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Comparison of severity of asthma hospitalization between African American and Hispanic children in the Bronx

Diana S. Lee, MD^a, Elissa Gross, DO, MPH^{b,c}, Arda Hotz, MD^d, and Deepa Rastogi, MBBS, MS^{b,c}

^aDepartment of Pediatrics, Mount Sinai Kravis Children's Hospital, Icahn School of Medicine at Mount Sinai, New York, NY, USA;

^bDepartment of Pediatrics, Children's Hospital at Montefiore, Bronx, NY, USA; ^cAlbert Einstein College of Medicine, Bronx, NY, USA;

^dDepartment of Pediatrics, Boston Children's Hospital, Boston, MA, USA

ABSTRACT

Objective: There are racial and ethnic disparities in childhood asthma burden and outcomes. Although there have been comparisons between whites and minorities, there are few between minority groups. This study aimed to compare characteristics of asthma hospitalizations in African American and Hispanic children.

Methods: A retrospective chart review was conducted to compare asthma characteristics between African American and Hispanic children aged 2–18 years hospitalized at an urban, tertiary care hospital for an acute asthma exacerbation. Length of stay (LOS), need for intensive care unit (ICU), and need for additional medications or respiratory support were compared between the groups.

Results: Of the 925 children that met the inclusion criteria, 64% were Hispanic and 36% were African American. The groups were similar in age, gender, insurance status, and weight classification. African American children were more likely to have severe persistent asthma (12% vs. 7%, $p=.02$). They were also more likely to require magnesium sulfate (45% vs. 32%, $p<.001$) and admission to the ICU from the emergency department (ED) (14% vs. 8%, $p=.01$), which were independent of asthma severity. There was no significant difference in LOS or other characteristics of hospitalization.

Conclusions: African American children hospitalized for asthma have more severe exacerbations compared to Hispanic children, which is independent of their asthma severity. However, this was not associated with longer LOS, which may indicate greater responsiveness to inpatient asthma management. Further investigation is needed to understand the mechanisms underlying asthma and exacerbation severity among minority groups.

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KEYWORDS

Inpatient; exacerbation; minority groups; disparity; urban

Abbreviations

ICU	intensive care unit
ED	emergency department
LOS	length of stay
NH	non-Hispanic
SES	socioeconomic status
US	United States

Introduction

There are known ethnic and racial disparities in the burden and treatment of childhood asthma. For children in the United States (US) younger than age 18 years in 2014, the prevalence of asthma was 7.6% in non-Hispanic (NH) whites as compared to 13.4% in African Americans and 8.5% in Hispanics (23.5% in Puerto Ricans) (1). In addition to higher

prevalence, African Americans and Hispanics have been found to have disproportionately higher rates of asthma-related hospitalizations and readmissions, under-use of controller medications and routine healthcare services, and overuse of emergency medical services (2–6).

Various reasons have been proposed for these disparities, including genetic susceptibility, high exposure to environmental allergens and irritants, suboptimal access to healthcare, socioeconomic factors (e.g., poverty, insurance status), and cultural differences (e.g., language barriers, differing perceptions of symptoms and control, and concerns about safety of medications) (4,7). Smith et al. found that racial and ethnic differences in the risk for asthma was only present among children in families with incomes less than half the federal poverty level and suggested that social

and environmental factors outweigh genetic risk (8). However, Thakur et al. showed that socioeconomic status (SES) has different effects on asthma depending on the racial or ethnic group, indicating a complex interplay between SES and race/ethnicity (9). There are studies that are designed to examine the complex relationships between genetic, social, and environmental factors in asthma in minority populations, including the Genes-Environment and Admixture in Latino Americans study and the Study of African Americans, Asthma, Genes and Environments (9). However, while the disparities between whites and minorities, including African Americans and Hispanics have been investigated, the differences between African Americans and Hispanics are less well elucidated. Additionally, asthma has been extensively investigated in the African American population, but details on the disease among Hispanics are still being defined (10).

The Bronx is the New York City borough with the highest overall rates of asthma prevalence, hospitalizations, and deaths in children (11). According to 2010 census data, the Bronx population was 11% NH white, 30% African American, and 54% Hispanic (12). The majority of the Hispanic population is Puerto Rican (22% of Bronx population) and Dominican (17% of Bronx population) (13). Thus, the Bronx is well-suited for the study of differences in pediatric asthma between African Americans and Hispanics.

Although hospitalization in itself is an indicator of asthma burden, the length of stay (LOS) in the hospital and the level of interventions required are also important as they can be indicators of severity of the exacerbation and responsiveness to treatment (14,15). Longer LOS in the hospital and need for higher levels of care also add costs to patients, families, and the healthcare system (16,17). We therefore conducted this study to characterize disease presentation during asthma hospitalizations among African American and Hispanic children in the Bronx, who are likely to have similar SES and environmental exposures. We hypothesized that African American children would have a higher asthma severity and severity of asthma exacerbation as compared to Hispanic children.

Methods

Participants

A retrospective cohort study was performed in children hospitalized for status asthmaticus or an asthma exacerbation to an urban, tertiary care, academic hospital in Bronx, New York. A proprietary, interactive query and clinical analytic software application,

Clinical Looking Glass (Streamline Health, Atlanta, GA), was queried to identify children aged 2–18 years admitted to the Children's Hospital at Montefiore with a diagnosis of status asthmaticus or asthma exacerbation based on *International Classification of Diseases, Ninth Revision* discharge codes (493.XX) between January 2012 and December 2014 (18).

A review of the electronic medical record was conducted on the identified children. Patients were excluded if they were other than African American or Hispanic or if they had any of the following: chronic cardiac disease, cystic fibrosis, trisomy 21, immunodeficiency or history of receiving a transplant, neuromuscular disease, Crohn's disease, ulcerative colitis, sickle cell disease, chronic lung disease requiring medication or home oxygen use, chronic systemic corticosteroid use, and cerebral palsy/intellectual disability.

Data collection and measures

Patient demographic characteristics including age, weight, height, race/ethnicity, gender, SES, and insurance were extracted using Clinical Looking Glass. SES in Clinical Looking Glass is reported as a z-score calculated from six socioeconomic variables based on the census block and census tract information available on the patient's address (19). The z-score represents the deviation of the value from the mean of the New York state population. Body mass index (BMI) was calculated and classified as obese (BMI $\geq$ 95th percentile for age and gender), overweight (BMI $\geq$ 85th percentile and $<$ 95th percentile), normal weight (BMI $\geq$ 5th percentile and $<$ 85th percentile), or underweight (BMI $<$ 5th percentile) using the Centers for Disease Control Children's BMI Group Calculator (20).

Clinical variables related to asthma history and inpatient asthma management were obtained by chart review. These included asthma severity documented in the electronic medical record, classified based on the National Heart Lung and Blood Institute guidelines (14) by the child's primary care provider for children followed in the medical system, or by the admitting clinician for children new to the medical system. Parental report of asthma controller medication use at the time of hospitalization and history of prior hospitalization for asthma were also collected. Outcome measures included in the analysis were LOS, medication use during the hospital stay including use of continuous albuterol, intravenous magnesium sulfate, intravenous terbutaline, and aminophylline, need for admission to the intensive care unit (ICU) from the emergency department (ED), administration of

Table 1. Comparison of demographics and weight status between Hispanic and African American children.

	Hispanic (n = 593)	African American (n = 332)	p value
Male sex (n (%))	340 (57)	178 (54)	.27
Age in years ^a	7.3 ± 4.0	7.9 ± 4.2	.05
SES z-score ^a	−4.6 ± 2.6	−4.0 ± 2.8	.002
Insurance (n (%))			.23
Medicaid	223 (38)	130 (39)	
Subsidized	256 (43)	123 (37)	
Private	112 (19)	77 (23)	
None	2 (0.3)	2 (1)	
Weight (kg) ^a	31.8 ± 19.3	36.7 ± 24.6	<.001
BMI (kg/m ²) ^a	19.1 ± 5.0	19.9 ± 6.5	.04
BMI percentile ^a	66.3 ± 32.9	65.5 ± 33.7	.72
Obese/overweight (n (%))	253 (43)	143 (43)	.90

^aThese variables are reported as mean ± SD.

supplemental oxygen, and use of positive pressure ventilation. LOS was calculated as the time from ED triage to hospital discharge, both of which were extracted using Clinical Looking Glass.

Analysis

The main outcomes of interest were the difference in LOS, need for ICU admission, medication use in addition to albuterol, supplemental oxygen use, and need for positive pressure ventilation between African American and Hispanic children. The variables were compared between the two groups using *t* test for continuous variables and χ^2 test for categorical variables or their nonparametric equivalents based on distribution of data. As asthma severity was greater in African Americans, we conducted a multivariable regression analysis to elucidate the contribution of asthma severity to the measures of asthma exacerbation, including need for ICU. Statistical analysis was done using Stata version 14 (Stata Corp, College Station, TX).

The study was approved by the Albert Einstein College of Medicine Institutional Review Board.

Results

Demographic characteristics of the study population

During the study period, 1261 African American or Hispanic children were hospitalized with an asthma exacerbation. After incorporating the exclusion criteria, 925 charts were included in the analysis. Sixty-four percent (*n* = 593) of our sample was Hispanic and 36% (*n* = 332) was African American; a distribution that mimics the race/ethnicity distribution in the Bronx (21). The groups were similar in age, gender, and insurance status (Table 1). Although both groups were more than 2 standard deviations below the mean

SES, Hispanics had a lower SES z-score than African Americans (−4.6 vs. −4.0, *p* = .002). Furthermore, Hispanics had a lower mean weight (31.8 vs. 36.7 kg, *p* < .001) and mean BMI than African Americans (19.1 vs. 19.9, *p* = .04), but the proportion of children who were overweight or obese were not different between the groups.

Asthma severity classification and medication use

A higher proportion of African Americans had more severe asthma (12% vs. 7% with severe persistent classification, *p* = .02) (Table 2). However, the proportion of children who had a history of prior admissions, the total numbers of prior admissions, and controller medication use did not differ between Hispanics and African Americans (Table 2).

Characteristics of hospitalization

Hospitalizations for Hispanics and African Americans differed in the need for admission to the ICU from the ED, with African Americans being more likely to require ICU admission (14% vs. 8%, *p* = .01). African Americans were also more likely to receive intravenous magnesium sulfate (45% vs. 32%, *p* < .001). There was no difference between the two groups in LOS, time to albuterol every 4 h, total steroid dose for weight, seasonal distribution of admissions, or need for positive pressure ventilation, supplemental oxygen, aminophylline, terbutaline, and continuous albuterol (Table 3). Multivariable analysis showed that need for magnesium was an independent predictor of admission to the ICU and LOS, while asthma severity was not an independent predictor of admission to the ICU, need for magnesium during the hospital stay, or LOS in African Americans (Tables 4 and 5).

Table 2. Comparison of asthma severity and medication use between Hispanic and African American children.

	Hispanic (n = 593)	African American (n = 332)	p value
Prior hospitalization ^a	390 (66)	230 (69)	.28
No. of prior hospitalizations (mean ± SD)	3.5 ± 5.9	3.4 ± 5.3	.77
Asthma severity ^a			.02
Intermittent	79 (13)	55 (16)	
Mild persistent	166 (28)	85 (26)	
Moderate persistent	164 (28)	83 (25)	
Severe persistent	39 (7)	40 (12)	
Undefined	145 (24)	69 (21)	
Controller medication use ^a	359 (61)	196 (59)	.65

^aVariables are reported as n (%).**Table 3.** Comparison of hospitalization characteristics between Hispanic and African American children.

	Hispanic (n = 593)	African American (n = 332)	p value
Length of stay (days) ^a	2.9 ± 1.7	3.0 ± 1.7	.38
Time to albuterol every 4 h ^a	2.2 ± 1.6	2.3 ± 1.6	.24
ED to PICU ^b	49 (8)	45 (14)	.01
Total steroid dose for weight (mg/kg) ^a	6.3 ± 4.2	6.4 ± 4.5	.75
Need of supplemental oxygen ^b	213 (36)	115 (35)	.70
Use of magnesium sulfate ^b	188 (32)	149 (45)	<.001
Use of continuous albuterol ^b	50 (8)	38 (11)	.13
Use of aminophylline ^b	6 (1)	5 (2)	.51
Use of terbutaline ^b	3 (0.5)	3 (0.9)	.67
Need for positive pressure ventilation ^b	24 (4)	22 (7)	.08
Hospitalization by season ^b			
January–March	126 (21)	63 (19)	.19
April–June	95 (16)	68 (21)	
July–September	110 (19)	70 (21)	
October–December	262 (44)	131 (39)	

^aVariables are reported as mean ± SD.^bVariables are reported as n (%).**Table 4.** Multivariable analysis of the factors associated with initial ICU admission.

	OR	95% CI	p value
African American	1.32	(0.81, 2.15)	.26
SES	0.99	(0.91, 1.08)	.87
Mild persistent ^a	1.08	(0.58, 2.01)	.81
Moderate persistent ^a	1.11	(0.60, 2.06)	.74
Severe persistent ^a	1.27	(0.53, 3.02)	.59
Body weight	1.00	(0.98, 1.01)	.44
Use of magnesium	5.60	(3.94, 7.95)	<.001

^aIntermittent asthma was the reference category for asthma severity.**Table 5.** Multivariable analysis of the factors associated with LOS.

	β	95% CI	p value
African American	−0.12	(−0.33, 0.08)	.24
SES	0.02	(−0.02, 0.05)	.42
Mild persistent ^a	−0.09	(−0.33, 0.16)	.48
Moderate persistent ^a	0.11	(−0.14, 0.36)	.40
Severe persistent ^a	0.28	(−0.10, 0.66)	.15
Body weight	0.003	(−0.002, 0.008)	.20
Use of magnesium	1.22	(1.06, 1.37)	<.001

^aIntermittent asthma was the reference category for asthma severity.

Discussion

In our study comparing the characteristics of asthma hospitalizations between African American and Hispanic children residing in an urban environment in the US, we found that more African Americans

have severe persistent asthma and present to the hospital with more severe asthma exacerbations requiring greater use of intravenous magnesium sulfate and admission from the ED to the ICU as compared to Hispanics. Despite this, the LOS was similar between these two groups. These findings suggest that although African Americans have more severe exacerbations, they may be more responsive to inpatient management than Hispanics. Understanding the similarities and differences in characteristics of asthma hospitalization between these groups highlights the need for further investigation.

We found that the LOS was longer but the need for ICU was lower in our population than in a recent study comparing African Americans and NH white children using a national Medicaid database (22). This study used data from a variety of settings across the US, while our findings were based on a majority African American and Hispanic population in an urban setting, which may account for these differences. However, similar to our findings, this study found that there was higher ICU utilization, but not a longer LOS, among African American children hospitalized for asthma.

Similar LOS despite greater utilization of the ICU and magnesium sulfate independent of asthma

severity points to several possible distinctions between African American and Hispanic children hospitalized for asthma. It could indicate that these groups have different asthma phenotypes, with African Americans being more responsive to inpatient management. Alternatively, it could stem from between-group differences in disease perception by the patients and their caregivers with the parents of one group being more responsive to the child's clinical status and seeking care sooner. However, a previous study at our institution showed that there was no statistically significant difference in the actions taken with exacerbation (visit primary care physician or go to ED), including use of alternative therapies, between Hispanics and African Americans (23). It is also possible that African American children were sicker at the time of presentation or perceived to be sicker at the time of presentation, which led to healthcare providers in the ED and the hospital to be more aggressive with their management. We did not collect information on vital signs at the time of presentation to the ED, which may have potentially addressed this issue. As we are the first to identify these differences between two minority groups in the US with high disease burden, our findings highlight the importance and need to further probe the mechanisms that may explain these differences to optimize asthma care.

Prior studies have found African Americans and Hispanics to have higher disease severity as compared to whites, with higher asthma mortality rates, hospitalization rates, and emergency room/urgent care utilization (4,24,25). However, few studies have investigated differences between African Americans and Hispanics, who often have similar environmental exposures and SES. Our finding of higher likelihood of severe persistent asthma in African Americans compared to Hispanics validates prior studies showing higher indicators of asthma severity, including asthma mortality and emergency room utilization, among African Americans compared to both Hispanics and NH whites (4).

Given the multifactorial nature of the disease, there is a substantial environmental and socioeconomic component to the disease severity that may explain the higher disease burden among minority populations. Environmentally, our findings of no difference for most characteristics and outcomes of asthma hospitalizations between African Americans and Hispanics suggest that environmental exposures play a substantial role in disease severity and asthma hospitalization outcomes, given that both groups in our study were presumably exposed to similar urban

housing and neighborhood environments in the Bronx and have been previously found to have similar patterns of atopic sensitization (26). Socioeconomically, lower SES did not lead to worse hospital outcomes in the Hispanic group in our study, despite SES having been found to be a contributing factor to poor asthma control and outcomes in prior studies (27,28). This is likely because the SES of both groups was far enough below the mean that the relatively small difference between them did not have a significant clinical impact.

In light of these similarities, the differences in asthma severity and response to inpatient management between Hispanics and African Americans highlight a potential variation in the pathophysiology of asthma between these groups that may be driven by differences in genetic admixture. Higher African ancestry has been associated with asthma risk and with severity of asthma exacerbation, particularly in males (29,30). Polymorphisms in the beta2-adrenergic gene in African Americans have been associated with more frequent exacerbations, increased airway hyper-responsiveness, and decreased bronchodilator response, which all contribute to poor disease control (31–33). The Study of African Americans, Asthma, Genes and Environments consortium also reported single nucleotide polymorphisms in genes coding for pro-atopic inflammation (interleukin 13 and interleukin 4 receptors and more recently NF- κ B) among African American individuals with asthma that correlated with pulmonary function and bronchodilator responsiveness (34). Similarly, genetic polymorphisms have been also associated with bronchodilator responsiveness among Hispanics (35). Moreover, epigenetic variation has been associated with increased odds of asthma in Puerto Ricans (36), the Hispanic subgroup more afflicted by asthma, who are highly represented among Hispanics in the Bronx (13). The extent to which these genetic differences underlie the differences we observed in clinical presentation needs further investigation. Studies that compare these vulnerable populations with genetic differences but similarity in environmental exposures are particularly needed to further elucidate the role of nature versus nurture in childhood asthma disease burden.

We recognize that our study has certain limitations. The study was done at a single institution and the results may not necessarily generalize to children with asthma in other settings. However, the study institution is in a location with a very high prevalence of asthma and we had a robust sample size for the analysis. We also presume that patients with the same

severity of presentation received similar care given that it was at a single institution, whereas there could be a large variation in the standard treatments given to children depending on the site in a multicenter study. Second, as we have included children 2 years or older, we recognize that there may be some overlap with children who were treated for asthma that had viral-induced wheezing. However, children under 4 years have been included in multiple prior studies on asthma hospitalizations (22,37,38). Additionally, there was not a significant difference in age between the groups, so we assume that any overlap with viral-induced wheezing should be similar between the groups. Third, while Puerto Ricans among Hispanics have higher disease severity as compared to the other Hispanic subgroups, we did not have these additional details in our medical records to compare specific subgroups. As such, there may be differences that were not detected given that the analysis was done with all Hispanics in one group. Similarly, race and ethnicity were extracted from hospital registration data, which were populated from self-report rather than direct query for a research study. Last, baseline medication use was assessed based on self-report and does not necessarily signify consistent and appropriate use.

Conclusions

There are known racial and ethnic disparities in childhood asthma prevalence, severity, and outcomes in the US. Although there has been significant investigation of the disparities between whites and minorities, there has been much less comparison of disease severity between different minority groups and subgroups. Our findings demonstrate many similarities, yet a few differences, between asthma hospitalizations in Hispanics and African American children. Given that asthma characteristics in these groups are not all the same, exploration of the mechanisms underlying the differences between minority groups is important to reduce disparities and provide effective care to all children with asthma.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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