

## Respiratory Diseases

Respiratory diseases and illness, such as asthma, bronchitis, pneumonia, allergic rhinitis, and sinusitis, 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, respiratory distress, and death in the most extreme cases, are responsible for substantial morbidity and a large cost burden to families and society.

Outdoor and indoor air pollution can adversely affect children's respiratory health.<sup>1-7</sup> Studies have shown that air pollution can exacerbate existing respiratory conditions such as asthma and upper airway allergies.<sup>1,8-10</sup> Increasing evidence suggests that exposure to certain air pollutants may contribute to 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.<sup>11-13</sup> Air pollution also increases a child's risk of developing respiratory infections, most likely by causing inflammation and/or impaired immune response.<sup>14-16</sup>

EPA sets health-based National Ambient Air Quality Standards for six air pollutants.<sup>17</sup> These pollutants, referred to as criteria air pollutants, are particulate matter (PM), ground-level ozone, nitrogen oxides, sulfur oxides, carbon monoxide (CO), and lead. Four of these pollutants have extensive evidence linking them to respiratory diseases in children (PM, ground-level ozone, nitrogen oxides, and sulfur oxides). The evidence for respiratory effects is weaker for CO, and lead has not been linked to adverse respiratory outcomes.

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.<sup>6</sup> Particulate air pollution has also been associated with respiratory-related infant mortality, even at relatively low PM levels that are commonly experienced in the United States.<sup>18,19</sup>

Short-term exposure to ground-level ozone can cause a variety of respiratory health effects, including airway inflammation; reduced lung function; increased susceptibility to respiratory infection; and respiratory symptoms such as cough, wheezing, chest pain, and shortness of breath.<sup>3,20,21</sup> Ozone exposure can decrease the capacity to perform exercise and has been associated with the aggravation of respiratory illnesses such as asthma and bronchitis, leading to increased use of medication, absences from school, doctor and emergency department visits, and hospital admissions.<sup>3</sup> Studies have also found that long-term ozone exposure may contribute to the development of asthma, especially among children with certain genetic susceptibilities and children who frequently exercise outdoors.<sup>22-24</sup>

Nitrogen dioxide (NO<sub>2</sub>) 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<sub>2</sub> 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.<sup>4</sup>

Short-term exposures of persons with asthma to elevated levels of sulfur dioxide (SO<sub>2</sub>) 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<sub>2</sub> exposure and increased respiratory symptoms in children, especially those with asthma or chronic respiratory symptoms. Short-term exposures to SO<sub>2</sub> have also been associated with respiratory-related emergency department visits and hospital admissions, particularly for children.<sup>5</sup>

Exposure to CO reduces the capacity of the blood to carry oxygen, thereby decreasing the supply of oxygen to tissues and organs such as the heart. Research suggests correlations between CO exposure and the exacerbation of asthma; however, CO levels are highly correlated with other combustion-related pollutants, especially in locations near roads. Few analyses clearly distinguish the contributions of CO from those of the larger traffic-related air pollutant mixture, thus it is uncertain whether the observed health effects are truly attributable to CO or whether they are due to other co-occurring air pollutants.<sup>7,10,25</sup>

In addition to the criteria air pollutants, EPA regulates 187 hazardous air pollutants (HAPs) that are known or suspected to cause serious health effects or adverse environmental effects. For many of these pollutants, information on health effects is scarce. HAPs that may be of particular concern for the induction and exacerbation of asthma include acrolein, formaldehyde, nickel, and chromium.<sup>26</sup> Acrolein has been identified as a HAP of particular concern for possible respiratory effects at levels commonly found in outdoor air in the United States.<sup>27-29</sup> Acrolein can cause respiratory irritation in individuals who do not have asthma.<sup>30</sup>

Pollution from traffic-related sources, a mix of criteria air pollutants and HAPs, 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 reduced growth of lung function during childhood.<sup>11-13,31-36</sup> 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.<sup>37</sup> Some studies have suggested that traffic-related pollutants may contribute to the development of allergic disease, either by affecting the immune response directly or by increasing the concentration or biological activity of the allergens themselves.<sup>38-40</sup>

Children can also be exposed to air pollution inside homes, schools, and other buildings. Indoor air pollutants from biological sources such as mold; dust mites; pet dander (skin flakes); and droppings and body parts from cockroaches, rodents, and other pests or insects, can lead to allergic reactions, exacerbate existing asthma, and have been associated with the development of respiratory symptoms.<sup>1,41,42</sup> Furthermore, the Institute of Medicine concluded that exposure

to dust mites can cause asthma in susceptible children, and exposure to cockroaches may cause asthma in young children.<sup>1</sup>

PM and NO<sub>2</sub>, discussed previously as outdoor air pollutants, also pollute indoor air when they are emitted from gas stoves, gas or oil furnaces, fireplaces, wood stoves, and kerosene or gas space heaters. Indoor concentrations of these combustion byproducts can reach very high levels in developing countries where solid fuels are used extensively for cooking and home heating, but may also affect the respiratory health of children in developed countries, especially during the winter when use of fireplaces and space heaters is more common.<sup>43</sup> Environmental tobacco smoke (ETS), also known as secondhand smoke, is an air pollutant mixture that includes particles and NO<sub>2</sub> as well as thousands of other chemicals. The Surgeon General has concluded that exposure to ETS causes sudden infant death syndrome (SIDS), acute lower respiratory infection, ear problems, and more severe asthma in children. Smoking by parents causes respiratory symptoms and slows lung growth in their children.<sup>2</sup>

A number of air pollutants emitted indoors by a variety of household items such as building materials and home furnishings, recently dry-cleaned clothes, cleaning supplies, and room deodorizers, have been associated with respiratory symptoms and may play a role in the exacerbation or development of childhood asthma.<sup>44,45</sup> A recent systematic review of seven studies concluded that there is a significant association between exposure to formaldehyde—a chemical released from particle board, insulation, carpet, and furniture—and self-reported or diagnosed asthma in children.<sup>46</sup>

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 window 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.<sup>2,47-50</sup> Studies have also found that prenatal exposure to polycyclic aromatic hydrocarbons (hazardous air pollutants found in diesel exhaust, ETS, and smoke from burning organic materials) is associated with childhood respiratory illnesses and the development of asthma, particularly when in combination with prenatal or postnatal exposure to ETS.<sup>51-53</sup> 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 who do develop asthma.<sup>11,54,55</sup> 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 periods.

## Asthma

Asthma is a chronic inflammatory disease of the airways. When children with asthma are exposed to an asthma trigger, the airway walls become inflamed and secrete more mucus, and the muscles around the airways tighten. This exaggerates the normal airway constriction that occurs on exhalation, trapping air in the lungs and compromising normal oxygen exchange.

These physiological 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 2009, it affected 7.1 million (or about 10% of) children in the United States.<sup>56</sup> It is costly in both human and monetary terms: estimated national costs of asthma in 2007 were \$56 billion.<sup>57</sup> The percentage of children with asthma increased substantially from 1980–1996 and remains high.<sup>58</sup> Researchers do not completely understand why children develop asthma or why the prevalence has increased.

Asthma is a complex disease with many factors, including genetic factors and environmental factors, that interact to influence its development and severity. The percentage of children reported to have current asthma differs by age, family history of asthma and allergies, racial and ethnic group, and family income. Children of color and children of lower-income families are more likely to be diagnosed with asthma. Because minority populations are more likely to be of low socioeconomic status, it is difficult to establish whether racial/ethnic group is an independent risk factor for the development of asthma. While some research has suggested that variations in asthma prevalence among racial groups can be explained by socioeconomic factors,<sup>59,60</sup> another study suggested that the difference persists even after accounting for socioeconomic factors.<sup>61</sup> Other researchers have proposed that the greater prevalence of asthma among Black children can be explained by their disproportionate presence in urban environments.<sup>62</sup>

Children living in poverty are more likely to have poorly maintained housing, which can present risk factors for asthma development and exacerbation. The Institute of Medicine concluded that exposure to dust mites causes asthma in susceptible children, and that cockroaches may cause asthma in young children.<sup>1</sup> Research suggests that lower-income children are more likely to live in homes with high levels of cockroach allergens and homes where someone smokes regularly.<sup>63-66</sup> A nationally representative survey of allergens in U.S. housing reported higher levels of dust mite allergen in bedding from lower-income families.<sup>67</sup> Household mouse allergen was also found at higher concentrations in low-income homes, mobile homes, and older homes.<sup>68</sup> In addition, total dust weight itself has been 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.<sup>69</sup> Furthermore, children living in poverty 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.<sup>70-76</sup> These factors may increase asthma morbidity, as evidenced by increased asthma symptoms among those diagnosed with the disease.

Asthma indicators provide data on the percentage of children who have asthma as well as health outcomes for children with asthma. Indicators H1 and H2 focus on the prevalence of asthma among children. Indicator H1 provides the best nationally representative data available on prevalence of asthma over time among children ages 0 to 17 years. It provides two

measures of asthma prevalence by year, from 1997–2010: current asthma prevalence and asthma attack prevalence. While the former measure reports on the percentage of children who have asthma each year, the latter measure presents data on children who had asthma attacks in the past year, and thus represents outcomes for children with asthma by identifying the proportion of children with ongoing or uncontrolled symptoms. Indicator H2 provides the best nationally representative data available to compare the prevalence of current asthma among children 0 to 17 years by race/ethnicity and family income for the years 2007–2010.<sup>i</sup>

### Emergency Room Visits and Hospitalizations for Respiratory Diseases

Children who visit emergency rooms or are hospitalized for respiratory diseases (including asthma and upper and lower respiratory infections such as bronchiolitis and pneumonia) usually represent the most severe cases of respiratory disease. 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 and bronchiolitis is the leading cause of acute illness and hospitalization in infants.<sup>77,78</sup>

Emergency room visits and hospital admissions for respiratory diseases can be related to a number of factors. These factors include exposure to asthma triggers, lack of access to primary health care, lack of or inadequate insurance, inadequate instructions for asthma management, or inadequate compliance with given instructions.<sup>79-83</sup> 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.<sup>84,85</sup>

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.<sup>3-6</sup>

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,<sup>86,87</sup> and that the gap between Black and White children in both hospitalizations and deaths from asthma appears to be growing.<sup>88-90</sup> 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.<sup>88</sup> Asthma is the leading cause of emergency room visits, hospitalizations, and missed school days in New York City's poorest neighborhoods.<sup>91</sup> 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.<sup>92</sup>

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<sup>i</sup> 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 H3 provides the best nationally representative data available on the frequency with which children experienced asthma or respiratory symptoms resulting in an emergency room visit or hospitalization for the years 1996–2008. This indicator highlights the most severe cases of respiratory illness among children ages 0 to 17 years. Indicator H3 includes further information on health outcomes for children with asthma, in addition to the asthma attack prevalence information in Indicator H1, by reporting on trends in children’s hospitalizations and emergency room visits due to asthma.

### Indicator H1: Percentage of children ages 0 to 17 years with asthma, 1997–2010

### Indicator H2: Percentage of children ages 0 to 17 years reported to have current asthma, by race/ethnicity and family income, 2007–2010

**About the Indicators:** Indicators H1 and H2 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 each year. Indicator H1 shows how children’s asthma rates have changed over time. Indicator H2 shows how children’s asthma rates vary by race/ethnicity and family income level.

## National Health Interview Survey

The National Health Interview Survey (NHIS) provides nationally representative data on the prevalence of childhood asthma in the United States each year. NHIS is a large-scale household interview survey of a representative sample of the civilian noninstitutionalized U.S. population, conducted by the National Center for Health Statistics (NCHS). The interviews are conducted in person at the participants’ homes. From 1997–2005, interviews were conducted for approximately 12,000–14,000 children annually. From 2006–2008, interviews were conducted for approximately 9,000–10,000 children per year. In 2009 and 2010, interviews were conducted for approximately 11,000 children per year.

With a major survey redesign implemented in 1997, the measurement of childhood 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). The data are obtained by asking a parent or other knowledgeable household adult questions regarding the child’s health status. NHIS asks “Has a doctor or other health professional ever told you that your child has asthma?” If the answer is YES to this question, NHIS then asks (1) “Does your child still have asthma?” and (2) “during the past 12 months, has your child had an episode of asthma or an asthma attack?” 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 (current asthma prevalence). 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.

## Data Presented in the Indicators

Indicator H1 presents two different measures of asthma prevalence using data from the NHIS: current asthma and asthma attack prevalence. Indicator H1 provides the annual estimates of asthma prevalence for all children 0 to 17 years of age for the years 1997–2010. Indicator H2 reports on the percentage of children ages 0 to 17 years reported to have current asthma, by

race/ethnicity and family income, in 2007–2010. NHIS is also the source of data for this indicator. The 2007, 2008, 2009 and 2010 data are combined for this indicator in order to increase the statistical reliability of the estimates for each race/ethnicity and income group.

For Indicator H2, five race/ethnicity groups are presented: White non-Hispanic, Black non-Hispanic, Asian non-Hispanic, Hispanic, and “All Other Races.” The “All Other Races” category includes all other races not specified, together with those individuals who report more than one race. The limits of the sample design and sample size often prevent statistically reliable estimates for smaller race/ethnicity groups. The data are also tabulated for three income groups: all incomes, below the poverty level, and greater than or equal to the poverty level. These prevalence data are based on a survey respondent reporting that asthma has been diagnosed by a health care provider. Accuracy of responses and access to health care providers may vary among population groups.<sup>93,94</sup>

In addition to the data shown in Indicator H1, 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 H2 shows the prevalence of current asthma for an expanded set of race/ethnicity categories, including Mexican-American and Puerto Rican. A supplemental data table shows the prevalence of current asthma by age and sex for the years 2007–2010.

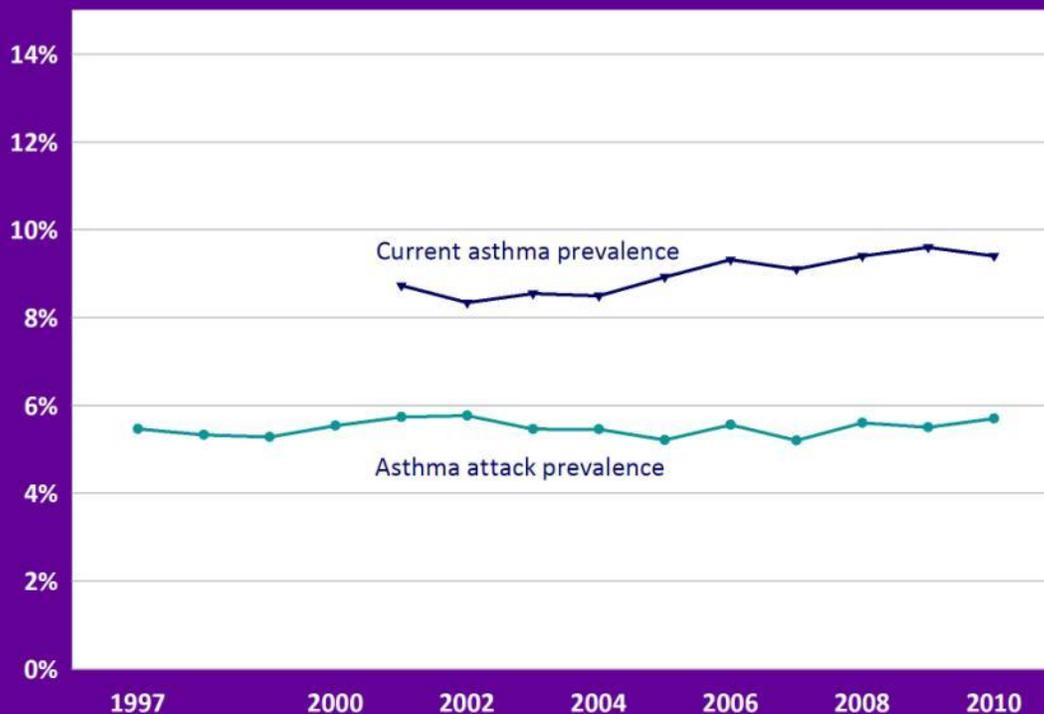
Please see the Introduction to the Health section for discussion of statistical significance testing applied to these indicators.

### Other Estimates of Asthma Prevalence

In addition to NHIS, other NCHS surveys provide data on asthma prevalence. A telephone-based survey conducted in 2007 by NCHS along with state and local governments found that 11% of high school students currently had asthma.<sup>95</sup> 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.<sup>96</sup>

Indicator H1

## Percentage of children ages 0 to 17 years with asthma, 1997-2010



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

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**Data characterization**

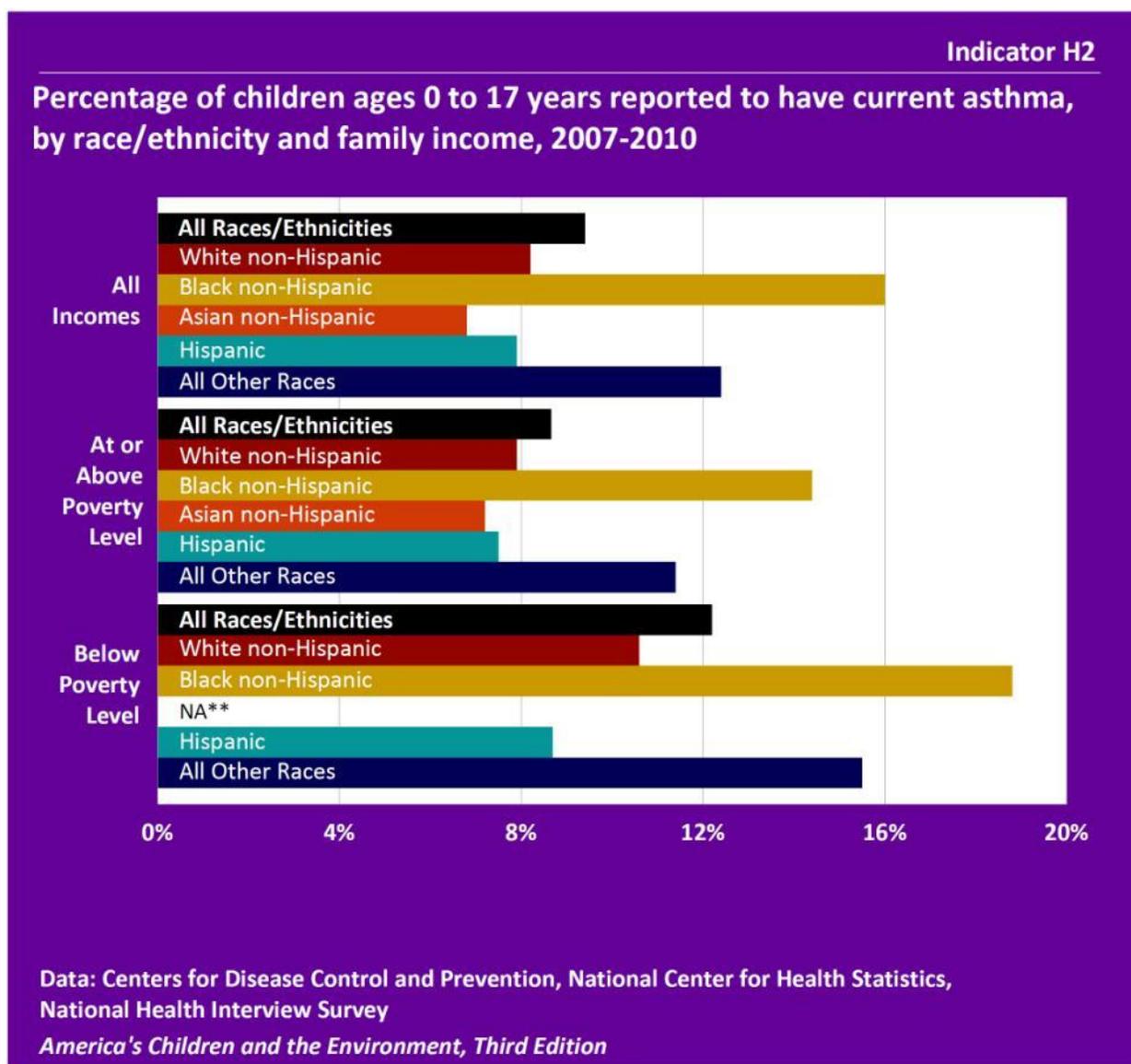
- Data for this indicator are obtained from an ongoing annual survey conducted by the National Center for Health Statistics.
- Survey data are representative of the U.S. civilian noninstitutionalized population.
- A parent or other knowledgeable adult in each sampled household is asked questions regarding the child's health status, including if they have ever been told the child has asthma, if the child has had an asthma attack in the past year, and if the child currently has asthma.

- The proportion of children reported to currently have asthma increased from 8.7% in 2001 to 9.4% in 2010.
- In 2010, 5.7% of all children were reported to have had one or more asthma attacks in the previous 12 months. There was little change in this rate between 1997 and 2010.

- In 2001, 61.7% of children with current asthma had one or more asthma attacks in the previous 12 months, and by 2010 this figure had declined to 58.3%.<sup>ii</sup> The decreasing trend from 2001 to 2010 was statistically significant. (See Table H1c.)
- Between 1980 and 1995 the percentage of children who had asthma in the past 12 months increased from 3.6% in 1980 to 7.5% in 1995. Methods for measurement of childhood asthma changed in 1997, so earlier data cannot be compared to the data from 1997–2010. (See Table H1b.)

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<sup>ii</sup> See indicator H3 for further information on outcomes for children with asthma.



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

**Data characterization**

- Data for this indicator are obtained from an ongoing annual survey conducted by the National Center for Health Statistics.
- Survey data are representative of the U.S. civilian noninstitutionalized population.
- A parent or other knowledgeable adult in each sampled household is asked questions regarding the child's health status, including if they have ever been told the child has asthma, if the child has had an asthma attack in the past year, and if the child currently has asthma.

- In 2007–2010, 9.4% of all children were reported to currently have asthma.

- Among children living in families with incomes below the poverty level, 12.2% were reported to currently have asthma. Among children living in families with incomes at the poverty level and higher, 8.7% were reported to currently have asthma. This difference was statistically significant.
- In 2007–2010, the percentages of Black non-Hispanic children and children of “All Other Races” reported to currently have asthma, 16.0% and 12.4% respectively, were greater than for White non-Hispanic children (8.2%), Hispanic children (7.9%), and Asian non-Hispanic children (6.8%).
  - The differences in current asthma prevalence among Black non-Hispanic or “All Other Races” 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.
- Among Hispanic children, about 1 in 4 Puerto Rican children (23.3%) 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 6.6%. This difference was statistically significant. (See Table H2.)
- Among boys, 10.7% were reported to have current asthma compared with 8.0% of girls. This difference was statistically significant. (See Table H2a.)
- Among children ages 0 to 5 years, 7.1% were reported to have current asthma compared with 10.0% of children ages 6 to 10 years and 11.0% of children ages 11 to 17 years. The difference in current asthma by age group was statistically significant. (See Table H2a.)

### Indicator H3: Children’s emergency room visits and hospitalizations for asthma and other respiratory causes, ages 0 to 17 years, 1996–2008

**About the Indicator:** Indicator H3 presents information about the number of children’s emergency room visits and hospitalizations for asthma and other respiratory causes. The data are from two national surveys that collect information from hospitals each year. Indicator H3 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 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, provide national data on emergency room visits and hospitalizations. 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. The diagnoses in both surveys include asthma and a number of other respiratory conditions. Both surveys exclude federal and military hospitals and report patient demographic information.

#### Data Presented in the Indicators

Indicator H3 uses data from NHAMCS and NHDS to display 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 H3 presents annual survey results from 1996–2008. 1996 was selected as the initial year for the indicator because not all of the needed hospitalization data for earlier years are available online. The indicator provides data through 2008 because it is the most recent year for which data from both NHAMCS and NHDS are available.

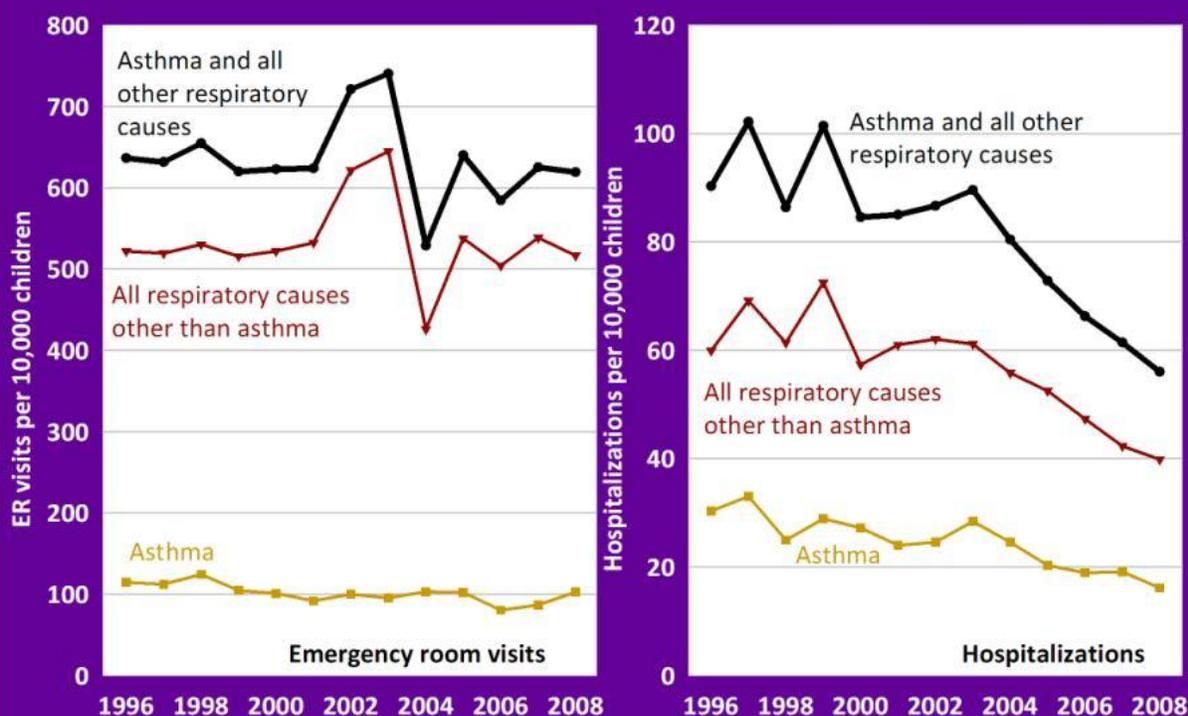
In addition to the data shown in the Indicator H3 graph, supplemental tables show the annual average rates of children’s emergency room visits and hospitalizations for asthma and all other respiratory causes, asthma, and all respiratory causes other than asthma (composed of the following subcategories: upper respiratory conditions, pneumonia or influenza, and other lower respiratory conditions besides asthma) by age and race/ethnicity for the years 2005–2008. For emergency room visits, five race/ethnicity groups are presented: White non-Hispanic, Black non-Hispanic, American Indian/Alaska Native non-Hispanic, Asian and Pacific Islander non-Hispanic, and Hispanic. For hospitalizations, race only is reported; the two groups presented are

White and Black. The supplemental tables do not include income data, since neither of these surveys includes the patient's income or family income.

Please see the Introduction to the Health section for discussion of statistical significance testing applied to these indicators.

Indicator H3

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



Data: Centers for Disease Control and Prevention, National Center for Health Statistics, National Hospital Ambulatory Medical Care Survey (emergency room visits) and National Hospital Discharge Survey (hospitalizations)

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**Data characterization**

- Data for this indicator are obtained from two ongoing annual surveys conducted by the National Center for Health Statistics.
- Survey data are representative of U.S. population visits to emergency rooms and stays at non-federal hospitals.
- The surveys collect data on physician diagnoses of patients in sampled hospitals, including diagnoses of asthma and other respiratory conditions.

**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 emergency room visits for asthma decreased from 114 visits per 10,000 children in 1996 to 103 visits per 10,000 children in 2008. This decreasing trend 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 H3a.)
  - 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 H3b.)

## Hospitalizations

- Between 1996 and 2008, hospitalizations for asthma and for all other respiratory causes decreased from 90 hospitalizations per 10,000 children to 56 hospitalizations per 10,000 children. Between 1996 and 2008, hospitalizations for asthma alone decreased from 30 per 10,000 children to 16 per 10,000 children, and hospitalizations for all other respiratory causes decreased from 60 per 10,000 children to 40 per 10,000 children. These decreasing trends were statistically significant.
- Children’s hospitalizations for asthma and all other respiratory causes vary widely by race. For the years 2005–2008, Black children had a rate of 84 hospitalizations for asthma and other respiratory causes per 10,000 children, while White children had a rate of 52 hospitalizations per 10,000 children. This difference was statistically significant. (See Table H3c.)
- Children’s hospitalizations 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 hospitalizations per 10,000 children, while children 16 to 17 years of age had a rate of 13 hospitalizations per 10,000 children. The differences between age groups were statistically significant. (See Table H3d.)

## Health

### Respiratory Diseases

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## Health

### Respiratory Diseases

**Table H1: Percentage of children ages 0 to 17 years with asthma, 1997-2010**

1997-2003							
	1997	1998	1999	2000	2001	2002	2003
<b>Asthma attack prevalence</b>	5.5	5.3	5.3	5.5	5.7	5.8	5.5
<b>Current asthma prevalence‡</b>					8.7	8.3	8.5
2004-2009							
	2004	2005	2006	2007	2008	2009	2010
<b>Asthma attack prevalence</b>	5.5	5.2	5.6	5.2	5.6	5.5	5.7
<b>Current asthma prevalence‡</b>	8.5	8.9	9.3	9.1	9.4	9.6	9.4

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

NOTE: Data represent responses to the following survey questions: "Has a doctor or other health professional ever told you that <child's name> had asthma?" and if yes, "During the past 12 months, has <child's name> had an episode of asthma or an asthma attack?" For 2001-2010 the survey included the question: "Does <child's name> still have asthma?" Responses are provided by a parent or other knowledgeable household adult.

‡ This survey question was first asked in 2001.

**Table H1a: Percentage of children ages 0 to 17 years with current asthma, 2001-2010, by sex**

	2001	2002	2003	2004	2005
<b>All children</b>	8.7	8.3	8.5	8.5	8.9
<b>Boys</b>	9.9	9.5	9.5	10.2	10.0
<b>Girls</b>	7.5	7.2	7.5	6.7	7.8
	2006	2007	2008	2009	2010
<b>All children</b>	9.3	9.1	9.4	9.6	9.4
<b>Boys</b>	11.0	9.7	11.4	11.3	10.5
<b>Girls</b>	7.5	8.5	7.4	7.9	8.2

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

NOTE: Data represent responses to the following survey questions: "Has a doctor or other health professional ever told you that <child's name> had asthma?" and if yes, "During the past 12 months, has <child's name> had an episode of asthma or an asthma attack?" For 2001-2010 the survey included the question: "Does <child's name> still have asthma?" Responses are provided by a parent or other knowledgeable household adult.

**Table H1b: Percentage of children ages 0 to 17 years with asthma, 1980-1996†**

1980-1987									
	1980	1981	1982	1983	1984	1985	1986	1987	
<b>Asthma in the past 12 months</b>	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
<b>Asthma in the past 12 months</b>	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

† 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. For 1980 to 1996, the asthma survey question was "Did <child's name> have asthma in the past 12 months?"

**Table H1c: Percentage of children ages 0 to 17 years with current asthma who reported an asthma attack in the past 12 months, 2001-2010**

2001-2008								
	2001	2002	2003	2004	2005	2006	2007	2008
Asthma attack prevalence among those with current asthma	61.7	64.9	62.7	61.2	56.7	56.1	54.8	57.2
2009-2010								
	2009	2010						
Asthma attack prevalence among those with current asthma	53.9	58.3						

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

NOTE: Data represent responses to the following survey questions: “Has a doctor or other health professional ever told you that <child’s name> had asthma?” and if yes, “During the past 12 months, has <child’s name> had an episode of asthma or an asthma attack?” For 2001-2010 the survey included the question: “Does <child’s name> still have asthma?” Responses are provided by a parent or other knowledgeable household adult.

**Table H2: Percentage of children ages 0 to 17 years reported to have current asthma by race/ethnicity and family income, 2007-2010**

Race / Ethnicity	All (n = 40,569)	< Poverty Level (n = 8,160)	≥Poverty Level (n = 32,409)	≥ Poverty Level (Detail)	
				100-200% of Poverty Level (n = 9,603)	≥ 200% of Poverty Level (n = 22,806)
<b>All Races/Ethnicities</b> (n = 40,569)	9.4	12.2	8.7	9.9	8.2
<b>White non-Hispanic</b> (n = 17,692)	8.2	10.6	7.9	9.6	7.5
<b>Black or African-American non-Hispanic</b> (n = 6,628)	16.0	18.8	14.4	15.0	13.9
<b>Asian non-Hispanic</b> (n = 2,255)	6.8	NA**	7.2	5.7*	7.7
<b>Hispanic</b> (n = 12,343)	7.9	8.7	7.5	7.3	7.8
<b>Mexican</b> (n = 8,114)	7.0	6.6	7.2	6.5	8.0
<b>Puerto Rican</b> (n=1,116)	16.5	23.3	12.6	15.3	11.0
<b>All Other Races†</b> (n = 1,651)	12.4	15.5	11.4	14.8	9.7
<b>American Indian or Alaska Native non-Hispanic</b> (n = 219)	10.7	13.0*	NA**	NA**	NA**

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

† The “All Other Races” category includes all other races not specified, together with those individuals who report more than one race.

\* 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).

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

Table H2a: Percentage of children ages 0 to 17 years reported to have current asthma by age and sex, 2007-2010

	Ages 0 to 17 years	Ages 0 to 5 years	Ages 6 to 10 years	Ages 11 to 17 years
All children	9.4	7.1	10.0	11.0
Boys	10.7	8.8	11.9	11.7
Girls	8.0	5.2	8.1	10.3

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

Table H3: 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
<b>Emergency Room Visits</b>				
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
<b>Hospitalizations</b>				
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
<b>Emergency Room Visits</b>				
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
<b>Hospitalizations</b>				
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
<b>Emergency Room Visits</b>				
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
<b>Hospitalizations</b>				
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
<b>Emergency Room Visits</b>	
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
<b>Hospitalizations</b>	
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).

\*\* Not available. 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 H3a: Children's emergency room visits for asthma and other respiratory causes, by race/ethnicity, ages 0 to 17 years, 2005-2008**

	Rate per 10,000 children				
	2005	2006	2007	2008	2005-2008
<b>All Races/Ethnicities</b> (n=5,366)	639.8	584.3	625.1	619.1	617.1
<b>White non-Hispanic</b> (n=2,248)	484.8	442.3	518.8	500.9	486.6
<b>Black non-Hispanic</b> (n=1,557)	1,242.7	1,276.0	1,183.5	1,258.0	1,240.1
<b>American Indian/Alaska Native non-Hispanic</b> (n=33)	NA**	NA**	NA**	NA**	536.2
<b>Asian and Pacific Islander non-Hispanic</b> (n=179)	409.4*	404.7	341.8*	333.1*	371.4
<b>Hispanic</b> (n=1,331)	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).

\*\* Not available. 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 H3b: 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
<b>Ages 0 to 17 years</b>	639.8	584.3	625.1	619.1	617.1
<b>Age &lt; 1 year</b>	2,344.8	2,040.5	2,098.3	2,090.4	2,142.1
<b>Age 1 year</b>	1,884.3	1,696.4	1,823.1	1,727.5	1,782.3
<b>Age 2 years</b>	1,081.9	957.2	1,015.0	972.7	1,006.3
<b>Ages 3 to 5 years</b>	778.4	668.1	719.8	751.9	729.5
<b>Ages 6 to 10 years</b>	391.6	384.1	389.5	382.7	387.0
<b>Ages 11 to 15 years</b>	252.6	251.0	276.7	268.3	262.0
<b>Ages 16 to 17 years</b>	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 H3c: Children's hospitalizations for asthma and other respiratory causes, by race,† ages 0 to 17 years, 2005-2008**

	Rate per 10,000 children				
	2005	2006	2007	2008	2005-2008
<b>All Races‡</b> (n=18,088)	72.8	66.3	61.4	56.0	64.1
<b>White</b> (n=9,213)	61.7	56.5	47.7	42.7	52.1
<b>Black</b> (n=4,154)	94.1	91.6	78.0	72.3	84.0

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.

‡ Includes races other than White and Black.

**Table H3d: Children’s hospitalizations for asthma and other respiratory causes, by age, 2005-2008**

	Rate per 10,000 children				
	2005	2006	2007	2008	2005-2008
<b>Ages 0 to 17 years</b>	72.8	66.3	61.4	56.0	64.1
<b>Age &lt; 1 year</b>	477.2	399.6	364.8	344.3	395.5
<b>Age 1 year</b>	232.7	211.9	173.5	152.2	191.9
<b>Age 2 years</b>	115.9	112.2	117.9	89.7	108.8
<b>Ages 3 to 5 years</b>	70.1	68.2	53.9	53.3	61.3
<b>Ages 6 to 10 years</b>	33.0	28.8	29.0	27.6	29.6
<b>Ages 11 to 15 years</b>	15.3	13.8	17.2	13.1	14.9
<b>Ages 16 to 17 years</b>	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