comparisons, the statistical tests compare the percentage for each pair of race/ethnicity groups. For the adjusted "All incomes (adjusted for age, sex, income)" comparisons, the explanatory variables are terms for each race/ethnicity group together with terms for each age, sex, and income group. For these adjusted comparisons, the statistical test compares the pair of race/ethnicity groups after accounting for any differences in the age, sex, and income distributions between the race/ethnicity groups.

In Table 1, for the unadjusted "Below Poverty Level" and "At or Above Poverty Level" comparisons, the only explanatory variables are terms for each of the 10 race/ethnicity/income combinations (combinations of five race/ethnicity groups and two income groups). For example, in row 1, the p-value for "Below Poverty Level" compares White non-Hispanics below the poverty level with Black non-Hispanics below the poverty level. The same set of explanatory variables are used in Table 2 for the unadjusted comparisons between one race/ethnicity group below the poverty level and the same or another race/ethnicity group at or above the poverty level. The corresponding adjusted analyses include extra explanatory variables for age and sex, so that race/ethnicity/income groups are compared after accounting for any differences due to age or sex.

Additional comparisons are shown in Table 3. The AGAINST = "age" unadjusted p-value compares the percentages for different age groups. The adjusted p-value includes adjustment terms for income, sex, and race/ethnicity in the model. The AGAINST = "sex" unadjusted p-value compares the percentages for boys and girls. The adjusted p-value includes adjustment terms for age, income, and race/ethnicity in the model. The AGAINST = "income" unadjusted p-value compares the percentages for those below poverty level with those at or above poverty level. The adjusted p-value includes adjustment terms for age, sex, and race/ethnicity in the model. The AGAINST = "year" p-value examines whether the linear trend in the percentages is statistically significant; the adjusted model for trend adjusts for demographic changes in the populations from year to year by including terms for age, sex, income, and race/ethnicity.

For more details on these statistical analyses, see the memorandum by Cohen (2010).[vi]

Table 1. Statistical significance tests comparing the percentages of children ages 0 to 17 with current asthma, between pairs of race/ethnicity groups, for 2005-2008.

			P-VALUES					
Variable	**RACE1**	**RACE2**	**All incomes**	**All incomes (adjusted for age, sex, income)**	**Below Poverty Level**	**Below Poverty Level (adjusted for age, sex)**	**At or Above Poverty Level**	**At or Above Poverty Level (adjusted for age, sex)**
Current asthma	White non-Hispanic	Black non-Hispanic	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Current asthma	White non-Hispanic	Asian non-Hispanic	0.013	0.015	0.048	0.041	0.042	0.054
Current asthma	White non-Hispanic	Hispanic	0.628	0.930	0.809	0.814	0.798	0.981
Current asthma	White non-Hispanic	Other	< 0.0005	< 0.0005	0.001	0.001	0.001	0.001
Current asthma	Black non-Hispanic	Asian non-Hispanic	< 0.0005	< 0.0005	0.001	0.001	< 0.0005	< 0.0005
Current asthma	Black non-Hispanic	Hispanic	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Current asthma	Black non-Hispanic	Other	0.376	0.653	0.395	0.392	0.223	0.299
Current asthma	Asian non-Hispanic	Hispanic	0.011	0.025	0.063	0.053	0.080	0.077
Current asthma	Asian non-Hispanic	Other	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Current asthma	Hispanic	Other	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.002	0.002
Current asthma	Mexican	Puerto Rican	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

Table 2. Statistical significance tests comparing the percentages of children ages 0 to 17 years with current asthma, between pairs of race/ethnicity/income groups at different income levels, for 2005-2008.

[vi] Cohen, J. 2010. *Selected statistical methods for testing for trends and comparing years or demographic groups in ACE NHIS and NHANES indicators.* Memorandum submitted to Dan Axelrad, EPA, 21 March, 2010.

			P-VALUES	
Variable	RACEINC1	RACEINC2	Unadjusted	Adjusted (for age, sex)
Current asthma	White non-Hispanic, < PL	White non-Hispanic, >= PL	0.058	0.024
Current asthma	White non-Hispanic, < PL	Black non-Hispanic, >= PL	0.002	0.005
Current asthma	White non-Hispanic, < PL	Asian non-Hispanic, >= PL	0.004	0.003
Current asthma	White non-Hispanic, < PL	Hispanic, >= PL	0.060	0.039
Current asthma	White non-Hispanic, < PL	Other, >= PL	0.210	0.245
Current asthma	Black non-Hispanic, < PL	White non-Hispanic, >= PL	< 0.0005	< 0.0005
Current asthma	Black non-Hispanic, < PL	Black non-Hispanic, >= PL	0.095	0.058
Current asthma	Black non-Hispanic, < PL	Asian non-Hispanic, >= PL	< 0.0005	< 0.0005
Current asthma	Black non-Hispanic, < PL	Hispanic, >= PL	< 0.0005	< 0.0005
Current asthma	Black non-Hispanic, < PL	Other, >= PL	0.021	0.022
Current asthma	Asian non-Hispanic, < PL	White non-Hispanic, >= PL	0.152	0.159
Current asthma	Asian non-Hispanic, < PL	Black non-Hispanic, >= PL	0.003	0.003
Current asthma	Asian non-Hispanic, < PL	Asian non-Hispanic, >= PL	0.513	0.493
Current asthma	Asian non-Hispanic, < PL	Hispanic, >= PL	0.167	0.160
Current asthma	Asian non-Hispanic, < PL	Other, >= PL	0.020	0.019
Current asthma	Hispanic, < PL	White non-Hispanic, >= PL	0.045	0.014
Current asthma	Hispanic, < PL	Black non-Hispanic, >= PL	< 0.0005	< 0.0005
Current asthma	Hispanic, < PL	Asian non-Hispanic, >= PL	0.003	0.002
Current asthma	Hispanic, < PL	Hispanic, >= PL	0.061	0.037
Current asthma	Hispanic, < PL	Other, >= PL	0.122	0.147
Current asthma	Other, < PL	White non-Hispanic, >= PL	< 0.0005	< 0.0005
Current asthma	Other, < PL	Black non-Hispanic, >= PL	0.073	0.059
Current asthma	Other, < PL	Asian non-Hispanic, >= PL	< 0.0005	< 0.0005
Current asthma	Other, < PL	Hispanic, >= PL	< 0.0005	< 0.0005
Current asthma	Other, < PL	Other, >= PL	0.021	0.023
Current asthma	Mexican, < PL	Mexican, >= PL	0.506	0.624
Current asthma	Mexican, < PL	Puerto Rican, >= PL	< 0.0005	< 0.0005
Current asthma	Puerto Rican, < PL	Mexican, >= PL	< 0.0005	< 0.0005
Current asthma	Puerto Rican, < PL	Puerto Rican, >= PL	0.015	0.012

Table 3. Other statistical significance tests comparing the percentages of children ages 0 to 17 years with asthma, for 2005-2008 (trends for 1997-2008).

				P-VALUES	
Variable	From	To	Against	Unadjusted	Adjusted*
Current asthma	2005	2008	age	< 0.0005	< 0.0005
Current asthma	2005	2008	sex	< 0.0005	< 0.0005
Current asthma	2005	2008	income	< 0.0005	< 0.0005
Current asthma	1997	2008	year	0.012	0.015
Asthma attack	1997	2008	year	0.954	0.222

*For AGAINST = "age," the p-values are adjusted for sex, race/ethnicity, and income.
For AGAINST = "sex," the p-values are adjusted for age, race/ethnicity, and income.
For AGAINST = "income," the p-values are adjusted for age, sex, and race/ethnicity.
For AGAINST = "year," the p-values are adjusted for age, sex, race/ethnicity, and income.

Methods (D3)

Indicator D3

Children's emergency room visits and hospitalizations for asthma and other respiratory causes, ages 0 to 17 years, 1996-2008.

Summary

Emergency Room Visits
Since 1992, the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention, has conducted the National Hospital Ambulatory Medical Care Survey (NHAMCS), a series of annual U.S. national surveys of visits to the emergency departments and outpatient departments of noninstitutional general and short-stay hospitals, exclusive of federal, military, and Veteran's Administration hospitals. For emergency room visits, this indicator uses the first diagnosis ICD-9 code to count emergency room visits for asthma and all other respiratory causes, asthma, and all respiratory causes other than asthma (composed of the following subcategories: upper respiratory conditions, pneumonia or influenza, and other lower respiratory conditions besides asthma) . The national numbers of emergency room visits by children ages 17 years and under are calculated by combining visits for each respiratory disease diagnosis with the survey weights for each child patient. The survey weights are the numbers of hospital emergency room visits by children ages 17 years and under in the noninstitutionalized civilian population represented by each patient visit in the survey database. This indicator shows the rate of emergency room visits per 10,000 children, calculated by dividing the national number of emergency room visits by the total U.S. population of noninstitutionalized civilian children ages 17 years and under. Table D3a provides the rate of emergency room visits by children 17 years and under, stratified by race/ethnicity, for the years 2005-2008. Table D3c provides the rate of emergency room visits by children 17 years and under, stratified by age group, for the years 2005-2008.

Hospitalizations
Since 1965, the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention, has conducted the National Hospital Discharge Survey (NHDS), a series of annual U.S. national surveys of hospital discharges from non-federal short-stay hospitals. This indicator uses the first diagnosis ICD-9 code to count hospital discharges for asthma and all other respiratory causes, asthma, and all respiratory causes other than asthma (composed of the following subcategories: upper respiratory conditions, pneumonia or influenza, and other lower respiratory conditions besides asthma). The national numbers of hospital discharges by children ages 17 years and under are calculated by combining hospital discharges for each respiratory disease diagnosis with the survey weights for each child patient. The survey weights are the numbers of hospital discharges by children ages 17 years and under in the noninstitutionalized civilian population represented by each hospital discharge in the survey database. This indicator shows the rate of hospital admissions per 10,000 children, calculated by dividing the national number of hospital discharges by the total U.S. population of noninstitutionalized civilian

children ages 17 years and under. Table D3b provides the rate of hospital admissions by children ages 17 years and under, stratified by race, for the years 2005-2008. Table D3d provides the rate of hospital admissions by children ages 17 years and under, stratified by age group, for the years 2005-2008.

Data Summary

Indicator	D3. Children's emergency room visits and hospitalizations for asthma and other respiratory causes, ages 0 to 17 years, 1996-2008.					
Time Period	1996-2008					
Data	Emergency room visits and hospitalizations by children ages 0 to 17 years.					
Years (1996-2001)	1996	1997	1998	1999	2000	2001
Emergency room visits sampled	5,777	5,690	6,153	5,072	6,264	8,386
Hospital discharges sampled	60,708	64,681	65,546	62,561	65,043	68,370
Years (2002-2007)	2002	2003	2004	2005	2006	2007
Emergency room visits sampled	8,849	9,725	8,642	8,159	9,231	7,929
Hospital discharges sampled	65,868	65,536	72,585	71,402	69,847	67,757
Years (2008)	2008					
Emergency room visits sampled	7,438					
Hospital discharges sampled	25,506					

Overview of Data Files

The following files are needed to calculate this indicator.

Emergency Room Visits

- NHAMCS 1996-2008: EDXXXX.exe, where XXXX denotes the four-digit year. Each file is a compressed executable file that when decompressed gives an ASCII file

containing emergency room visit data for a survey year. These files were obtained from the ftp site:

ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/NHAMCS/

The variables needed for this indicator are the survey year, age, physician's diagnosis #1 (DIAG1), and the following sampling design information: the patient visit weight (PATWT), masked stratum (STRATM for years 1996 to 2001, CSTRATM for years 2002 to 2008), and masked primary sampling unit (PSUM for years 1996 to 2001, CPSUM for years 2002 to 2008) The masked variables provide an approximation to the exact sample design variables, and were created by CDC by combining stratum information in a manner to protect the confidentiality of the publicly released data. For the supplemental table, the patient race and ethnicity variables RACE (RACEIM for 2007 and 2008) and ETHNIC (ETHIM for 2007 and 2008) are also needed.

- Census data. For the years 1996 to 1999, the national noninstitutionalized civilian populations were obtained from the url:

  http://www.census.gov/popest/archives/1990s/nat_monthly_noninstitutional.html

  For the years 2000 to 2008, the national noninstitutionalized civilian populations were obtained from the url:

  http://www.census.gov/popest/national/asrh/2009-nat-ni.html

  In each case, the file for each year includes the required variables: month, year, age, total U.S. population. The "month" gives the date for the population estimate. For these analyses, data for month = 7 were selected, corresponding to the populations as of July 1.

  For Table D3a, populations stratified by race and ethnicity were obtained using the detailed population data in the same census files for the years 2005 to 2008, as detailed below.

Hospitalizations

- NHDS 1996-2008: NHDSXX.PU.TXT, where XX denotes the two-digit year (NHDS96.ASC and NHDS97,ASC for 1996 and 1997). Each file is downloadable as a compressed file that decompresses into an ASCII file containing hospital discharge data for a survey year. These files were obtained from the ftp site:

  ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/NHDS/

This site only contains the files from 1996 onwards. The variables needed for this indicator are the survey year, age, physician's diagnosis #1 (DIAG1), and the analysis weight. For Table D3b, the patient race variable RACE is also needed.

- Census data. For the years 1996 to 1999, the national noninstitutionalized civilian populations were obtained from the url:

  http://www.census.gov/popest/archives/1990s/nat_monthly_noninstitutional.html

  For the years 2000 to 2008, the national noninstitutionalized civilian populations were obtained from the url:

  http://www.census.gov/popest/national/asrh/2009-nat-ni.html

  In each case, the file for each year includes the required variables: month, year, age, total U.S. population. The "month" gives the date for the population estimate. For these analyses, data for month = 7 were selected, corresponding to the populations as of July 1.

  For Table D3b, populations stratified by race were obtained using the detailed population data in the same census files for the years 2005 to 2008, as detailed below.

National Hospital Ambulatory Medical Care Survey (Emergency Room Visits)

The National Hospital Ambulatory Medical Care Survey (NHAMCS) is conducted by the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention. The complex multi-stage survey is designed to collect data on ambulatory care services in hospital emergency and outpatient departments; these analyses only used the emergency department visits. Sampled hospitals are noninstitutional general and short-stay hospitals located in all states and Washington DC, but exclude federal, military, and Veteran's Administration hospitals. Data from sampled visits are obtained on the demographic characteristics, expected source(s) of payments, patients' complaints, physician's diagnoses, diagnostic and screening services, procedures, types of health care professionals seen, and causes of injury.

These analyses focused on visits to emergency rooms by children ages 17 years and under for respiratory diseases. Emergency room data was selected by using the ED files only. The age variable was used to select visits by children ages 17 years and under. The respiratory disease categories were selected based on the first physician's diagnosis code (DIAG1) using the International Classification of Diseases (ICD-9), first three characters:

- Asthma and all other respiratory causes: codes 460-466, 480-488, 490-496
- All respiratory causes other than asthma: codes 460-466, 480-488, 490-492, 494-496
- Upper respiratory: codes 460-466
- Pneumonia or influenza: codes 480-488

- Other lower respiratory: codes 490-492, 494-496
- Asthma: code 493

The NHAMCS uses a complex multi-stage, stratified, clustered sampling design. The statistical analyses used the patient visit survey weights (PATWT) to re-adjust the sample of visits to represent the total national population of emergency room visits in each calendar year.

National Hospital Discharge Survey (Hospitalizations)

The National Hospital Discharge Survey (NHDS) is conducted by the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention. The complex multi-stage survey is designed to collect data on inpatients discharged from non-federal short-stay hospitals. Sampled hospitals are short-stay general or children's general hospitals located in all states and Washington DC, with an average length of stay of fewer than 30 days and six or more beds staffed for patients use. Federal, military, and Veteran's Administration hospitals are excluded, as are hospital units of institutions. Data from sampled visits are obtained on the demographic characteristics and physician's diagnoses.

These analyses focused on hospital discharges by children ages 17 years and under for respiratory diseases. The age variable was used to select visits by children ages 17 years and under. The respiratory disease categories were selected based on the first physician's diagnosis code (DIAG1) using the International Classification of Diseases (ICD-9), first three characters:

- Asthma and all other respiratory causes: codes 460-466, 480-488, 490-496
- All respiratory causes other than asthma: codes 460-466, 480-488, 490-492, 494-496
- Upper respiratory: codes 460-466
- Pneumonia or influenza: codes 480-488
- Other lower respiratory: codes 490-492, 494-496
- Asthma: code 493

The NHDS uses a complex multi-stage, stratified, clustered sampling design. The statistical analyses used the survey analysis weights to re-adjust the sample of discharges to represent the total national population of hospital discharges in each calendar year.

Although the available data were collected for hospital discharges, we assume for these analyses that admission and discharge rates are equal.

Calculation of Indicator

Emergency Room Visits
Indicator D3 shows the rate of emergency room visits by noninstitutionalized civilian children ages 17 years or under that were for a given respiratory disease.

For each year and respiratory disease, we carried out the following calculations:

1. We extracted the NHAMCS survey data for all the emergency room visits by children ages 17 years or under for the given respiratory disease. We selected all visits where the age was between 0 and 17 and the first three characters of the diagnosis code were:

- Asthma and all other respiratory causes: codes 460-466, 480-488, 490-496
- All respiratory causes other than asthma: codes 460-466, 480-488, 490-492, 494-496
- Upper respiratory: codes 460-466
- Pneumonia or influenza: codes 480-488
- Other lower respiratory: codes 490-492, 494-496
- Asthma: code 493

For each visit, the patient weight (PATWT) denotes the national number of patient visits represented by that visit.

2. We summed the NHAMCS patient weights for all the selected visits to estimate the total number of emergency room visits by children ages 17 or under for the given respiratory disease:

$$\text{Total Number of Visits} = \Sigma \text{ PATWT, summed over all selected visits}$$

3. Using the census data, we calculated the total population of children ages 17 years or under by summing the populations for the ages 0, 1, 2, … 17:

$$\text{Population} = \Sigma \text{ Population (age A), summed over ages 0, 1, 2, … 17}$$

4. We divided the total number of visits (NHAMCS data) by the total population (census data) to get the rate per 10,000 of children's visits for the respiratory disease:

$$\text{Rate per 10,000} = [\text{Total Number of Visits} / \text{Population}] \times 10000$$

For Table D3c, rates stratified by age group were tabulated for the years 2005, 2006, 2007, 2008, and for the four-year period 2005-2008. These rates were calculated using the same procedure as above, except that the visits and populations were summed across the children in each age group.

Race/Ethnicity

For Table D3a, rates stratified by race/ethnicity[vii] group were tabulated for the years 2005, 2006, 2007, 2008, and for the four-year period 2005-2008. These rates were calculated using the same procedure as above, except that the visits and populations were summed across the children in each race/ethnicity group and year.

[vii] These data are not stratified by income because the NHAMCS data do not give the patient's income. Since 2006, NHAMCS reports the median family income for the patient's zip code, which would poorly match the available census income data (the patient's zip code is not available in the publicly released NHAMCS data).

The race/ethnicity groups were defined using the variables RACE and ETHNIC in the NHAMCS files. These are the patient's race and ethnicity, and are given statistically imputed values in the database if they are not reported. For 2007 and 2008 these variables are defined as RACEIM and ETHIM.

These variables were coded as follows:

ETHNIC: Patient ethnicity (Hispanic/Non-Hispanic)
- 0 = Blank
- 1 = Hispanic or Latino
- 2 = Not Hispanic or Latino

RACE: Patient race
- 1 = White only
- 2 = Black/African American only
- 3 = Asian only
- 4 = Native Hawaiian/Other Pacific Islander only
- 5 = American Indian/Alaska Native only
- 6 = More than one race reported

Using these variables, the following race/ethnicity groups were defined for the NHAMCS emergency room visits data:

- All: RACE = any, ETHNIC = any
- White non-Hispanic: RACE = 1, ETHNIC = 2 or 0
- Black non-Hispanic: RACE = 2, ETHNIC = 2 or 0
- American Indian/Alaska Native, Non-Hispanic: RACE = 5, ETHNIC = 2 or 0
- Asian and Pacific Islander, Non-Hispanic: RACE = 3 or 4, ETHNIC = 2 or 0
- Hispanic: ETHNIC = 1

The associated populations were computed from the post-censal 2000 noninstitutionalized civilian population files for the year 2009 at:

http://www.census.gov/popest/national/asrh/2009-nat-ni.html

For each month, year, and age, the file provides the total population as well as the populations by age, sex, race and ethnicity. Populations are provided for male Hispanics, female Hispanics, male Non-Hispanics, and female Non-Hispanics of the following race combinations:

RACENUM (Census data)

1. White alone
2. Black alone
3. American Indian/Alaska Native alone
4. Asian alone

5. Hawaiian or Pacific Islander alone
6. Two or more races

(Other specific multiple race combinations are also provided in the dataset, such as "White alone, or in combination with another race").

Thus the total census populations corresponding to the selected NHAMCS race/ethnicity groups are obtained by summing the populations as follows:

- All: Total population
- White non-Hispanic: RACENUM = 1, Non-Hispanic, Age <= 17, Gender = male or female
- Black non-Hispanic: RACENUM = 2, Non-Hispanic, Age <= 17, Gender = male or female
- American Indian/Alaska Native non-Hispanic: RACENUM = 3, Non-Hispanic, Age <= 17, Gender = male or female
- Asian and Pacific Islander non-Hispanic: RACENUM = 4 or 5, Non-Hispanic, Age <= 17, Gender = male or female
- Hispanic: RACENUM = 1 to 6, Hispanic, Age <= 17, Gender = male or female

Using the same four steps described above under "Calculation of Indicator," the total number of visits and total population for each race/ethnicity group are used to get the rate per 10,000 of children's visits for the respiratory disease:

$$\text{Rate per 10,000} = [\text{Total Number of Visits} / \text{Population}] \times 10000$$

Relative Standard Error

The uncertainties of the rates were calculated using SUDAAN® (Research Triangle Institute, Research Triangle Park, NC 27709) statistical survey software. SUDAAN was used to calculate the estimated percentages and the standard errors of the estimated percentages. The standard error is the estimated standard deviation of the percentage, and this depends upon the survey design. For this purpose, the public release version of NHAMCS includes the following variables:

- Masked Stratum (CSTRATM)
- Masked Primary Sampling Unit (CPSUM)

These variables are "Masked" so that the sample design represented by these variables is an approximation to the true sample design, which was not made publicly available in order to protect confidentiality. Note that starting in 2003, the public release version does not include masked sampling design variables beyond the first stage of sampling. For approximate variance estimation, the survey design can be approximated as being a multi-stage random sample where

the first stage samples with replacement the masked primary sampling units from the masked strata.

The survey software was used to estimate the standard deviation of the total number of visits by children ages 17 or under for the given respiratory disease, SD (Total Visits).

The rate of visits is calculated as:

$$\text{Rate per 10000} = [\text{Total Number of Visits} / \text{Population}] \times 10000$$

Treating the census population estimates as having negligible uncertainty, we get the standard error of the rate by dividing the standard deviation of the total by the population:

$$\text{Standard Error (Rate)} = [\text{SD (Total Visits)} / \text{Population}] \times 10000$$

The relative standard error is the standard error divided by the estimated rate:

$$\text{Relative Error (\%)} = [\text{Standard Error (Rate)} / \text{Rate}] \times 100\%$$

Rates with a relative error less than 30% and with at least 30 sampled visits (for the given disease) sampled were treated as being reliable and were tabulated. Rates with a relative error greater than or equal to 30% but less than 40% and with at least 30 sampled visits were treated as being unstable; these values were tabulated but were flagged to be interpreted with caution. Rates with a relative error greater than or equal to 40% or missing or with at most 29 sampled visits were treated as being unreliable; these values were not tabulated and were flagged as having a large uncertainty.

Hospitalizations

Indicator D3 also shows the rate of hospital admissions by civilian children ages 17 or under that were for a given respiratory disease.

For each year and respiratory disease, we carried out the following calculations:

1. We extracted the NHDS survey data for all the hospital discharges by children ages 17 years or under for the given respiratory disease. We selected all hospital discharges where the age was between 0 and 17 years and the first three characters of the diagnosis code were:

- Asthma and all other respiratory causes: codes 460-466, 480-488, 490-496
- All respiratory causes other than asthma: codes 460-466, 480-488, 490-492, 494-496
- Upper respiratory: codes 460-466
- Pneumonia or influenza: codes 480-488
- Other lower respiratory: codes 490-492, 494-496
- Asthma: code 493

For each hospital discharge, the survey analysis weight (WEIGHT) denotes the national number of hospital discharges represented by that discharge.

2. We summed the NHDS analysis weights for all the selected hospital discharges to estimate the total number of hospital discharges by children ages 17 years or under for the given respiratory disease:

Total Number of Hospital Discharges = Σ WEIGHT,
summed over all selected discharges

3. Using the census data, we calculated the total population of children ages 17 years or under by summing the populations for the ages 0, 1, 2, … 17:

Population = Σ Population (age A), summed over ages 0, 1, 2, … 17

4. We divided the total number of hospital discharges (NHDS data) by the total population (census data) to get the estimated rate of children's hospital admissions for the respiratory disease:

Rate per 10000 = [Total Number of Hospital Discharges / Population] × 10000.

For Table D3d, rates stratified by age group were tabulated for the years 2005, 2006, 2007, 2008, and for the four-year period 2005-2008. These rates were calculated using the same procedure as above, except that the hospital discharges and populations were summed across the children in each age group.

Race

For Table D3b, rates stratified by race group were tabulated for the years 2005, 2006, 2007, 2008, and for the four-year period 2005-2008. These rates were calculated using the same procedure as above, except that the hospital discharges and populations were summed across the children in each race group and year.

The race groups were defined using the variable RACE in the NHDS files. There is no variable for Hispanic ethnicity in NHDS.

For the years 2005-2008, this variable was coded as follows:

RACE: Patient race
1 = White
2 = Black/African American
3 = American Indian/Alaskan Native
4 = Asian

5 = Native Hawaiian or other Pacific Isldr
6 = Other
8 = Multiple race indicated
9 = Not stated

Using this variable, the following race groups were defined for the NHDS hospital discharge data:

- All: RACE = any
- White: RACE = 1
- Black: RACE = 2
- American Indian/Alaska Native: RACE = 3
- Asian and Pacific Islander: RACE = 4 or 5

The associated populations were computed from the post-censal 2000 noninstitutionalized civilian population files for the year 2009 at:

http://www.census.gov/popest/national/asrh/2009-nat-ni.html

For each month, year, and age, the file provides the total population as well as the populations by age, sex, race, and ethnicity. Populations are provided for various combinations including males and females of the following race combinations:

RACENUM (Census data)

1. White alone
2. Black alone
3. American Indian/Alaska Native alone
4. Asian alone
5. Hawaiian or Pacific Islander alone
6. Two or more races

(Other specific multiple race combinations are also provided in the dataset, such as "White alone, or in combination with another race").

Thus the total census populations corresponding to the selected NHDS race groups are obtained by summing the populations as follows:

- All: Total population
- White: RACENUM = 1, Age <= 17, Gender = male or female
- Black: RACENUM = 2, Age <= 17, Gender = male or female
- American Indian/Alaska Native: RACENUM = 3, Age <= 17, Gender = male or female
- Asian and Pacific Islander: RACENUM = 4 or 5, Age <= 17, Gender = male or female

Using the same four steps described above under "Calculation of Indicator," the total number of discharges and total population for each race group are used to get the estimated rate per 10,000 of children's hospital admissions for the respiratory disease:

Rate per 10,000 = [Total Number of Hospital Discharges / Population] × 10000

Relative Standard Error

The uncertainties of the rates were computed for the years 1996 to 2008 using approximate relative standard error equations provided in the file documentation for each year. The documentation is provided at the ftp site:

ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHDS/

The equation provided in the documentation is of the form:

Relative Standard Error (Total Discharges) =
√(a + b / Total Discharges) × 100%

The relative standard error is defined as the standard deviation divided by the estimated value:

Relative Standard Error (Total Discharges) =
[Standard Deviation (Total Discharges) / Total Discharges] × 100%

To derive error estimates for public release that would be applicable to a wide variety of statistics, NCHS produced numerous estimates and their variances. NCHS then used a regression model to produce best-fit curves, based on the empirically determined relationship between the size of an estimate X and its relative variance. The regression intercepts a and slopes b were tabulated by NCHS for various population subgroups and selected statistics.

The NCHS tabulated parameters a and b for the first-listed diagnosis for the Under 15 age group are listed in the following table.

Year	a	b
1996	0.017	229.443
1997	0.0147	181.262
1998	0.013772	221.956
1999	0.016494	223.072
2000	0.021332	284.1142
2001	0.019559	255.6805
2002	0.0211	241.964
2003	0.02189	278.306

Year	a	b
2004	0.02165	252.708
2005	0.02222	211.185
2006	0.02734	220.637
2007	0.036972	167.01187
2008	0.05044	516.705

The rate equals the total discharges divided by the total population:

$$\text{Rate per 10000} = [\text{Total Number of Hospital Discharges} / \text{Population}] \times 10000$$

The relative standard error of each rate is the estimated standard deviation of the rate divided by the estimated rate. Assuming that the uncertainty of the census populations is negligible, the relative standard error of the rate is equal to the relative standard error of the total discharges:

$$\text{Relative Standard Error (Rate)} = \sqrt{(a + b / \text{Total Discharges})} \times 100\%$$

For the rates for the years 2005-2008 combined, the calculation is more complicated.

1. Use the above equations for each year, 2005, 2006, 2007 and 2008 to obtain the standard deviation for the total discharges in that year:

$$\text{SD (Total Discharges, Year Y)} = [\text{Relative Standard Error (Total Discharges)} \times \text{Total Discharges}] / 100 = \sqrt{(a + b / \text{Total Discharges})} \times \text{Total Discharges}$$

2. Calculate the variance, Var, for each year:

$$\text{Var (Total Discharges, Year Y)} = [\text{SD (Total Discharges, Year Y)}]^2$$

3. Estimate the total discharges for years 2005 to 2008 by summing the four annual estimates:

$$\text{Total Discharges (2005-2008)} = \text{Total Discharges (2005)} + \text{Total Discharges (2006)} + \text{Total Discharges (2007)} + \text{Total Discharges (2008)}$$

4. Estimate the total population for years 2005 to 2008 by summing the four annual populations:

$$\text{Total Population (2005-2008)} = \text{Population (2005)} + \text{Population (2006)} + \text{Population (2007)} + \text{Population (2008)}$$

5. Estimate the rate for years 2005-2008 by dividing the total discharges by the total population:

$$\text{Rate per 10000 (2005-2008)} = [\text{Total Discharges (2005-2008)} / \text{Total Population (2005-2008)}] \times 10000$$

6. Estimate the variance of the total discharges for 2005-2008. Assuming that the annual estimates are (approximately) independent, the variance of the sum equals the sum of the variances, which gives:

Var (Total Discharges (2005-2008)) = Var (Total Discharges, 2005) + Var (Total Discharges, 2006) + Var (Total Discharges, 2007) + Var (Total Discharges, 2008)

(This uses the results of the second step).

7. Calculate the standard deviation of the total discharges for 2005-2008:

SD (Total Discharges, 2005-2008) = √[Var (Total Discharges, 2005-2008)]

8. Calculate the relative standard error of the total discharges using the results of the third and seventh steps:

Relative Standard Error (Total Discharges, 2005-2008) = [SD (Total Discharges, 2005-2008) / (Total Discharges, 2005-2008)] × 100%

9. Calculate the relative standard error of the rate of discharges for 2005-2008. Assuming the populations have negligible uncertainty, it again follows that the relative standard error of the rate equals the relative standard error of the total discharges, which is given in the eighth step:

Relative Standard Error (Rate per 10000, 2005-2008) = Relative Standard Error (Total Discharges, 2005-2008)

Rates with a relative error less than 30% and at least 30 sampled hospital discharges (for the given disease) were treated as being reliable and were tabulated. Rates with a relative error greater than or equal to 30% but less than 40% and with at least 30 sampled hospital discharges were treated as being unstable; these values were tabulated but were flagged to be interpreted with caution. Rates with a relative error greater than or equal to 40% or missing or with at most 29 sampled hospital discharges were treated as being unreliable; these values were not tabulated and were flagged as having a large uncertainty.

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.

Statistical Comparisons

Statistical analyses of the emergency room visit rates or hospitalization rates were used to determine whether the differences between rates for different demographic groups were statistically significant. For these analyses, the rates and their standard errors were calculated for each combination of age group, sex, and race/ethnicity or race group using the method described in the corresponding "Relative Standard Error" section. For emergency room visits, rates and their standard errors are calculated for each combination of age group, sex, and race/ethnicity. For hospitalizations, rates and the relative standard errors of the rates are calculated for each combination of age group, sex, and race. The standard error of the rate is given by the product of the rate and its relative standard error. These calculated standard errors account for the survey weighting and design.

Using a weighted linear regression model, the rate was assumed to be the sum of explanatory terms for age, sex, and/or race/ethnicity or race and a random error term; the error terms were assumed to be approximately independent and normally distributed with a mean of zero and a variance equal to the square of the standard error. Using this model, the difference in the value of a rate between different demographic groups is statistically significant if the difference between the corresponding sums of explanatory terms is statistically significantly different from zero. A p-value at or below 0.05 implies that the difference is statistically significant at the 5% significance level. No adjustment is made for multiple comparisons.

For each type of comparison, we present unadjusted and adjusted analyses. The unadjusted analyses directly compare a rate between different demographic groups. The adjusted analyses add other demographic explanatory variables to the statistical model and use the statistical model to account for the possible confounding effects of these other demographic variables. For example, the unadjusted race/ethnicity comparisons for emergency room visits use and compare the visit rates between different race/ethnicity pairs. The adjusted race/ethnicity comparisons use the rates for each age/sex/race/ethnicity combination. The adjusted analyses add age and sex terms to the statistical model and compare the rates between different race/ethnicity pairs after accounting for the effects of the other demographic variables. For example, if Hispanic children tend to be younger than White non-Hispanics, and if the visit rate strongly depends on age only, then the unadjusted differences between these two race/ethnicity groups would be significant but the adjusted difference (taking into account age) would not be significant.

Comparisons of emergency room visit rates for asthma and other respiratory causes between pairs of race/ethnicity groups are shown in Table 1. Comparisons of hospitalization rates for asthma and other respiratory causes between pairs of race groups are shown in Table 2. In Tables 1 and 2, for the "Unadjusted" comparisons, the only explanatory variables are terms for each race/ethnicity or race group. For these unadjusted comparisons, the statistical tests compare the percentiles for each pair of race/ethnicity or race groups. For the "Adjusted for age, sex" comparisons, the explanatory variables are terms for each race/ethnicity or race group together with terms for each age group and sex. For these adjusted comparisons, the statistical test compares the pair of race/ethnicity or race groups after accounting for any differences in the age and sex distributions between the race/ethnicity or race groups.

Additional comparisons are shown in Table 3 for emergency room visits and in Table 4 for hospitalizations. The AGAINST = "age" unadjusted p-value compares the rates between all the

age groups. The adjusted p-value includes adjustment terms for sex and race/ethnicity or race in the model. The AGAINST = "year" unadjusted p-value compares the trends in the rates by regressing against the calendar year. The adjusted p-value includes adjustment terms for age, sex and race/ethnicity or race in the model.

For the analyses of emergency room visits, the race/ethnicity groups used were: White non-Hispanic; Black non-Hispanic; API non-Hispanic; AIAN non-Hispanic; Hispanic; Other. API denotes either Asian or Native Hawaiian or Pacific Islander. AIAN denotes American Indian or Alaska Native. For these data the "Other" race/ethnicity category denotes children reporting multiple races and was not an available category for the years 1996 to 1998. For the analyses of hospitalizations, the race groups used were: White; Black; API; AIAN; Other. API denotes either Asian or Native Hawaiian or Pacific Islander. AIAN denotes American Indian or Alaska Native. For these data the "Other" race category includes children of Other races,[viii] children of multiple races (for 2000 or later), and children with a race that was not stated. For the analyses of emergency room visits and hospitalizations, the age groups used were: < 12 months, 1 to < 2 years, 2 to < 3 years, 3 to < 6 years, 6 to < 11 years, 11 to < 16 years, and 16 to < 18 years.

For more details on these statistical analyses, see the memorandum by Cohen (2010). [ix]

Table 1. Statistical significance tests comparing the rates of emergency room visits for asthma and other respiratory causes by children ages 0 to 17 years, between pairs of race/ethnicity groups, for 2005-2008.

		P-VALUES		
Variable	**RACE1**	**RACE2**	**Unadjusted**	**Adjusted for age, sex**
Asthma and all other respiratory causes	White non-Hispanic	Black non-Hispanic	< 0.0005	< 0.0005
Asthma and all other respiratory causes	White non-Hispanic	API non-Hispanic	0.745	0.032
Asthma and all other respiratory causes	White non-Hispanic	AIAN non-Hispanic	0.142	< 0.0005
Asthma and all other respiratory causes	White non-Hispanic	Hispanic	0.030	0.084
Asthma and all other respiratory causes	White non-Hispanic	Other	< 0.0005	< 0.0005
Asthma and all other respiratory causes	Black non-Hispanic	API non-Hispanic	< 0.0005	< 0.0005
Asthma and all other respiratory causes	Black non-Hispanic	AIAN non-Hispanic	< 0.0005	< 0.0005
Asthma and all other respiratory causes	Black non-Hispanic	Hispanic	< 0.0005	< 0.0005
Asthma and all other respiratory causes	Black non-Hispanic	Other	< 0.0005	< 0.0005
Asthma and all other respiratory causes	API non-Hispanic	AIAN non-Hispanic	0.318	0.881
Asthma and all other respiratory causes	API non-Hispanic	Hispanic	0.421	0.007

[viii] Although the NHDS hospital discharge data includes Other races as a possible category, the corresponding census population data only provides estimates for the single race groups: White, Black,, Asian, AIAN, Hawaiian and Pacific Islander; and for multiple races.

[ix] Cohen, J. 2010. *Selected statistical methods for testing for trends and comparing years or demographic groups in other ACE health-based indicators.* Memorandum from J. Cohen, ICF to Dan Axelrad, EPA, 15 November, 2010.

		P-VALUES		
Variable	**RACE1**	**RACE2**	**Unadjusted**	**Adjusted for age, sex**
Asthma and all other respiratory causes	API non-Hispanic	Other	0.001	< 0.0005
Asthma and all other respiratory causes	AIAN non-Hispanic	Hispanic	0.005	< 0.0005
Asthma and all other respiratory causes	AIAN non-Hispanic	Other	< 0.0005	< 0.0005
Asthma and all other respiratory causes	Hispanic	Other	< 0.0005	< 0.0005

Table 2. Statistical significance tests comparing the rates of hospitalizations for asthma and other respiratory causes by children ages 0 to 17 years, between pairs of race groups, for 2005-2008.

		P-VALUES		
Variable	**RACE1**	**RACE2**	**Unadjusted**	**Adjusted for age, sex**
Asthma and all other respiratory causes	White	Black	0.001	< 0.0005
Asthma and all other respiratory causes	White	API	0.074	< 0.0005
Asthma and all other respiratory causes	White	AIAN	< 0.0005	< 0.0005
Asthma and all other respiratory causes	White	Other	< 0.0005	< 0.0005
Asthma and all other respiratory causes	Black	API	< 0.0005	< 0.0005
Asthma and all other respiratory causes	Black	AIAN	< 0.0005	< 0.0005
Asthma and all other respiratory causes	Black	Other	< 0.0005	0.640
Asthma and all other respiratory causes	API	AIAN	0.324	0.410
Asthma and all other respiratory causes	API	Other	< 0.0005	< 0.0005
Asthma and all other respiratory causes	AIAN	Other	< 0.0005	< 0.0005

Table 3. Other statistical significance tests comparing the rates of emergency room visits for asthma and other respiratory causes by children ages 0 to 17 years for 2005 to 2008 (trends for 1996-2008).

				P-VALUES	
Variable	**From**	**To**	**Against**	**Unadjusted**	**Adjusted***
Asthma and all other respiratory causes	2005	2008	age	< 0.0005	< 0.0005
Asthma and all other respiratory causes	1996	2008	year	0.381	< 0.0005
Other respiratory causes	1996	2008	year	0.679	0.056
Asthma	1996	2008	year	0.023	0.004

*For AGAINST = "age," the p-values are adjusted for sex and race/ethnicity.
For AGAINST = "year," the p-values are adjusted for age, sex, and race/ethnicity.

Table 4. Other statistical significance tests comparing the rates of hospitalizations for asthma and other respiratory causes by children ages 0 to 17 years for 2005 to 2008 (trends for 1996-2008).

				P-VALUES	
Variable	**From**	**To**	**Against**	**Unadjusted**	**Adjusted***

				P-VALUES	
Variable	**From**	**To**	**Against**	**Unadjusted**	**Adjusted***
Asthma and all other respiratory causes	2005	2008	age	< 0.0005	< 0.0005
Asthma and all other respiratory causes	1996	2008	year	< 0.0005	< 0.0005
Other respiratory causes	1996	2008	year	0.001	< 0.0005
Asthma	1996	2008	year	< 0.0005	< 0.0005

*For AGAINST = "age," the p-values are adjusted for sex and race.
For AGAINST = "year," the p-values are adjusted for age, sex, and race.