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## Assessing asthma severity among children and adults with current asthma

Hatice S. Zahran, MD, Cathy M. Bailey, MS, Xiaoting Qin, MS, and Jeanne E. Moorman, MS  
Division of Environmental Hazards and Health Effects, National Center for Environmental Health,  
Centers for Disease Control and Prevention, Atlanta, GA, USA

### Abstract

**Background**—Asthma severity is a key indicator to assess asthma care and management. Severity status may vary over time. Assessing asthma severity periodically is important for monitoring the health and well-being of people with asthma.

**Objective**—To assess population-based asthma severity and to identify related-risk factors among children and adults with asthma.

**Methods**—We used the 2006–2010 BRFSS child and adult Asthma Call-back Survey. Asthma severity was classified as intermittent or persistent. We performed multivariate logistic regression to identify related-risk factors.

**Results**—Overall, 63.8% of persons with asthma had persistent asthma. Persistent asthma was more prevalent among children aged 0–4 years (71.8%; prevalence rate ratio [PR] = 1.3). Among adults with current asthma, persistent asthma was more prevalent among those who were 45 years or older (aged 45–54: 69.4%; PR = 1.1, aged 55–64: 72.6%; PR = 1.2, and aged 65+: 77.8%; PR = 1.3); annual household incomes of <\$15 000 (74.1%; PR = 1.1); and first diagnosed at age 55 years or older (first diagnosed at age 55–64: 80.4%; PR = 1.1, at age 65 + : 81.5%; PR = 1.1). The prevalence of persistent asthma was also higher among current smokers who were also exposed to secondhand smoke (SHS) (74.7%; PR = 1.1); and among those with Chronic Obstructive Pulmonary Disease (COPD) (77.1%; PR = 1.2).

**Conclusions**—Nearly two-thirds of children and adults with asthma had persistent asthma. Identifying related-risk factors could help improve targeted interventions or strategies to reduce modifiable predictors (low income, smoking, and SHS) of increased asthma severity. Such strategies could improve asthma care and quality of life.

### Keywords

Asthma control; current asthma; demographic characteristics; intermittent asthma; low income; persistent asthma; risk factors

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Correspondence: Hatice S. Zahran, MD, MPH, Epidemiologist, Division of Environmental Hazards and Health Effects, National Center for Environmental Health, Centers for Disease Control and Prevention, 4770 Buford Highway, NE, MS F-60, Atlanta, GA 30341, USA. Tel: 770/488-1509. Fax: 770/488-1540. HZahran@cdc.gov.

Declaration of interest

The authors, H.S. Zahran, C. Bailey, X. Qin, and J.E. Moorman declare no conflicts of interest. The authors alone are responsible for the content and writing of the article.

## Introduction

Asthma is a chronic lung disease that inflames and narrows the airways. Asthma affects nearly 26 million people, including 7.0 million children [1] who may experience recurring episodes of wheezing, chest tightness, shortness of breath, and coughing. These recurring episodes cause sleeplessness, daytime fatigue, reduced activity levels, school and work absenteeism, and increased health care use [1,2]. These, in turn, increase the economic burden on patients and society [3]. Although asthma cannot be cured, with effective asthma care and management, most persons with asthma can be free of symptoms and have a better quality of life. One of the key components of effective asthma care and management is assessing asthma severity to select appropriate therapy and to monitor the health and well-being of people with asthma [4,5].

Although the causes of asthma and the determinants of asthma severity remain poorly understood, multiple environmental and genetic factors play an important role in the development of asthma and the exacerbation of asthma symptoms [6–8]. Asthma severity is the inherent intensity of the disease process while asthma control refers to the degree that symptoms are successfully managed. Disease progression and symptoms can vary among individuals and within an individual's experience over time. Although we do not know the factors that determine these variations and the underlying asthma severity, knowing asthma severity status is important to determining the type of treatment, its duration, and its effects on the level of asthma control that minimizes the frequency and intensity of symptoms and functional limitations [4,5].

Assessing the health and economic burden of the disease requires that one take both asthma severity and control into account. Several population-based studies have assessed the level of asthma control and examined the factors associated with asthma control [9–12]. However, to the best of our knowledge, limited population-based studies attempt to assess asthma severity [13,14]. One major issue in classifying asthma severity after treatment has started is that the severity of disease is most accurately assessed in patients before the initiation of long-term control medication and once a therapy has been started, the focus is on monitoring the level of control, not the level of severity [4]. Many respondents are already receiving long-term control medication at the time of the survey, further complicating the classification of asthma severity. Other issues impeding the population-based assessment of asthma severity is the varying measures used to classify severity, and the confusion between the underlying severity of disease and the current level of symptom control [15,16].

To evaluate population-based asthma severity, Fuhlbrigge and colleagues [13] defined asthma severity using the NAEPP 2003 guidelines. They showed that 77.3% of the study population (both children and adults with asthma) had moderate to severe persistent asthma. Colice and colleagues [14] used the NAEPP 2007 guidelines (EPR-3) to define asthma severity by using measures for current impairments and risk for future exacerbations among adolescents (aged 12–17 years) and adults (aged 18 years). They showed that 79% of patients had persistent asthma. For this study, we used the NAEPP 2007 guidelines for asthma severity classification for clinical research and population-based evaluations—that is, severity can be inferred from the least amount of treatment required to maintain asthma

control [4]. We assessed asthma severity and determined the factors associated with it among children and adults with asthma in the states that participated in the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (BRFSS) Asthma Call-back Survey (ACBS).

## Methods

### Survey data description

We analyzed 2006–2010 data from the BRFSS Asthma Call-back Survey (ACBS) for children (aged 0–17 years) and adults (aged 18 years and older). We combined 5 years of survey data to provide more stable estimates. During the 2006–2010 survey years, 35 states and the District of Columbia participated in the Child ACBS, while 40 states and the District of Columbia participated in the Adult ACBS.

The BRFSS ACBS is developed and funded by the Air Pollution and Respiratory Health Branch (APRHB) in the National Center for Environmental Health (NCEH), Centers for Disease Control and Prevention (CDC). It has been implemented as a follow-up survey to the BRFSS since 2006. The BRFSS ACBS is conducted approximately 2 weeks after the BRFSS telephone interview. Although BRFSS is a state-based, random-digit-dialed telephone survey of non-institutionalized U.S. adults, the BRFSS survey contains a Random Child Selection module and a Child Asthma Prevalence module, both of which were used in participating states to identify households with a child who had asthma in order to administer the Child ACBS. BRFSS respondents who report ever being diagnosed with asthma are eligible for the ACBS. Only one adult or one child per household could participate in the ACBS. An adult family member served as a proxy respondent for the child. The ACBS collects in-depth information about asthma symptoms and episodes/attacks, self-management education, healthcare utilization and access, medication use, comorbidities, and environmental allergens and irritants [17]. The ACBS response rate for children and adults varies by state and year. The median ACBS response rates for children (via adult proxies) ranged from 47.6% to 53.7% and for adults ranged from 47.5% to 54.3% during 2006–2010. More information on participating states, weight calculation, and the response rate can be found in the ACBS Summary Data Quality Report for each year at <http://www.cdc.gov/brfss/acbs> [17]. The data include sample weights to adjust for the unequal probability of selection, the disproportionate selection of population subgroups relative to the state's population distribution, and disproportionate non-response.

### Variables

We evaluated asthma severity status among children and adults with current asthma. Consistent with the methodology used with previous CDC publications, respondents were considered to have current asthma if they answered “yes” to both questions “Have you ever been told by a doctor, nurse, or other health professional that you had asthma?” and “Do you still have asthma?” [1,2].

Asthma severity was classified according to the severity classification for clinical research and population-based evaluations that was stated in EPR-3 [4]. Severity was inferred from

the least amount of treatment required to maintain control. This way of defining severity depends on whether a respondent is receiving treatment and how well that treatment achieves a satisfactory level of control. To classify asthma severity, we first classified respondents as well controlled, not well controlled, and very poorly controlled using three impairment measures: daytime symptoms during the past 30 d, nighttime symptoms during the past 30 d, and use of short-acting  $\beta_2$ -agonists (SABA) during the past 3 months for symptom control (not for prevention of exercise-induced bronchospasm) (Table 1). This is a modified version of the 2007 NAEPP guidelines because the ACBS did not include all required measures for current impairment (e.g. pulmonary function measures) and for future risk assessment (e.g. asthma exacerbations, progressive decline in lung function in adults, or reduced lung growth in children). We did not include one of the impairment measures, interference with normal activities, because the reference time for the question was the past 12 months and should only include more recent experiences [18]. Long-term asthma control medications (e.g. inhaled corticosteroids, systemic corticosteroids, long-acting beta<sub>2</sub> agonist, Leukotriene receptor antagonists, methylxanthines, and immunomodulators) are used daily on a long-term basis to achieve and maintain control of persistent asthma [4]. Using asthma control status and long-term control medication status, we classified asthma severity into two categories: intermittent and persistent. Intermittent asthma includes those with current asthma whose asthma is well-controlled without being on long-term control medications. Persistent asthma includes those on long-term control medications, regardless of asthma control status, and those not on long-term control medications whose asthma is not well controlled or is very poorly controlled (Table 2). We did not sub-categorize persistent asthma as mild, moderate, or severe to avoid misclassification because of the absence of detailed information on long-term control medication use in the data.

In addition, for both children and adults, variables for demographic characteristics (age, sex, race/ethnicity), annual household income, age at the time asthma was first diagnosed, time since asthma was diagnosed, and environmental factors (secondhand smoking, pets allowed in bedroom, saw cockroach inside home in past 30 d, and saw or smelled mold in the past 30 d) were included in the analysis. For adults only, body mass index (BMI) (defined as weight in kilograms divided by height in square meters; obese = BMI  $\geq$  30), the presence of chronic obstructive pulmonary disease (COPD), depression, and smoking status were also included in the analysis. Depression variable includes responses to the question: “ever been told by a doctor or other professional that you were depressed?” and the COPD variable includes responses to the questions: “ever been told by a doctor or other professional that you have emphysema,” “ever been told by a doctor or other professional that you have COPD,” or “ever been told by a doctor or other professional that you have chronic bronchitis.”

### Statistical analysis

We used SAS-callable SUDAAN (version 10.0.0, RTI International, NC) to account for the complex sampling design of the BRFSS ACBS. Data from the participating states for each year were reweighted to account for the differences in sample size by year. We used sample weights to produce estimates that were generalizable to a participating state’s population. In addition to calculating descriptive statistics, we used the chi-square test and multivariate logistic regression to test for group differences and association between persistent asthma

status and independent variables of interest. We presented weighted percent estimates, adjusted prevalence ratios (aPR) (predicted marginal risk ratio), and 95% confidence intervals (CI). All prevalence ratios for both children and adults were adjusted (aPR) for sex, age, annual household income, age at first asthma diagnosis, time since asthma diagnosis, and environmental factors. In addition, prevalence ratios for adults were also adjusted for BMI, COPD, and depression. We did not find any multi-collinearity between independent variables since all tolerance estimates were  $> 0.73$ , and only tolerance estimates below 0.40 are a concern [19]. Statistical significance was determined as a  $p$  value  $< 0.05$  by a non-directional  $z$ -test or by non-overlapping 95% CIs. Relative standard error (RSE = standard error/prevalence estimate) was used as a measure of an estimate's reliability (a RSE of  $< 0.30$  indicates a "reliable" estimate) [20].

## Results

### All persons with current asthma

Overall, 63.8% of persons with current asthma had persistent asthma, 36.2% had intermittent asthma, 42.5% were on long-term control medication, and 47.5% had uncontrolled asthma.

### Children with current asthma

**Characteristics**—In the combined 2006 through 2010 BRFSS ACBS sample, 9697 children met the definition of current asthma and were included in this analysis. Of children with current asthma, 60.3% met the definition for persistent asthma and 39.7% for intermittent asthma. Forty-six percent of children with current asthma were on long-term control medications and 38.4% had uncontrolled asthma (either not well controlled or very poorly controlled asthma) (Table 3).

Most of the children with current asthma were non-Hispanic white (57%) and male (57%). By age, 18.3% of children with asthma were aged 0–4 years, 43% were aged 5–11 years and 38% were aged 12–17 years. More than 50% of the children with asthma were in homes with annual household income of \$50 000 or more. More than 65% had their asthma initially diagnosed when they were between ages 0 and 4 years. About 10% had been diagnosed with asthma within the past 12 months, and 41% were diagnosed 1–5 years ago, while 48% were diagnosed more than 5 years ago. The birth weight of most children with asthma was 2500 g or more (not low birth weight). Sixty-six percent had pets, and for 33% of the children, the pet was allowed in the child's bedroom. Between 8% and 10% of the children with asthma were exposed to secondhand smoke (SHS) (9.9%), lived where a cockroach was seen (8.0%), or where mold was seen or smelled inside the home in the past 30 d (9.0%) (Table 4).

### Asthma severity and related risk factors among children with asthma—

Persistent asthma prevalence was significantly higher among children with asthma aged 0–4 years (71.8%; aPR = 1.3[1.1–1.5]) than among those aged 12–17 years (52.9%), and was significantly lower among members of other races (49.0%; aPR = 0.8[0.6–0.9]) than among whites (61.3%). Unadjusted persistent asthma prevalence was also significantly higher

among those who had been diagnosed with asthma at 0–4 years of age (63.9%) than among those who had been diagnosed at 12–17 years of age (47.1%). It was also higher if the time since asthma was first diagnosed was within the past 12 months (73.8%) than if it was diagnosed more than 5 years ago (57.8%); however, after adjustment for other variables in the model, these associations were no longer statistically significant. Regardless of adjustment, no association was observed with sex, household income, birth weight, and all environmental factors (SHS, saw cockroach inside home in past 30 d, or saw or smelled mold in past 30 d) (Table 4).

### Adults with current asthma

**Characteristics**—In the combined 2006 through 2010 BRFSS ACBS sample 52210 adults classified as having current asthma were included in this analysis. Of adults with current asthma, 64.8% met the definition of persistent asthma and 35.2% met the definition of intermittent asthma. About 41% of adults with current asthma were on long-term control medications and 50% had uncontrolled asthma (either not well controlled or very poorly controlled asthma) (Table 3).

The majority of adults with current asthma were non-Hispanic whites (74.6%), and female (63.1%). About 31% of adults with current asthma were aged 18–34 years, 18.5% were aged 35–44 years, 19.6% were aged 45–54 years, 15.9% were aged 55–64, and 15.3% were aged 65+ years. Nearly 45% of adults with asthma had annual household incomes of \$50 000 or more. Forty-five percent had child-onset asthma and 55% had adult-onset asthma. Most of the adults with current asthma were diagnosed more than 5 years ago (85.7%). Thirty-nine percent were obese. About 50.4% were smokers (current or former) or exposed to SHS. One-third had COPD (34.6%) and 34.7% had depression. Sixty percent had pets, and 44% of adults with asthma allowed the pets in their bedroom. About 10% saw a cockroach inside the home in the past 30 d (9.7%) or saw/smelled mold in the past 30 d (11.6%) (Table 5).

**Asthma severity and related risk factors among adults with current asthma**—Persistent asthma prevalence was significantly higher among adults with current asthma who were 45 years or older (45–54: 69.4%; aPR = 1.1[1.1–1.2]; 55–64: 72.6%; aPR = 1.2[1.1–1.2]; 65 + : 77.8%; aPR = 1.3[1.2–1.3]) than among those aged 18–34 years (53.4%). Persistent asthma prevalence was higher among adults with household income less than \$15 000 (74.1%; aPR = 1.1[1.1–1.2]) than among those with income of \$75 000 or more (58.1%). Persistent asthma prevalence was higher for those with older age at first diagnosis. Rates were significantly higher for those with an age at first diagnosed of 55–64 (80.4%; aPR = 1.1[1.1–1.2]) and 65+: 81.5%; aPR = 1.1[1.1–1.2]. In contrast, persistent asthma prevalence for those diagnosed at age 18–24 years was 63.2%. Also significantly associated with higher rates of persistent asthma were having COPD (77.1%; aPR = 1.2[1.1–1.2]) and smokers who were also exposed to SHS (74.7%; aPR = 1.1[1.1–1.2]). The corresponding reference levels were 58.4% and 60.1% respectively. Unadjusted persistent asthma prevalence was significantly higher among females (66.3%) than among males (62.2%) and among adults whose time since asthma diagnosis was within the past 12 months (75.5%) than if initial diagnosis was more than 5 years ago (64.1%). The unadjusted persistent asthma prevalence was higher among the obese (68.4%) than among the non-obese (62.3%)

and it was higher among those who were depressed (70.5%) than among those who were not (62.0%). However, after adjustment for other variables in the model, the associations with sex, time since diagnosis, obesity, and depression were no longer statistically significant. Regardless of adjustment, neither race/ethnicity nor any of the environmental factors (pets allowed in bedroom, saw cockroach inside home in past 30 d, or saw or smelled mold in past 30 d) were associated with persistent asthma status (Table 5).

## Discussion

The purpose of this population-based study was to assess asthma severity and identify related potential risk factors among children and adults with current asthma who participated in the ACBS in the years 2006 through 2010. Similar to the findings of previous studies [13,14], persistent asthma prevalence was high among this study population (63.8%); the rate was 60.3% among children and 64.8% among adults with current asthma. However, the rate was not as high as that reported by Fuhlbrigge et al. 2002 (77.3%) [13] and Colice et al. 2012 (79%) [14]. The difference in the rates reported by those studies could be attributable to differences in study methods and the population characteristics. In addition, our analysis finds that 42.5% of those with current asthma were on long-term control medications (higher for children [46%] than adults [41%]), and 47.5% had uncontrolled asthma (higher for adults [50.0%] than children [38.4%]).

Multiple extraneous factors (e.g. inadequate treatment, non-adherence to treatment regimens, reduced responsiveness to therapy, uncontrolled environmental triggers and irritants, and comorbid conditions) could contribute to these findings [6,9,21–25]. However, many of these factors were either not examined because of a lack of data or else examined but did not show an association. In this study, we were able to identify some of the predictors of persistent asthma. Age was a strong predictor of asthma severity for both children and adults. Persistent asthma was more prevalent among children aged 0–4 years and among adults aged 45 years or older. Children, especially preschoolers, are at greater risk of developing illness because of developing immune system, hand-to-mouth behavior, lower body weight and higher intake rate, resulting in a greater dose of hazardous substance per unit of body weight, and dependence on others to meet basic needs such as housing, medical care and protection from hazardous environmental conditions [26]. These characteristics make children prone to frequent upper respiratory infections (common cold, ear infections, and epiglottitis) and make them susceptible to environmental allergens and irritants that may lead to exacerbation of asthma symptoms [24,26]. Although we did not observe the association, asthma duration (time since diagnosed) is associated with having persistent asthma (lower lung function, greater airway responsiveness, more asthma symptoms, and greater use of quick-relief asthma medications) among children [27,29].

As with previous studies [21,22,25,28,29], our study indicates that factors associated with persistent asthma among adults were being 45 years or older, having a household income of less than \$15 000, older age at first diagnosis (aged 55 years or older), smoking and also exposure to SHS, and having COPD. However, for both children and adults, none of the known environmental risk factors for symptom exacerbations (cockroaches, mold, pets, and SHS [children only]) were significantly associated with persistent asthma [5,6]. Ours is not

an unusual result, since a study of the same population at different time periods or a study of different populations can produce different results [30] and also because of social desirability bias associated with self-report surveys that is over-reporting desirable behaviors (exercise, not smoking) or under-reporting less desirable behaviors (smoking, mold, and cockroaches) [31]. Additional studies can be helpful in identifying additional modifiable predictors of uncontrolled asthma and determining contributing factors for persistent asthma. These efforts can lead to developing targeted interventions, producing strategies that reduce the health risks and economic impact of asthma and improving the health and well-being of people with asthma.

The strength of this study is that we analyzed a large sample size of children and adults with current asthma and assessed asthma severity status and symptom control in states that participated in the ACBS; the ACBS is the only survey providing most of the indicators that allow classification of asthma severity and asthma control by use of the NAEPP guidelines (EPR-3) and can be used to evaluate population-based asthma severity and symptom control.

There are also limitations to our study. One limitation is that the indicators available in the ACBS which can be used to classify asthma control and severity circumscribed our findings. Because of the content of the ACBS questionnaire, we were unable to include all of the required elements in the NAEPP guidelines (e.g. activity limitation, pulmonary function measures, asthma exacerbations that require oral corticosteroid and lung growth status in children) [4]. This limitation may lead to underestimation of persistence asthma prevalence. However, the definition of asthma control and severity in this analysis is consistent with the definition in other reports of population-based estimates [9,13,14]. Another limitation is that the ACBS response rates for the participating states were around 50%. Low response rates may affect the results by introducing non-response bias, if survey respondents differed from non-responders on the characteristics studied. However, the BRFSS sampling procedures and varying response rates among states over the 5-year study period can minimize non-response effects on the results [20,30]. In addition, because of the cross-sectional nature of the survey data, we could not generally determine the temporal sequence or causality. Finally, the findings cannot be generalized to the people with current asthma in states that did not participate in the ACBS.

## Conclusion

Our findings indicate that nearly two-third of children and adults with current asthma had persistent asthma. Moreover, despite national guidelines for asthma control and available advanced medical treatments, 38% of children and 50% of adults had uncontrolled asthma. Age (being aged 0–4 or 45 years or older), having a household income of less than \$15 000, the age at which asthma is initially diagnosed (if aged 55 years or older), smoking and exposure to SHS, and COPD were significantly associated with having persistent asthma. There is a need for further studies to identify additional modifiable contributing factors for persistent asthma, because asthma severity determines the level of asthma control and responsiveness to therapy. Such additional studies can lead to development of targeted interventions or strategies that will reduce modifiable predictors of increased asthma severity and poor asthma control and, in turn, improve asthma care and quality of life.



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**Table 1**

Classification of asthma control modified from the National Asthma Education and Prevention Program Expert Panel Report 3 guidelines.

| Measures for current impairment                          | Well controlled   | Not well controlled   | Very poorly controlled  |
|--|---|---|---|
| Symptoms   | 2 d/week  | >2 d/week   | Throughout the day  |
| Nighttime awakenings                                     | 1×/month (aged 0–4 yrs)<br>1×/month (aged 5–11 yrs)<br>2×/month (aged 12 yrs) | >1×/month (aged 0–4 yrs)<br>2×/month (aged 5–11 yrs)<br>1–3×/week (aged 12 yrs) | >1×/week (aged 0–4 yrs)<br>2×/week (aged 5–11 yrs)<br>4×/week (aged 12 yrs) |
| Short-acting $\beta$ 2-agonists used for symptom control | 2 d/week  | >2 d/week   | Several times/day   |

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**Table 2**

Classification of asthma severity for research and population-based estimates from the National Asthma Education and Prevention Program Expert Panel Report 3 guidelines.

| Asthma severity status | Long-term control medication use | Asthma control status  |
|------------------------|----------------------------------|--|
| Intermittent asthma    | No                               | <ul style="list-style-type: none"> <li>Well controlled</li> </ul>  |
| Persistent asthma      | Yes                              | <ul style="list-style-type: none"> <li>Well controlled,</li> <li>Not well controlled, or</li> <li>Very poorly controlled asthma</li> </ul> |
|                        | No                               | <ul style="list-style-type: none"> <li>Not well controlled or</li> <li>Very poorly controlled asthma</li> </ul>                            |

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**Table 3**

Asthma severity, long-term control medication, and uncontrolled asthma status among children and adults with current asthma<sup>a</sup>: Behavioral Risk Factor Surveillance System Asthma Call-back Survey, 2006–2010.

|  | <b>All persons with asthma</b> | <b>Children with asthma (aged 0–17 years) (n=9697)</b> |                               | <b>Adults with asthma (aged 18 years or older) (n=52 210)</b> |                               |
|--|--------------------------------|--|-------------------------------|---|-------------------------------|
|  | <b>% (95% CI<sup>b</sup>)</b>  | <b>Sample size<sup>c</sup></b>                         | <b>% (95% CI<sup>b</sup>)</b> | <b>Sample size<sup>c</sup></b>                                | <b>% (95% CI<sup>b</sup>)</b> |
| Asthma severity status   |                                |  |                               |   |                               |
| Intermittent Asthma  | 36.2 (35.2–37.1)               | 4013   | 39.7 (37.4–41.9)              | 15 680  | 35.2 (34.1–36.2)              |
| Persistent Asthma  | 63.8 (62.9–64.8)               | 5684   | 60.3 (58.1–62.6)              | 36 530  | 64.8 (63.8–65.9)              |
| Long-term control medication                                     | 42.5 (41.6–43.4)               | 4332   | 46.0 (43.7–48.3)              | 24 786  | 41.5 (40.5–42.5)              |
| Uncontrolled asthma (Not well- or very poorly controlled asthma) | 47.5 (46.6–48.5)               | 3518   | 38.4 (36.2–40.8)              | 27 832  | 50.0 (49.0–51.1)              |

Data source: CDC/BRFSS. Behavioral Risk Factor Surveillance System: Child and Adult Asthma Call-Back Survey, 2006–2010.

<sup>a</sup> Includes persons who answered “yes” to the questions: “Have you ever been told by a doctor, nurse, or other health professional that you had asthma?” and “Do you still have asthma?”

<sup>b</sup> Weighted and unadjusted percentage and 95% confidence interval.

<sup>c</sup> Unweighted pooled sample size, 2006–2010. Due to item non-response, individual characteristic categories may not sum to total.

**Table 4**

Asthma severity status among children (aged 0–17 years) with current asthma<sup>a</sup>: Behavioral Risk Factor Surveillance System Asthma Call-back Survey, 2006–2010.

| Characteristics                        | Survey respondents<br>(children with current asthma) |                         | Persistent asthma prevalence<br>(n=5684) | Adjusted prevalence<br>rate ratio |
|--|--|-------------------------|--|-----------------------------------|
|  | Sample size <sup>b</sup>                             | % (95% CI) <sup>c</sup> | % (95% CI) <sup>c</sup>                  | aPR                               |
| Total                                  | 9697   |                         | 60.3 (58.1–62.6)                         |                                   |
| Sex                                    |  |                         | <i>p</i> =0.3628                         |                                   |
| Male                                   | 5536   | 57.0 (54.7–59.3)        | 61.2 (58.2–64.1)                         | Referent                          |
| Female                                 | 4126   | 43.0 (40.7–45.4)        | 59.0 (55.5–62.5)                         | 1.0 (0.9–1.1)                     |
| Age, year range                        |  |                         | <i>p</i> <0.0001                         |                                   |
| 0–4                                    | 1213   | 18.3 (16.4–20.4)        | 71.8 (66.3–76.8)                         | 1.3 (1.1–1.5)                     |
| 5–11                                   | 3746   | 43.5 (41.2–45.9)        | 62.1 (58.6–65.4)                         | 1.1 (1.0–1.3)                     |
| 12–17                                  | 4738   | 38.2 (36.0–40.4)        | 52.9 (49.4–56.3)                         | Referent                          |
| Race/ethnicity <sup>d</sup>            |  |                         | <i>p</i> =0.0515                         |                                   |
| White                                  | 6472   | 57.2 (54.7–59.6)        | 61.3 (58.7–63.8)                         | Referent                          |
| Black                                  | 991  | 15.9 (14.2–17.9)        | 62.4 (56.1–68.3)                         | 1.0 (0.9–1.1)                     |
| Hispanic                               | 971  | 16.9 (15.0–19.1)        | 63.2 (56.3–69.5)                         | 1.0 (0.9–1.1)                     |
| Other race                             | 904  | 10.0 (8.5–11.6)         | 49.0 (40.9–57.1)                         | 0.8 (0.6–0.9)                     |
| Household income                       |  |                         | <i>p</i> =0.6349                         |                                   |
| <\$15 000                              | 811  | 11.7 (9.9–13.9)         | 65.2 (56.9–72.7)                         | 1.1 (0.9–1.2)                     |
| \$15 000–\$24 999                      | 1223   | 14.5 (12.9–16.3)        | 56.7 (50.0–63.2)                         | 0.9 (0.8–1.1)                     |
| \$25 000–\$49 999                      | 2103   | 21.0 (19.3–22.9)        | 60.4 (55.6–64.9)                         | 1.0 (0.9–1.1)                     |
| \$50 000–\$74 999                      | 1684   | 16.6 (14.9–18.5)        | 59.7 (54.0–65.2)                         | 1.0 (0.9–1.1)                     |
| \$75 000                               | 3351   | 36.1 (34.0–38.3)        | 60.9 (57.3–64.3)                         | Referent                          |
| Age at asthma diagnosis                |  |                         | <i>p</i> <0.0001                         |                                   |
| 0–4                                    | 5633   | 65.8 (63.7–67.9)        | 63.9 (61.1–66.6)                         | 1.2 (1.0–1.5)                     |
| 5–11                                   | 3120   | 28.5 (26.5–30.5)        | 54.7 (50.6–58.7)                         | 1.2 (0.9–1.4)                     |
| 12–17                                  | 751  | 5.7 (4.8–6.7)           | 47.1 (38.5–55.8)                         | Referent                          |
| Time since asthma diagnosis            |  |                         | <i>p</i> <0.001                          |                                   |
| Within the past 12 months              | 810  | 9.9 (8.6–11.4)          | 73.8 (66.5–80.0)                         | 1.2 (1.0–1.4)                     |
| 1–5 years ago                          | 3698   | 41.5 (39.2–43.8)        | 60.2 (56.5–63.7)                         | 1.0 (0.9–1.1)                     |
| More than 5 years ago                  | 5156   | 48.6 (46.3–51.0)        | 57.8 (54.7–61.0)                         | Referent                          |
| Birth weight                           |  |                         | <i>p</i> =0.3099                         |                                   |
| Low birth weight (less than 2500 g)    | 1059   | 14.0 (12.5–15.7)        | 57.4 (51.1–63.5)                         | 0.9 (0.8–1.0)                     |
| Not low birth weight                   | 8070   | 86.0 (84.3–87.5)        | 60.9 (58.4–63.3)                         | Referent                          |
| Secondhand Smoke exposure <sup>e</sup> |  |                         | <i>p</i> =0.6409                         |                                   |
| Yes                                    | 877  | 9.9 (8.3–11.8)          | 58.5 (49.8–66.8)                         | 1.0 (0.9–1.1)                     |
| No                                     | 8796   | 90.1 (88.2–91.7)        | 60.6 (58.3–62.9)                         | Referent                          |
| Pets allowed in bedroom                |  |                         | <i>p</i> =0.0228                         |                                   |
| Pets allowed                           | 3754   | 33.3 (31.2–35.5)        | 56.1 (52.4–59.8)                         | 0.9 (0.9–1.0)                     |
| Pets NOT allowed                       | 2226   | 22.7 (20.9–24.7)        | 63.3 (58.4–67.9)                         | 1.1 (1.0–1.2)                     |

| Characteristics                     | Survey respondents<br>(children with current asthma) |                         | Persistent asthma prevalence<br>( <i>n</i> =5684) | Adjusted prevalence<br>rate ratio |
|-------------------------------------|--|-------------------------|---|-----------------------------------|
|                                     | Sample size <sup>b</sup>                             | % (95% CI) <sup>c</sup> | % (95% CI) <sup>c</sup>                           | aPR                               |
| No pets                             | 3710   | 44.0 (41.7–46.3)        | 62.0 (58.5–65.4)                                  | Referent                          |
| Saw cockroach inside home past 30 d |  |                         | <i>p</i> =0.5452                                  |                                   |
| Yes                                 | 721  | 8.0 (6.9–9.3)           | 62.8 (54.6–70.3)                                  | 1.0 (0.9–1.2)                     |
| No                                  | 8945   | 92.0 (90.7–93.1)        | 60.3 (57.9–62.6)                                  | Referent                          |
| Saw or smelled mold past 30 d       |  |                         | <i>p</i> =0.0293                                  |                                   |
| Yes                                 | 929  | 9.1 (7.8–10.6)          | 68.0 (61.2–74.2)                                  | 1.1 (1.0–1.3)                     |
| No                                  | 8720   | 90.9 (89.4–92.2)        | 59.7 (57.3–62.1)                                  | Referent                          |

Data source: CDC/BRFSS. Behavioral Risk Factor Surveillance System: Child Asthma Call-Back Survey, 2006–2010.

<sup>a</sup>Includes persons who answered “yes” to the questions: “Have you ever been told by a doctor, nurse, or other health professional that you had asthma?” and “Do you still have asthma?”

<sup>b</sup>Unweighted pooled sample size, 2006–2010. Due to item non-response, individual characteristic categories may not sum to total.

<sup>c</sup>Weighted and unadjusted percentage and 95% confidence interval.

<sup>d</sup>Race categories “white, non-Hispanic”, “black, non-Hispanic”, include persons who indicated only a single race group. “Other races, non-Hispanic” includes Asian, American Indian Alaskan Native, Native Hawaiian and Other Pacific Islander, persons reporting more than one race, and persons reporting their race as something other than those listed here.

<sup>e</sup>Second-hand smoke exposure (SHS) status: includes children whose caregivers answered “yes” to the questions: “In the past week, has anyone smoked inside [his/her] home?”

**Table 5**

Asthma severity status among adults (aged 18 years or older) with current asthma<sup>a</sup>: Behavioral Risk Factor Surveillance System Asthma Call-back Survey, 2006–2010.

| Characteristics             | Survey respondents<br>(adults with current asthma) |                                       | Persistent asthma<br>prevalence (n=36 530) | Adjusted prevalence<br>rate ratio |
|-----------------------------|--|---------------------------------------|--|-----------------------------------|
|                             | Sample size <sup>b</sup>                           | % <sup>c</sup> (95% CI <sup>c</sup> ) | % <sup>c</sup> (95% CI <sup>c</sup> )      | aPR                               |
| Total                       | 52 210   |                                       | 64.8 (63.8–65.9)                           |                                   |
| Sex                         |  |                                       | <i>p</i> <0.001                            |                                   |
| Male                        | 13 760   | 36.9 (35.9–38.0)                      | 62.2 (60.2–64.3)                           | Referent                          |
| Female                      | 38 450   | 63.1 (62.0–64.1)                      | 66.3 (65.2–67.5)                           | 1.0 (1.0–1.1)                     |
| Age, year range             |  |                                       | <i>p</i> <0.0001                           |                                   |
| 18–34                       | 5617   | 30.7 (29.5–31.9)                      | 53.4 (50.8–56.0)                           | Referent                          |
| 35–44                       | 6821   | 18.5 (17.8–19.3)                      | 61.4 (59.1–63.7)                           | 1.1 (1.0–1.1)                     |
| 45–54                       | 11 416   | 19.6 (18.9–20.3)                      | 69.4 (67.8–71.0)                           | 1.1 (1.1–1.2)                     |
| 55–64                       | 13 509   | 15.9 (15.4–16.5)                      | 72.6 (71.1–74.1)                           | 1.2 (1.1–1.2)                     |
| 65+                         | 14 643   | 15.3 (14.8–15.8)                      | 77.8 (76.5–79.1)                           | 1.3 (1.2–1.3)                     |
| Race/ethnicity <sup>d</sup> |  |                                       | <i>p</i> =0.2426                           |                                   |
| White                       | 42 517   | 74.6 (73.6–75.6)                      | 65.5 (64.3–66.6)                           | Referent                          |
| Black                       | 3236   | 9.7 (9.0–10.3)                        | 63.8 (60.1–67.4)                           | 1.0 (0.9–1.1)                     |
| Hispanic                    | 2342   | 9.0 (8.3–9.7)                         | 61.6 (57.2–65.8)                           | 1.0 (0.9–1.0)                     |
| Other race                  | 3656   | 6.7 (6.2–7.4)                         | 62.8 (57.8–67.5)                           | 1.0 (0.9–1.0)                     |
| Household income            |  |                                       | <i>p</i> <0.0001                           |                                   |
| <\$15 000                   | 8146   | 14.7 (14.0–15.5)                      | 74.1 (71.5–76.5)                           | 1.1 (1.1–1.2)                     |
| \$15 000–\$24 999           | 8967   | 16.7 (15.8–17.5)                      | 69.5 (66.6–72.3)                           | 1.1 (1.0–1.1)                     |
| \$25 000–\$49 999           | 12 351   | 23.8 (23.0–24.7)                      | 65.7 (63.7–67.7)                           | 1.0 (1.0–1.1)                     |
| \$50 000–\$74 999           | 7143   | 15.1 (14.4–15.8)                      | 63.0 (60.4–65.6)                           | 1.0 (1.0–1.1)                     |
| \$75 000                    | 10 428   | 29.7 (28.7–30.7)                      | 58.1 (55.9–60.2)                           | Referent                          |
| Age at asthma diagnosis     |  |                                       | <i>p</i> <0.0001                           | Not included                      |
| Child-onset asthma          | 15 033   | 44.9 (43.8–46.0)                      | 57.5 (55.6–59.3)                           | –                                 |
| Adult-onset asthma          | 34 303   | 55.1 (54.0–56.2)                      | 71.4 (70.2–72.5)                           | –                                 |
| Age at asthma diagnosis     |  |                                       | <i>p</i> <0.0001                           |                                   |
| 0–4                         | 4262   | 12.4 (11.7–13.2)                      | 63.8 (60.5–67.0)                           | 1.1 (1.0–1.1)                     |
| 5–11                        | 6347   | 18.8 (17.9–19.8)                      | 55.8 (52.9–58.7)                           | 0.9 (0.9–1.0)                     |
| 12–17                       | 4424   | 13.6 (12.8–14.5)                      | 54.0 (50.5–57.4)                           | 0.9 (0.9–1.0)                     |
| 18–24                       | 4329   | 10.4 (9.8–11.1)                       | 63.2 (59.9–66.3)                           | Referent                          |
| 25–34                       | 6915   | 13.5 (12.8–14.2)                      | 66.1 (63.2–68.9)                           | 1.0 (1.0–1.1)                     |
| 35–44                       | 7817   | 12.7 (12.1–13.3)                      | 72.9 (70.5–75.2)                           | 1.1 (1.0–1.2)                     |
| 45–54                       | 7109   | 9.2 (8.8–9.7)                         | 76.6 (74.6–78.5)                           | 1.1 (1.0–1.2)                     |
| 55–64                       | 4849   | 5.6 (5.3–6.0)                         | 80.4 (78.0–82.6)                           | 1.1 (1.1–1.2)                     |
| 65+                         | 3284   | 3.7 (3.4–3.9)                         | 81.5 (78.8–83.9)                           | 1.1 (1.1–1.2)                     |
| Time since asthma diagnosis |  |                                       | <i>p</i> <0.0001                           |                                   |
| Within the past 12 months   | 1471   | 3.0 (2.7–3.4)                         | 75.5 (69.9–80.4)                           | 1.1 (1.0–1.2)                     |



| Characteristics                     | Survey respondents<br>(adults with current asthma) |                                       | Persistent asthma<br>prevalence (n=36 530) | Adjusted prevalence<br>rate ratio |
|-------------------------------------|--|---------------------------------------|--|-----------------------------------|
|                                     | Sample size <sup>b</sup>                           | % <sup>c</sup> (95% CI <sup>c</sup> ) | % <sup>c</sup> (95% CI <sup>c</sup> )      | aPR                               |
| 1–5 years ago                       | 6088   | 11.3 (10.6–12.0)                      | 68.0 (64.4–71.3)                           | 1.0 (0.9–1.1)                     |
| More than 5 years ago               | 44 466   | 85.7 (84.9–86.4)                      | 64.1 (63.0–65.2)                           | Referent                          |
| Body Mass Index (BMI)               |  |                                       | <i>p</i> <0.0001                           |                                   |
| Obese                               | 20 714   | 39.4 (38.4–40.4)                      | 68.4 (66.7–70.1)                           | 1.1 (1.0–1.1)                     |
| Non-obese                           | 29 539   | 60.6 (59.6–61.6)                      | 62.3 (61.0–63.7)                           | Referent                          |
| Smoking status and SHS <sup>e</sup> |  |                                       | <i>p</i> <0.0001                           |                                   |
| Current smoker & SHS                | 6353   | 11.9 (11.2–12.6)                      | 74.7 (71.7–77.6)                           | 1.1 (1.1–1.2)                     |
| Current smoker & No SHS             | 3138   | 7.6 (7.1–8.2)                         | 65.2 (61.5–68.8)                           | 1.0 (1.0–1.1)                     |
| Former smoker & SHS                 | 1341   | 2.6 (2.3–2.9)                         | 74.2 (68.6–79.2)                           | 1.1 (1.0–1.2)                     |
| Former smoker & No SHS              | 16 247   | 24.6 (23.8–25.4)                      | 69.3 (67.3–71.2)                           | 1.0 (1.0–1.1)                     |
| Non-smoker & SHS                    | 1143   | 3.8 (3.3–4.3)                         | 61.3 (53.9–68.3)                           | 1.0 (0.9–1.1)                     |
| Non-smoker & No SHS                 | 23 667   | 49.6 (48.6–50.7)                      | 60.1 (58.6–61.6)                           | Referent                          |
| COPD <sup>f</sup>                   |  |                                       | <i>p</i> <0.0001                           |                                   |
| Yes                                 | 21 539   | 34.6 (33.7–35.5)                      | 77.1 (75.6–78.6)                           | 1.2 (1.1–1.2)                     |
| No                                  | 30 480   | 65.4 (64.5–66.4)                      | 58.4 (57.1–59.7)                           | Referent                          |
| Depression                          |  |                                       | <i>p</i> <0.0001                           |                                   |
| Yes                                 | 19 734   | 34.7 (33.7–35.6)                      | 70.5 (68.9–72.1)                           | 1.1 (1.0–1.1)                     |
| No                                  | 32 133   | 65.3 (64.4–66.3)                      | 62.0 (60.6–63.3)                           | Referent                          |
| Pets allowed in bedroom             |  |                                       | <i>p</i> =0.2233                           |                                   |
| Pets allowed                        | 22 711   | 44.3 (43.3–45.3)                      | 65.6 (64.1–67.1)                           | 1.1 (1.0–1.1)                     |
| Pets NOT allowed                    | 6950   | 15.2 (14.4–16.0)                      | 65.5 (62.6–68.4)                           | 1.0 (1.0–1.1)                     |
| No pets                             | 22 542   | 40.5 (39.5–41.5)                      | 63.7 (62.1–65.3)                           | Referent                          |
| Saw cockroach inside home past 30 d |  |                                       | <i>p</i> =0.4950                           |                                   |
| Yes                                 | 4098   | 9.7 (9.1–10.3)                        | 66.0 (62.5–69.4)                           | 1.0 (0.9–1.1)                     |
| No                                  | 47 972   | 90.3 (89.7–90.9)                      | 64.8 (63.7–65.8)                           | Referent                          |
| Saw or smelled mold past 30 d       |  |                                       | <i>p</i> <0.01                             |                                   |
| Yes                                 | 6017   | 11.6 (11.0–12.2)                      | 69.1 (66.2–71.8)                           | 1.1 (1.0–1.1)                     |
| No                                  | 45 844   | 88.4 (87.8–89.0)                      | 64.3 (63.2–65.4)                           | Referent                          |

Data source: CDC/BRFSS. Behavioral Risk Factor Surveillance System: Child Asthma Call-Back Survey, 2006–2010.

<sup>a</sup>Includes persons who answered “yes” to the questions: “Have you ever been told by a doctor, nurse, or other health professional that you had asthma?” and “Do you still have asthma?”

<sup>b</sup>Unweighted pooled sample size, 2006–2010. Due to item non-response, individual characteristic categories may not sum to total.

<sup>c</sup>Weighted and unadjusted percent and 95% confidence interval.

<sup>d</sup>Race categories “white, non-Hispanic”, “black, non-Hispanic”, include persons who indicated only a single race group. “Other races, non-Hispanic” includes Asian, American Indian Alaskan Native, Native Hawaiian and Other Pacific Islander, persons reporting more than one race, and persons reporting their race as something other than those listed here.

<sup>e</sup>Includes adults who smoke and answered “yes” to the questions: “In the past week, has anyone smoked inside your home [secondhand smoke exposure (SHS)]?”.

<sup>f</sup>Includes adults with emphysema or chronic bronchitis.