

# Disparities in Mortality and Morbidity in Pediatric Asthma Hospitalizations, 2007 to 2011

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## ABSTRACT

**OBJECTIVE:** Asthma is a leading cause of pediatric admissions. Although several factors including race have been linked to increased overall asthma morbidity and mortality, few studies have explored factors associated with inpatient asthma outcomes. We examined factors associated with mortality and morbidity in children admitted for asthma.

**METHODS:** Data were obtained from the US Nationwide Inpatient Sample for 2007 to 2011. Patients 2 to 18 years old with a primary diagnosis of asthma were included. Predictor variables were sociodemographic and hospital factors and acute/chronic secondary diagnoses. Outcomes were mortality, intubation, length of stay (LOS), and costs. Weighted national estimates were calculated. Multivariable analyses were performed.

**RESULTS:** There were 97,379 (478,546 weighted) asthma admissions. Most patients were male (60.6%); 30% were white, 28% black, and 18% Hispanic. Mortality rate was 0.03%, and 0.3% were intubated. Median LOS was 2 (interquartile range, 1–3) days. Median costs were \$2,950 (interquartile range,

\$1990–\$4610). Native American race, older age (13–18 years), and West region were significant independent predictors of mortality. Intubation rate was lower in Hispanic compared with white children ( $P = .028$ ). LOS was shorter in Asian compared with white children ( $P = .022$ ) but longer in children with public insurance and from low income areas ( $P < .001$ ). Average costs were higher in black, Hispanic, and Asian compared with white children ( $P < .05$ ).

**CONCLUSIONS:** With the exception of Native Americans, race/ethnicity is not associated with inpatient asthma mortality and has varied effects on morbidity. Recognition of factors associated with increased asthma mortality and morbidity might allow for earlier, more effective treatment and avoidance of complications.

**KEYWORDS:** asthma; disparities; hospitalizations; morbidity; mortality

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## WHAT'S NEW

Native American children have higher inpatient asthma mortality rates compared with white children. Race and ethnicity are otherwise not independent predictors of inpatient mortality and have varied effects on intubation, length of stay, and costs.

ASTHMA IS ONE of the most common conditions seen in pediatric patients. In 2009, 9.6% of children (7.1 million children) in the United States were estimated to have asthma.<sup>1</sup> Asthma symptoms lead to 10.5 million missed school days per year.<sup>1</sup> More than 5% of all pediatric hospital admissions are for asthma,<sup>2</sup> making it a leading cause of pediatric hospitalizations.

It has been well established that racial and ethnic disparities exist in pediatric patients with asthma. Black and Hispanic children have a higher asthma prevalence and overall rates of mortality compared with white children.<sup>1–3</sup> Readmission rates are twice as high in black compared with white children.<sup>4</sup> Black and Hispanic children have higher rates of emergency department (ED) use and hospitalizations for asthma.<sup>5–8</sup> Black and Hispanic children often use the ED for their usual source of care<sup>9</sup> and miss more school days because of their asthma compared with white children.<sup>10</sup> These disparities can in part be explained by financial and social hardship,<sup>4</sup> worse access to care including to primary care physicians,<sup>7,11</sup> and improper controller and rescue medication use.<sup>6,10,12</sup>

Although black and Hispanic race and ethnicity have been shown to be predictors of mortality and morbidity

from asthma in the outpatient setting, little is known on the national level about whether disparities persist for children after they have been admitted. One national study that examined inpatient asthma disparities in pediatric and adult patients ages 5 and older reported no significant differences in hospital deaths from asthma according to race or ethnicity in their multivariable analysis.<sup>13</sup> The study reported that mortality was more likely in older adults, male patients, patients with more chronic conditions, and during winter months.<sup>13</sup> Although this study provides some evidence against racial and ethnic disparities associated with inpatient asthma mortality, it did not specifically examine predictors of other more common adverse outcomes such as increased costs, longer length of stay (LOS), or other measures of more severe disease/morbidity, which might have different predictors or in which disparities would be more easily identified because mortality is rare. In addition, the study did not provide detail regarding the specific comorbidities that might lead to worse outcomes as has been done in studies in other settings.<sup>14–16</sup> Another study of asthmatics at academic children's hospitals (from July 2002 to June 2003) found that black children had statistically shorter unadjusted LOS and lower charges (after adjusting for LOS) than white children although these differences might not be clinically significant<sup>17</sup>; additional multivariable analyses were not presented. Furthermore, in the past decade there have been no published nationally representative studies on racial and ethnic disparities in inpatient asthma admissions and little work on asthma outcomes in Native American or Asian children.

The purpose of this study was to determine the factors associated with mortality, intubation, LOS, and costs in children admitted for asthma exacerbations between 2007 and 2011 in a nationally representative sample in the United States, including whether racial and ethnic disparities or the presence of specific diagnoses are independent predictors of these outcomes.

## METHODS

### DATA SOURCE

We analyzed data from the 2007 to 2011 Nationwide Inpatient Sample (NIS), the largest all-payer publicly available inpatient data set, which is part of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality. The NIS consists of a representative stratified sample of approximately 20% of US hospital admissions; the complex sampling design allows for the calculation of national estimates.<sup>18</sup> Because of the deidentified nature of the data present in the NIS, this study did not meet the definition for human subjects research and was exempt from full review by the New York University School of Medicine institutional review board.

### SUBJECTS

Patient records were included in the analysis if they had a primary discharge diagnosis of asthma according to the

*International Classification of Diseases, Ninth Revision* code 493, and were 2 to 18 years old. Patients with asthma as a secondary diagnosis were not included. There were no additional exclusion criteria.

### MEASURES

The primary predictor variable of interest was race/ethnicity (a single category in the NIS, with "Hispanic" defining anyone identified as being of Hispanic ethnicity in the data set). Data were also collected on additional possible indicators of income disparities (insurance type and median household income quartile [income ranges vary by year<sup>18</sup>; 2007 ranges were used for simplicity] according to patient zip code [patient location according to zip code is not available]), demographic factors (sex, age [grouped as ages 2–5, 6–12, and 13–18 years]), hospital-level characteristics (region, rural/urban location, teaching status, and bed size [small, medium, or large; definition differs depending on location and teaching status as defined by the Healthcare Cost and Utilization Project<sup>18</sup>]), and hospitalization timing (weekend admission, year [as a continuous variable], and discharge quarter [January–March, April–June, July–September, October–December]). Data on presence of several acute (pneumonia, influenza, and respiratory syncytial virus [RSV]) as well as chronic (obesity, obstructive sleep apnea [OSA], allergic rhinitis, eczema, mood disorders, gastroesophageal reflux disease, and tobacco addiction [coded in the patient record]) secondary diagnoses chosen on the basis of previous studies showing associations with presence of asthma or worse asthma severity<sup>14–16</sup> were also collected (see the [Appendix](#) for secondary diagnosis coding criteria).

The outcome variables of interest were mortality, intubation (defined by presence of *International Classification of Diseases, Ninth Revision* procedural codes for intubation/mechanical intubation: 96.04, 96.70, 96.71, 96.72), LOS, and total costs. To determine estimated total costs of hospitalization, charges were converted to costs using NIS Cost-to-Charge data files.<sup>19</sup> Group-weighted average cost-to-charge ratios were used in the analysis.

### ANALYSIS

Bivariate and multivariable regression analyses were performed to determine whether any of the previously mentioned predictor variables were associated with the outcomes of mortality, intubation, LOS, and costs. LOS was also included as a predictor in the multivariable regressions in which cost was the outcome. In addition, missing data for all predictor variables were reassigned to a separate missing variable category and analyzed to determine if missing data predicted any of the outcomes. Logistic and linear regressions were used for dichotomous (mortality and intubation) and continuous (LOS and costs) outcomes, respectively. Because LOS and cost distributions were skewed, the data were natural log-transformed for all bivariate and multivariable linear regression analyses. We then applied Duan's method to retransform all linear regression results from the log to the original scale.<sup>20</sup> A *P* value < .05 was considered significant in all cases. All

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