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EPIDEMIOLOGY

## Asthma Incidence among Children and Adults: Findings from the Behavioral Risk Factor Surveillance System Asthma Call-back Survey—United States, 2006–2008

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**Background.** Asthma, a chronic respiratory condition affecting 8.2% of the US population (2009), causes significant societal and economic burden, resulting in missed school/work days, activity limitations, and increased healthcare utilization. Annual asthma prevalence estimates are available from national surveys, but these surveys have not routinely collected asthma incidence data that are important for identifying risk factors and trends in rates of disease onset. The Asthma Call-back Survey (ACBS), implemented in 2006, provides detailed asthma data that supplement Behavioral Risk Factor Surveillance System (BRFSS) data. We analyzed BRFSS and ACBS data to estimate annual asthma incidence and to determine whether these rates differed by age group, sex, and race/ethnicity. **Methods.** BRFSS and ACBS data from the participating states during 2006–2008 (24 states and District of Columbia [DC] in 2006; 34 states and DC in 2007 and 2008) were analyzed to calculate 12-month incidence rates. Incident cases of asthma were defined as people diagnosed with asthma by a healthcare provider within 12 months prior to survey participation. **Results.** Estimated asthma incidence among at-risk adults was 3.8/1000, whereas that among at-risk children was 12.5/1000. Incidence among children aged 0–4 years was 23.4/1000, more than five times greater than that among youth aged 12–17 years (4.4/1000). Adult females had 1.8 times greater asthma incidence than adult males (4.9/1000 vs. 2.8/1000, respectively). Incidence among non-Hispanic (NH) White adults was 3.9/1000, among NH non-White adults was 3.2/1000, and among Hispanic adults was 4.0/1000. **Conclusions.** This is the first successful application of the BRFSS–ACBS during 2006–2008 to estimate asthma incidence rates from participating states and DC. As with known patterns in asthma prevalence, we found that asthma incidence was higher in children than adults, higher in younger children than older children and adolescents, and higher in adult females than adult males. However, we were unable to identify statistically significant differences in asthma incidence among most race/ethnic groups. As additional data on asthma incidence become available from the ACBS, these rates, coupled with ACBS data on symptoms, asthma self-management practices, and healthcare utilization, may help asthma control programs identify risk factors for disease development and target asthma prevention and control measures to populations most affected.

**Keywords** asthma, Asthma Call-back Survey, Behavioral Risk Factor Surveillance System, epidemiology, incidence, surveillance

### BACKGROUND

Asthma, a chronic inflammatory respiratory condition characterized by hyperresponsive airways and reversible airflow obstruction, is a substantial public health problem (1). Over the past 30 years, patterns in asthma epidemiology have shown that prevalence of current asthma is higher in children compared with adults, higher in adult females compared with adult males, higher in Blacks compared with Whites, and higher in Hispanics of Puerto Rican ancestry compared with those of Mexican ancestry (2). However, disease etiology and causes of these sex and race/ethnicity differences have not been fully elucidated. In the United States in 2009, approximately 8.2% of the population had current asthma (7.1 million children and 17.5 million adults) (3). In 2007, asthma was the primary diagnosis for 1.8 million emergency department visits (3), 456,000 inpatient hospitalizations (4), and 3447

deaths (5). The direct and indirect costs of asthma to society in 2007 were estimated to be 56 billion dollars (6).

In addition to the high burden of disease, including healthcare utilization and economic impact, it is concerning that asthma prevalence is increasing. From 1980 to 1996, data from the National Health Interview Survey (NHIS) indicated that the average, annual, self-reported, 12-month period asthma prevalence in the United States increased from 3.1% to 5.6% (2). Due to changes in the survey questionnaire, there was no comparable measure of asthma prevalence between 1997 and 2000. Current asthma prevalence, a similar but not identical measure to 12-month period prevalence, increased from 7.3% in 2001 to 8.2% in 2009 (7). This prevalence increase illustrates rising national disease burden over the past three decades. However, these percentages reflect a combination of the number of new cases and the duration of the disease. Incidence rates, which include only the number of new cases during a specified time period, may not follow the same trends as prevalence.

Much of what we know about asthma epidemiology comes from analyses of asthma prevalence from national surveys. However, asthma incidence estimates, not just prevalence estimates, are important to quantify disease

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onset rates. Moreover, incidence estimates could reveal whether the number of new asthma cases is increasing and help elucidate asthma risk factors and etiologies. Past attempts to produce asthma incidence estimates have been performed using national samples, such as the National Health and Nutrition Examination Survey (NHANES) and the NHIS. However, these surveys currently do not include questions to estimate asthma incidence, whereas the Behavioral Risk Factor Surveillance System (BRFSS) Asthma Call-back Survey (ACBS) does (8–10). The purpose of this study was to use BRFSS and ACBS data to estimate the average 12-month incidence of asthma during 2006–2008 among children and adults from participating states. Although differences in asthma prevalence among demographic groups are well-documented, we sought to determine whether asthma incidence rates differed by age group, sex, and race/ethnicity, and whether patterns in asthma incidence among demographic groups paralleled the well-known patterns in asthma prevalence.

## METHODS

### *Survey Data Description*

BRFSS and ACBS data from the participating states during 2006–2008 were used to estimate asthma incidence rates (8–10). The BRFSS is a state-based, cross-sectional, continuous, random-digit-dialed telephone survey of the adult (aged 18 years and older), civilian, noninstitutionalized population conducted in all 50 states, District of Columbia (DC), Puerto Rico, the US Virgin Islands, and Guam (8, 9). One randomly selected adult per residential household is selected to participate (11). Through an optional Random Child Selection Module (RCSM), the BRFSS allows an adult respondent to serve as a proxy for one randomly selected child (aged 17 and younger) per household (10). The BRFSS survey has two questions to measure asthma prevalence. “Lifetime asthma” is defined as an affirmative response to the question, “Have you ever been told by a doctor, nurse, or other health professional that you have asthma?” “Current asthma” is defined as an affirmative response to that question, followed by an affirmative response to the subsequent question, “Do you still have asthma?” An adult respondent who answers affirmatively to the first question about lifetime asthma is asked to participate in the follow-up telephone ACBS, which is administered within 2 weeks of the BRFSS telephone interview. If a state includes the RCSM in the BRFSS and the randomly selected child has ever been diagnosed with asthma, then the child is eligible for the ACBS. If both the selected child and the BRFSS adult in a household have asthma, then one or the other is eligible for the ACBS. The BRFSS survey was administered among adults in all 50 states, DC, and three territories, but the child random selection and child asthma prevalence modules were not.

The ACBS is a continuous survey that provides annual data files with detailed information about people with asthma, including demographics, symptoms, asthma

self-management practices, healthcare utilization, and associated costs. The ACBS was implemented in 24 states and DC in 2006, and in 34 states and DC in 2007 and 2008; however, not all states included both adults and children each year (Figure 1). For adults, the total sample size each year is the number of adult BRFSS survey respondents in the areas participating in the ACBS. For children, the total sample size each year is the number of adult BRFSS survey respondents in states that participated in the RCSM and the ACBS. Response rates for BRFSS and ACBS are calculated using Council of American Survey and Research Organizations guidelines. The median BRFSS response rate among the 24 states and DC participating in the 2006 ACBS was 48.6% (range, 36.9–66.0%), among the 34 states and DC participating in the 2007 ACBS was 47.6% (range, 31.4–65.4%), and among the 34 states and DC participating in the 2008 ACBS was 50.3% (range, 35.8–65.5%). The median ACBS response rate for adults was 53.1% in 2006, 54.3% in 2007, and 50.6% in 2008; the median ACBS response rate for children (via adult proxies) was 51.4% in 2006, 51.5% in 2007, and 49.1% in 2008 (12).

### *Measures of Incidence*

“Incidence rate” is defined as the number of newly diagnosed cases of a disease within a specified time period in an at-risk population (13). The ACBS includes two questions directed at onset of asthma: “How old were you when you were first told by a doctor or other health professional that you had asthma?” followed by “How long ago was that? Was it (1) within the past 12 months; (2) 1–5 years ago; (3) more than 5 years ago.” For this analysis, respondents with incident asthma were defined as those who answered “yes” to the BRFSS “lifetime asthma” question and whose response to the ACBS question, “How long ago was that?” was “Within the past 12 months.” People who responded, “Within the past 12 months” were assigned year of asthma onset to the calendar year of the BRFSS phone call.

BRFSS respondents were classified as “never having asthma” if they answered “no” to the BRFSS lifetime asthma question. BRFSS respondents with missing or incomplete data on asthma status were excluded. For incidence calculations, ACBS respondents with missing data about asthma onset were excluded.

For this analysis, we calculated the number of incident cases as population estimates (weighted counts) of those diagnosed with asthma within the past 12 months of each survey year during 2006–2008 (estimated from 2006 to 2008 ACBS data). We defined the at-risk population as the weighted estimate of those who never had a diagnosis of asthma (estimated by using 2006–2008 BRFSS data) plus the number of incident cases (defined above). We then calculated the average 12-month incidence rate during 2006–2008 using the number of incident cases as the numerator and the at-risk population as the denominator (Figure 2) (13).

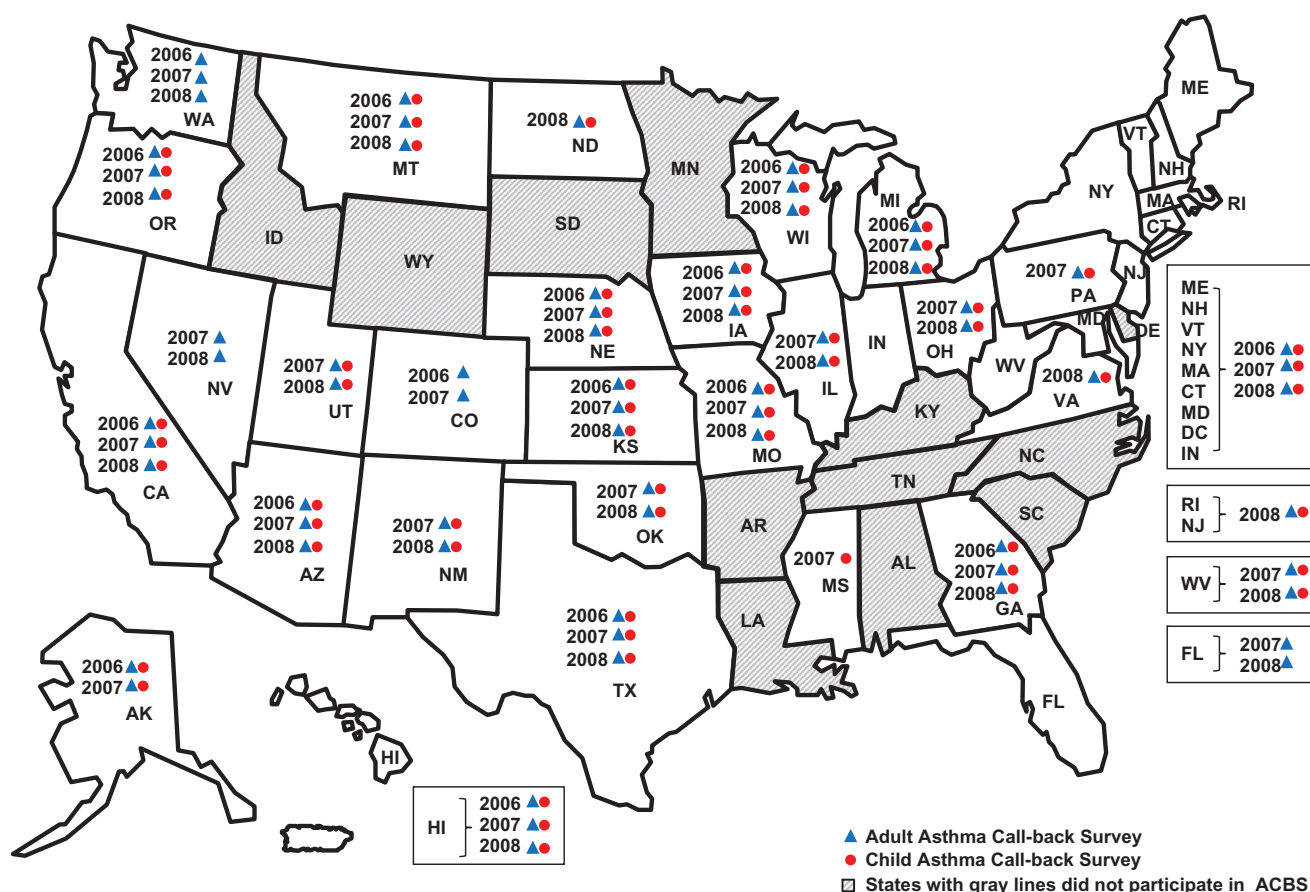


FIGURE 1.—States participating in Adult and Child Asthma Call-back Survey (ACBS), 2006–2008.

### Statistical Analyses

Data were weighted to account for nonresponse differences in the sample and unequal probability of sample selection. Data for states that participated in the ACBS during multiple years were reweighted as original weights divided by number of data years (14). BRFSS weighted totals represent the state population. ACBS-weighted total estimates represent the state population with lifetime asthma. SUDAAN version 10.0.1 (Research Triangle Park, NC, USA) analysis software was used to adjust standard error (SE) calculations for the complex survey design.

Average 12-month incidence rates during 2006–2008 were calculated separately for children (age groups 0–4, 5–11, and 12–17 years) and adults (age groups 18–34, 35–44, 45–54, 55–64, and 65 years and older). Separate rates for adults and children were also stratified by sex (male and female), race/ethnicity (non-Hispanic [NH], White; NH, non-White; and Hispanic), and year (2006, 2007, and 2008). Race/ethnicity was grouped this way because small numerator sample sizes prevented more detailed categorization. Rates were calculated for at-risk populations per 1000 adults or children in each demographic group, and 95% confidence intervals were calculated for all incidence rates. Statistical significance was determined using a two-tailed  $z$ -test with  $p < .05$ .

SE and relative SE (the SE divided by the estimate) were calculated for each incidence rate (11). We

calculated SE for incidence rates by using the formula for “variance of ratios” assuming zero covariance. Relative SE estimates were used as a measure of an estimate’s reliability. No estimates had a relative SE greater than 30%.

### RESULTS

#### *Asthma Incidence for Adults and Children*

We found that the asthma incidence rate among at-risk adults participating in the ACBS was 3.8/1000 during 2006–2008. When stratified by year, asthma incidence rates among at-risk adults were 4.0/1000, 3.9/1000, and 3.6/1000 in 2006, 2007, and 2008, respectively (Table 1), which represent weighted population estimates of 429,208 adult incident cases in 2006; 607,928 in 2007; and 567,287 in 2008 in ACBS participating states and DC. We would caution that incidence estimates should not be compared year to year because different states and different numbers of states participated in the adult ACBS in 2006, 2007, and 2008. The asthma incidence rate among at-risk children in areas participating in the ACBS was 12.5/1000 during 2006–2008. When stratified by year, asthma incidence rates among at-risk children were 13.6/1000, 9.9/1000, and 14.0/1000 in 2006, 2007, and 2008, respectively (Table 2), which represent weighted population estimates of 435,847 child incident cases in 2006; 440,575 child incident cases in 2007; and 623,291



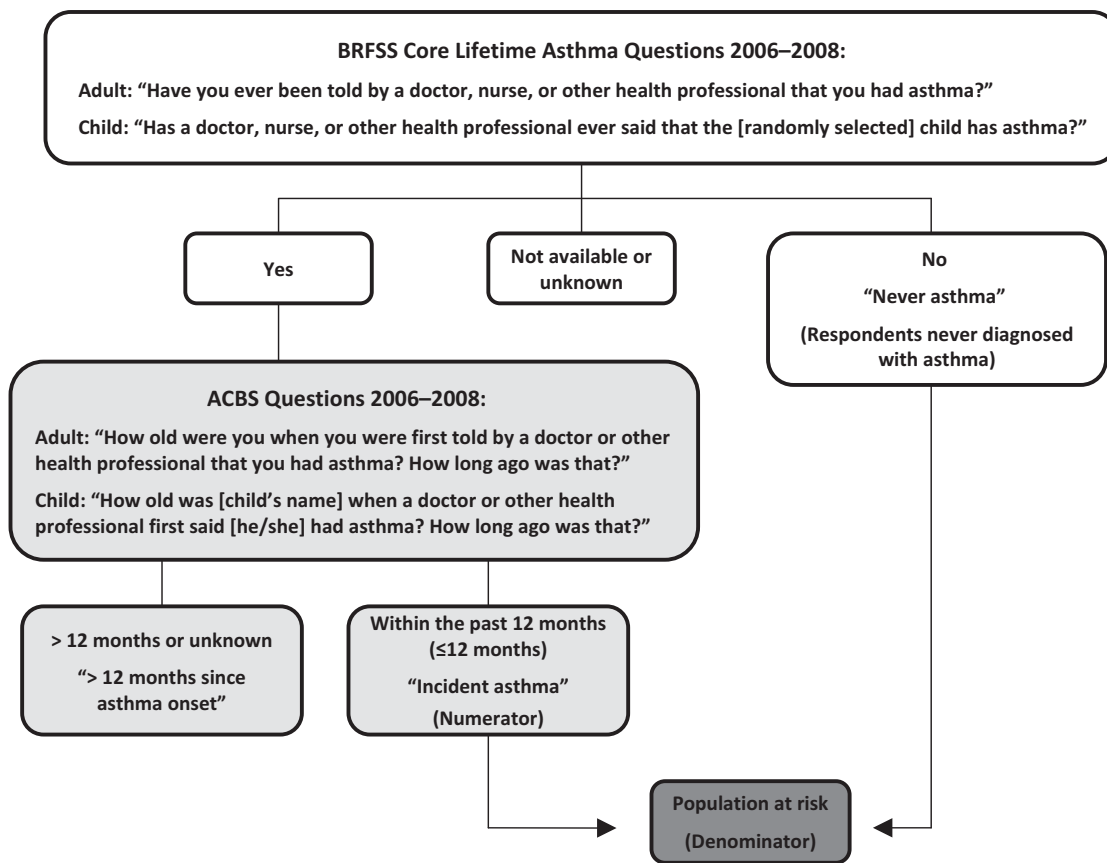


FIGURE 2.—Determination of at-risk adult population and child population—Behavioral Risk Factor Surveillance System (BRFSS) and Asthma Call-back Survey (ACBS), 2006–2008.

child incident cases in 2008 in ACBS participating states and DC.

#### *Asthma Incidence by Age Group Categories*

During 2006–2008, asthma incidence was 3.3 times higher in children compared with adults ( $p < .001$ ). This trend of higher asthma incidence among children compared with adults remained statistically significant when analyzed across 2006, 2007, and 2008 separately ( $p < .001$  for each year). In addition, the asthma incidence rate was highest among the youngest child age group (0–4 years) at 23.4/1000; lower in children aged 5–11 years at 11.1/1000; and lowest in the oldest children (age 12–17 years) at 4.4/1000 ( $p < 0.001$ ) (Table 2). Among adults, the incidence rate for the 65 years and older age group was 3.1/1000, which was significantly lower than the rate of 4.6/1000 for the 55–64 age group ( $p < .03$ ) (Table 1).

#### *Asthma Incidence by Sex and Race/Ethnicity*

Adult females had a statistically significant higher incidence rate (4.9/1000) compared with adult males (2.8/1000) during 2006–2008 ( $p < .001$ ) (Table 1); however, observed differences in asthma incidence rates between boys (13.6/1000) and girls (11.5/1000) did not reach statistical significance (Table 2). Incidence among NH White adults was 3.9/1000; among NH non-White adults was 3.2/1000; and among Hispanic

adults was 4.0/1000. Incidence among NH White children was 12.8/1000; among NH non-White children was 15.8/1000; and among Hispanic children was 9.9/1000. There were no statistically significant differences among race/ethnicity groups in children or adults (Tables 1 and 2).

#### DISCUSSION

This analysis is the first to use the BRFSS–ACBS during 2006–2008 to estimate asthma incidence in adults and children. Consistent with prevalence patterns described earlier, we found that during the 3 years represented in our analysis, asthma incidence rates were statistically significantly higher for children compared with adults; higher for adult females compared with adult males; and higher for younger children compared with older children and adolescents. However, unlike asthma prevalence, in which boys are known to have higher prevalence than girls in childhood, there were no statistically significant differences in asthma incidence rates between boys and girls during the 3 years included in this analysis. Race/ethnicity incidence rates also did not follow known patterns in prevalence. The power and reliability of these 12-month incidence estimates to predict trends and patterns among these groups will be improved with larger sample sizes as additional years of ACBS data become available for analysis.

TABLE 1.—Estimated annual asthma incidence rate per 1000 at-risk adults by year, sex, age group, and race/ethnicity—Behavioral Risk Factor Surveillance System (BRFSS) adult Asthma Call-back Survey (ACBS), 2006–2008.

Annual incidence rate over rate period, 2006–2008 ( <i>n</i> = 733,437) <sup>a</sup>			
	Number <sup>b</sup>	Rate <sup>c</sup>	95% CI
Total	1033	3.8	(3.2,4.4)
Year			
2006 (24 states + DC, <i>n</i> = 175,868) <sup>d</sup>	288	4.0	(2.8,5.1)
2007 (33 states + DC, <i>n</i> = 281,591)	383	3.9	(3.0,4.8)
2008 (34 states + DC, <i>n</i> = 275,978)	362	3.6	(2.9,4.4)
Sex			
Male	254	2.8	(1.8,3.7)
Female	779	4.9	(4.1,5.6)
Age (years)			
18–34	118	4.0	(2.4,5.6)
35–44	164	4.0	(2.8,5.2)
45–54	219	3.6	(2.8,4.5)
55–64	269	4.6	(3.5,5.8)
65+	263	3.1	(2.2,3.9)
Race <sup>e</sup> /ethnicity			
NH White	817	3.9	(3.2,4.7)
NH Non-White	132	3.2	(2.0,4.4)
Hispanic	74	4.0	(2.4,5.5)

Notes: DC, District of Columbia; CI, confidence interval; NH, non-Hispanic.

<sup>a</sup>Unweighted number of adult BRFSS respondents from the states participating in ACBS during 2006–2008.

<sup>b</sup>Unweighted number of adult ACBS respondents diagnosed in the past year.

<sup>c</sup>Denominator is those at risk of developing asthma during the time period. At risk at the beginning of the time period is defined as never diagnosed plus first diagnosed in the past year.

<sup>d</sup>Unweighted number of adult BRFSS respondents from the states participating in ACBS that year.

<sup>e</sup>Race category “NH White” comprises people who indicated only this single race group. “NH Non-White” includes people reporting “NH Black,” “NH Other,” and “NH Multiracial,” where “NH Other” includes Asian, American Indian and Alaskan Native, Native Hawaiian and Other Pacific Islander, and people reporting their race as something other than those listed here or above. Race categorized according to the 1997 standards for Federal Data. Unknown race was excluded.

Apart from the state-based BRFSS–ACBS, no other large-scale source of asthma incidence estimates is available. Over recent years, it has not been possible to calculate annual asthma incidence estimates from long-standing, nationally representative data sets such as NHIS and NHANES, because these surveys have not included variables to calculate annual asthma incidence estimates. The most recently available national estimates of asthma incidence were calculated from the 1980–1996 NHIS (15). The estimated asthma incidence during those years ranged from 1.2 to 4.7 per 1000 at-risk adults and 5.7 to 9.6 per 1000 at-risk children (17). Because the NHIS question regarding time of asthma onset was removed from the questionnaire in 1997, more recent national asthma incidence estimates are not available. The NHANES I cohort study (1971–1975) and associated NHANES I Epidemiologic Follow-up Study (1982–1984) estimated the adjusted average annual asthma incidence rate among adults to be 2.1/1000 at-risk adults (16). This estimate of asthma incidence was produced only once.

TABLE 2.—Estimated annual asthma incidence rate per 1000 at-risk children by year, sex, age group, and race/ethnicity—Behavioral Risk Factor Surveillance System (BRFSS) child Asthma Call-back Survey (ACBS), 2006–2008.

Annual incidence rate over rate period, 2006–2008 ( <i>n</i> = 164,327) <sup>a</sup>			
	Number <sup>b</sup>	Rate <sup>c</sup>	95% CI
Total	592	12.5	(10.5,14.4)
Year			
2006 (22 states + DC, <i>n</i> = 38,004) <sup>d</sup>	172	13.6	(9.6,17.6)
2007 (30 states + DC, <i>n</i> = 60,031)	186	9.9	(7.4,12.4)
2008 (31 states + DC, <i>n</i> = 66,292)	234	14.0	(10.2,17.7)
Sex			
Male	313	13.6	(10.5,16.6)
Female	277	11.5	(8.7,14.2)
Age (years)			
0–4	265	23.4	(17.8,28.9)
5–11	191	11.1	(8.1,14.2)
12–17	131	4.4	(2.9,5.9)
Race <sup>e</sup> /ethnicity			
NH White	408	12.8	(10.3,15.3)
NH Non-White	110	15.8	(10.0,21.7)
Hispanic	68	9.9	(6.0,13.8)

Notes: DC, District of Columbia; CI, confidence interval; NH, non-Hispanic.

<sup>a</sup>Unweighted number of child by proxy BRFSS respondents from the states participating in ACBS during 2006–2008.

<sup>b</sup>Unweighted number of child by proxy ACBS respondents diagnosed in the past year.

<sup>c</sup>Denominator is those at risk of developing asthma during the time period. At risk at the beginning of the time period is defined as never diagnosed plus first diagnosed in the past year.

<sup>d</sup>Unweighted number of child by proxy BRFSS respondents from the states participating in ACBS that year.

<sup>e</sup>Race category “NH White” comprises people who indicated only this single race group. “NH Non-White” includes people reporting “NH Black,” “NH Other,” and “NH Multiracial,” where “NH Other” includes Asian, American Indian and Alaskan Native, Native Hawaiian and Other Pacific Islander, and people reporting their race as something other than those listed here or above. Race categorized according to the 1997 standards for Federal Data. Unknown race was excluded.

Despite nonuniform participation among states in the ACBS and incident asthma being a rare event that further limits the size of the numerator, we recognize that one application of the ACBS can be to provide annual estimates of asthma incidence. At present, asthma control programs use prevalence estimates to detect disproportionately affected subpopulations and then appropriately allocate resources. However, monitoring asthma incidence is better for delineating the affected at-risk subpopulations previously unaffected by asthma. Identifying subpopulations with higher asthma incidence can prompt closer investigation into the potential risk factors responsible for the higher disease burden.

The findings in this report are subject to at least four limitations. First, annual incidence rate estimates for each year analyzed cannot be compared with one another because there were different number of states and differences in which states participated in the ACBS each year from 2006 to 2008. This might explain some of the observed variation in incidence rates from year to year. Second, the rarity of the diagnosis event (incident asthma)

reduced statistical power to detect differences among demographic subgroups. Although the sample sizes from the BRFSS each year were large (175,000–281,000 for adults), the numbers of respondents with incident asthma diagnosed in the past year were very small (288–383 for adults). Thus, comparison of demographic subgroups to identify those disproportionately affected by incident asthma was limited. Third, the high asthma incidence rate among children aged 0–5 years may be an overestimate. The diagnosis of asthma is difficult to make and confirm among children under 5 years of age because young children are prone to transient respiratory conditions, such as pneumonia and bronchitis, that may cause wheezing and may result in misdiagnosis (17, 18). Finally, these newly diagnosed cases of asthma underestimate the total national burden of incident asthma, because not all states participated in the ACBS.

### CONCLUSIONS

Asthma causes significant personal and economic burden, including activity limitations; missed school and work days; and demands on emergency departments and healthcare providers (3). Our analysis is the first to estimate asthma incidence by year, age group, sex, and race/ethnicity for states participating in the BRFSS–ACBS from 2006 to 2008. Similar to patterns observed in asthma prevalence, we were able to demonstrate that children experience higher rates of incident asthma than adults; younger children have higher rates as compared with older children; and adult females experience higher rates of incident asthma than adult males. We were not able to show statistically significant differences in asthma incidence by most adult age groups, child sex, or race/ethnicity. When several additional years of ACBS data are available, it will be possible to produce more detailed estimates that can be used to compare subgroups with more certainty.

Our analysis demonstrated that a combined total of almost 3 million children and adults were diagnosed with incident asthma during 2006–2008 in ACBS participating states. These people with new-onset asthma have been added to the pool of asthma prevalence, increasing the burden of asthma in the United States and making adherence to cost-effective care strategies and asthma management guidelines a national imperative.

We realize the value of the ACBS to provide information on asthma risk factors as well as incidence. As additional data on asthma incidence and risk factors are collected through the ACBS in coming years, asthma control programs may be able to use these rates to identify risk factors associated with disease onset and promote targeted interventions to reduce these risk factors. We support expansion of the BRFSS sample size and subsequently the ACBS sample size to produce more reliable estimates. In the future, we encourage greater state participation in the ACBS and expansion of the BRFSS to include additional sampling methods that would allow for increased participation. In addition, we encourage national surveys to include questions regarding time of

onset of the initial asthma diagnosis to provide nationally representative annual asthma incidence estimates. Such nationally representative asthma incidence estimates, in addition to state representative estimates from the ACBS, could help elucidate risk factors and etiologies for asthma onset.

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### DECLARATION OF INTEREST

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

### REFERENCES

1. National Heart Lung and Blood Institute. Global strategy for asthma management and prevention. 2009. Available at: <http://www.ginasthma.org/pdf/archived/GINWorkshop05Clean.pdf>. Accessed November 10, 2010.
2. Moorman JE, Rudd RA, Johnson CA, King M, Minor P, Bailey C, Scalia MR, Akinbami LJ. National surveillance for asthma—United States, 1980–2004. *MMWR Surveill Summ* 2007; 56(8):1–54.
3. Akinbami LJ, Moorman JE, Liu X. Asthma prevalence, health care use, and mortality: United States, 2005–2009. *Natl Health Stat Report* 2011; (32):1–16.
4. Jean Hall M, DeFrances C, Williams S, Golosinskiy A, Schwartzman A. National Hospital Discharge Survey: 2007 summary. *Natl Health Stat Report* 2010; 26(29):1–21.
5. Xu J, Kochanek K, Murphy S, Tejada-Vera B. Deaths: final data for 2007. *Natl Vital Stat Report* 2010; 58(19):1–135.
6. Barnett SB, Nurmagambetov TA. Costs of asthma in the United States: 2002–2007. *J Allergy Clin Immunol* 2011; 127(1):145–152.
7. Zahran H, Bailey C, Garbe P. Asthma prevalence, disease characteristics, and self-management education—United States, 2001–2009. *MMWR* 2011; 60:547–552.
8. Centers for Disease Control and Prevention. About the BRFSS: turning information into public health. 2008. Available at: <http://www.cdc.gov/brfss/about.htm>. Accessed October 20, 2010.
9. Mokdad AH. The Behavioral Risk Factors Surveillance System: past, present, and future. *Annu Rev Public Health* 2009; 29(30):43–54.
10. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance Survey (BRFSS). 2009. Available at: <http://www.cdc.gov/asthma/survey/brfss.html#callback>. Accessed October 12, 2010.

11. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance Survey System: operational and user's guide, version 3.0. 2006. Available at: <ftp://ftp.cdc.gov/pub/Data/Brfss/userguide.pdf>. Accessed October 20, 2010.
12. Centers for Disease Control and Prevention. 2006–2008 ACBS Summary Data Quality Report. 2011. Available at: <http://www.cdc.gov/brfss/acbs/2008/2008.htm>. Accessed March 31, 2011.
13. Mausner JS, Bahn AK. Epidemiology: An Introductory Text. Philadelphia: W.B. Saunders Company, 1974.
14. Korn EL, Graubard BI. Analysis of Health Surveys. New York: John Wiley & Sons, 1999.
15. Rudd RA, Moorman JE. Asthma incidence: data from the National Health Interview Survey, 1980–1996. *J Asthma* 2007; 44(1):65–70.
16. McWhorter WP, Polis MA, Kaslow RA. Occurrence, predictors, and consequences of adult asthma in NHANESI and follow-up survey. *Am Rev Respir Dis* 1989; 139(3):721–724.
17. Akinbami LJ, Schoendorf KC. Trends in childhood asthma: prevalence, health care utilization, and mortality. *Pediatrics* 2002; 110(2 Pt 1): 315–322.
18. Martinez FD, Wright AL, Taussig LM, Holberg CJ, Halonen M, Morgan WJ. Asthma and wheezing in the first six years of life. *New England J Med* 1995; 332(3):133–138.