

Asthma outcomes in children and adolescents with multiple morbidities: Findings from the National Health Interview Survey

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Background: More Americans are managing multiple chronic conditions (MCCs), and trends are particularly alarming in youth.

Objective: The purpose of this study was to examine the prevalence and distribution of 9 chronic conditions in children and adolescents with and without asthma, and adverse asthma outcomes associated with having MCCs.

Methods: Cross-sectional interview data from the National Health Interview Survey were analyzed (N = 66,790) between 2007 and 2012 in youth 0 to 17 years of age. Bivariate analysis methods and multivariate generalized linear regression were used to examine associations.

Results: Five percent of children with asthma had 1 or more coexisting health conditions. The prevalence of 1 or more comorbidities was greater among those with asthma than those without (5.07% [95% CI: 4.5-5.6] vs 2.73% [95% CI: 2.6-2.9]). Those with asthma were twice as likely to have co-occurring hypertension (prevalence ratio [PR] = 2.2 [95% CI: 1.5-3.2]) and arthritis (PR = 2.7 [95% CI: 1.8-4.0]) compared with those without asthma. Every additional chronic condition with asthma was associated with a greater likelihood of an asthma attack (PR = 1.1 [95% CI: 1.0-1.2]), all-cause emergency department visits (PR = 1.3 [95% CI: 1.1-1.5]), and missed school days (PR = 2.3 [95% CI: 1.7-3.2]).

Conclusions: Children and adolescents with asthma in the US who suffer from MCCs have increased asthma symptoms, missed school days, and all-cause emergency department visits. Further research on optimal management strategies for this group is needed. (*J Allergy Clin Immunol* 2015;135:1444-9.)

Key words: Outcomes, comorbidity, epidemiology, asthma, pediatrics

Chronic diseases affect 1 in 2 adults in the US, and alarming trends show that 1 in 4 of all adults are now managing multiple chronic conditions (MCCs), defined as 2 or more chronic health

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Abbreviations used

BMI: Body mass index
ED: Emergency department
MCCs: Multiple chronic conditions
NHIS: National Health Interview Survey
PR: Prevalence ratio

conditions that affect a person at the same time.¹ Trends are concerning in youth, with 26% of US children managing a chronic condition, and 1 in 15 now managing MCCs.^{2,3} MCCs have profound effects on cognitive, emotional, and social development, increasing expenditures for health care and disability programs, and put youth at substantially greater risk for decreased work force participation, educational opportunities, and quality of life.⁴ Children with multiple chronic medical conditions have higher rates of readmission after illness episodes,⁵ have been shown to seek a majority of their care in the emergency department (ED),⁶ and account for a large proportion of health care expenditures.⁷

Estimates from the National Health Interview Survey (NHIS) from the 1980s reveal that MCCs are most prominent in youth who are older, male, of white race, and non-poor, and those with atopic conditions.⁴ Since the 1980s, chronic diseases in children have risen by nearly 10%. As a result, current population trends may be different and shifting, and a better understanding of where to target support efforts may be timely.

Asthma is the most common chronic condition evident in children (9.5%, 7.1 million)⁸ and is the main reason children use urgent care services for a chronic disease.⁹ Asthma is among the top 10 conditions with the highest prevalence of readmission rates among children.¹⁰ It is a condition also marked by significant disparities.⁸ In adults, national estimates suggest that more than half of adults with asthma have 1 or more coexisting health conditions, and adverse outcomes are evident.¹¹ Whether similar trends are evident in children with asthma is unknown. Such information may better inform clinical and community support efforts to assist families in managing asthma in the presence of other chronic conditions.

This study analyzed recent data from the NHIS¹² to 1) compare the prevalence of 9 chronic conditions evident in children and adolescents with and without asthma and 2) assess the extent to which comorbid conditions are associated with adverse asthma outcomes.

METHODS

Data source

The NHIS is a cross-sectional household interview survey that examines a nationally representative sample each year of about 35,000 civilian,

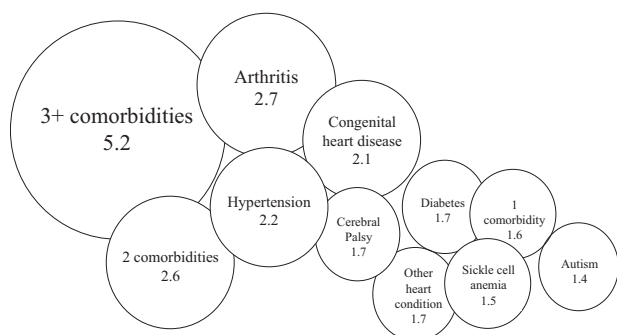


FIG 1. PR of the associations between asthma and other chronic conditions in US children and adolescents, adjusted for age, sex, race, and socioeconomic status.

noninstitutionalized households that comprise 90,000 individuals from 35,000 families.¹² NHIS uses a complex, multistage area probability sample design that permits the representative sampling of households and noninstitutional group quarters.¹² Details of the multistage sampling strategy of NHIS are described elsewhere.¹² Select groups such as African Americans, Hispanics, and Asians are oversampled in order to increase the reliability of their health status estimates. From each family in the NHIS, 1 sample adult and 1 sample child are randomly selected, and information on each is collected with the Sample Adult Core and the Sample Child Core questionnaires. Interviews are conducted using computer-assisted personal interviewing mode. Written informed consent and assent are collected from all participating families.

Analytic sample

Six years (2007 to 2012) of NHIS survey data were pooled for the current analysis in order to increase sample size and the statistical reliability of estimates. The analytic sample includes only children 0 to 17 years of age. The overall unweighted interview response rate was 88.4% (n = 9,417) in 2007, 85.6% (n = 8,815) in 2008, 89.9% (n = 11,156) in 2009, 89.8% (n = 11,277) in 2010, 91.8% (n = 12,850) in 2011, and 90.7% (n = 13,275) in 2012. The final unweighted sample comprised 66,790 individuals interviewed between 2007 and 2012. Of this group, 6,350 individuals were identified as having asthma, based on positive responses to the following questions: “Has a doctor or health professional ever told you that your child has asthma?” and “Does the child still have asthma?”

In addition to asthma, parents were asked if a doctor had ever told them that their child had any of the following chronic conditions: cerebral palsy, muscular dystrophy, sickle cell anemia, autism, diabetes, arthritis, congenital heart disease, other heart condition, or hypertension. These conditions were chosen due to the availability of data on chronic health conditions in the data source in each survey cycle that was pooled and met the following definition of a chronic health condition as cited by other work in children: a health condition that lasts ≥ 12 months or at time of diagnosis is likely to have a duration of ≥ 12 months.⁴ The conditions available in the NHIS were determined for inclusion based on US Department of Health and Human Services recommendations for standardized reporting of common conditions.¹³ For this paper, an aggregate measure of chronic conditions for children was created using the following groupings: 0, 1, 2, or ≥ 3 . MCCs in this paper refer to having asthma and 1 or more other chronic conditions.

Measures

Outcomes investigated included ED visits due to asthma, all-cause ED visits, asthma attacks, and missed school days all assessed over the past year. These outcomes give indication of the level of a child’s asthma control.¹⁴ *ED visits*: “During the past 12 months, did the child have to visit an emergency room or urgent care center because of {his/her} asthma?” assessed ED visits specific to asthma, while the item “During the past 12 months, how many times has the child gone to a hospital or emergency room about his/her

health?” assessed ED visits related to the child’s overall health. *Asthma symptom episodes*: “During the past 12 months, has the child had an episode of asthma or an asthma attack?” assessed symptoms related to asthma, specifically exacerbations. *Missed school days*: “During the past 12 months, about how many days did the child miss school because of illness or injury?” assessed missed school days. Socioeconomic status in this study was defined as poverty (income to needs ratio < 2) or above poverty level (ratio ≥ 2). The basis for estimating financial needs based on family size was adapted from the literature¹⁵ and relates needs to income, meaning that those whose income is less than 2 times their financial needs are considered to be in poverty.

Analyses were computed in SAS (v.9.3) and SUDAAN (V11.1). SAS survey and SUDAAN procedures were used to adjust for the NHIS complex sample design. The data were weighted using the full sample 1-year health interview weight for NHIS. Since 6 years of data were combined for this analysis, each cycle-specific case weight was divided by 6, which produced a scaled weight across all 6 years that summed to the US population on average across the 6-year period.¹² Missing data were ignored, given that less than 10% of missing data were observed on variables in the analysis. Statistical significance was assigned based on a Type 1 error level of $\alpha = .05$ or 95% CI for estimates of population statistics.

The weighted prevalence of each chronic condition and mean of number of chronic conditions in the US population with and without asthma were analyzed and compared using SAS Proc SurveyFreq and Proc Survey Means. Multivariate Poisson regression (log link, Poisson pseudo likelihood) using the SUDAAN Proc Loglink procedure was used to estimate the prevalence ratios (PR; relative risk) for asthma diagnosis comparing persons with/without each chronic condition. Consistent with the complex sample design of NHIS, the Taylor Series Linearization method was used to compute robust estimates for the Poisson regression coefficients and CIs for the corresponding PR estimates.

The weighted prevalence of demographic and clinical characteristics, and adverse asthma outcomes (asthma attacks, missed school days, ED visits due to asthma, all-cause ED visits) in the US population with asthma only and asthma with comorbidity were estimated using SAS 9.3 survey procedures. This analysis was stratified by children 0 to 11 years of age, and adolescents 12 to 17 years of age. Note that body mass index (BMI) was only available for adolescents aged 12 to 17 years. Estimates were compared using a Student *t* test or χ^2 tests of independence with the Rao-Scott complex sample design adjustment.

Multivariate Poisson regression was also used to examine the number of comorbid chronic conditions predicting adverse asthma outcomes. This analysis was stratified by children 0 to 11 years of age and adolescents 12 to 17 years of age. Models were estimated in SUDAAN with Taylor Series variance estimation to capture the complex sample design. All models were estimated using the NHIS analysis weight and were adjusted for age, sex, race, and socioeconomic status. For adolescents, models were additionally adjusted for BMI.

RESULTS

Ten percent (n = 6,350) of children and adolescents between 0 and 17 years of age in the national sample reported continued presence of physician-diagnosed asthma, and 5% of children with asthma reported having 1 or more comorbidities. Weighted estimates of demographic characteristics of the sample stratified by individuals with and without asthma are presented in [Table 1](#). A high percentage of children with asthma were in households who met federal guidelines for poverty (50.5%; [95% CI: 48.9-52.1]). Children with asthma were older on average than those without asthma (9.7 years [95% CI: 9.6-9.8] vs 8.5 years [95% CI: 8.4-8.6]; $P < .001$) and included a higher percentage of individuals who were male (56.8% [95% CI: 55.6-58.1] vs 50.7% [95% CI: 50.3-51.1]; $P < .001$) and African American (28.6% [95% CI: 27.3-30.0] vs 15.9% [95% CI: 15.3-16.5]; $P < .001$). A greater proportion of the asthma group reported at

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