



Predictors of emergency department use in children with persistent asthma in metropolitan Atlanta, Georgia

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ABSTRACT

Background: Racial disparities are evident among children with asthma in the United States, with non-Hispanic black children at particularly high risk for poor asthma outcomes, including frequent emergency department (ED) use for asthma exacerbations.

Objective: To compare asthma features in non-Hispanic black vs white children in Atlanta, Georgia, and determine what clinical features predict future ED use for asthma.

Methods: Self-reported black and white children 6 to 17 years of age with persistent asthma treated with controller medications completed medical history questionnaires, lung function testing, aeroallergen sensitization testing, and venipuncture. Medical records were reviewed for asthma-related ED visits for 12 months after the initial study visit.

Results: A total of 276 children were enrolled. Black children, compared with white children, resided in more disadvantaged zip code areas and were more likely to have public insurance. Black children also had more features of asthma severity and more ED visits during the study period. Predictors of ED use, aside from a previous ED visit, differed by race. After adjustment for socioeconomic status, predictors of ED use in white children included an ED visit in the previous year and sensitization to pets and dust; in black children, predictors included ED use in the previous year, the number of asthma controller medications, forced expiratory volume in 1 second less than 80% predicted, blood eosinophil count greater than 4%, and mold sensitization.

Conclusion: Asthma features and ED use differ between black and white children in metropolitan Atlanta. Strategies to eliminate allergen exposure in the home and improve asthma control in these children may require tailoring for different racial groups.

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Introduction

Ongoing surveillance data clearly indicate racial disparities among children with asthma in the United States. Since 2001, the prevalence of asthma has been consistently higher in non-Hispanic black vs white children and reached a peak prevalence ratio of 2.1 (95% confidence interval [CI], 1.7–2.4) in 2011.¹ More recent (2014) prevalence estimates demonstrate a similar trend, with 13.4% vs 7.6% of non-Hispanic black vs white children with current asthma, defined by a physician diagnosis and current asthma features.² The prevalence of asthma is also higher in children with low household income¹ and children residing in metropolitan areas³;

however, a greater proportion of black children live in low-income and metropolitan environments than white children.⁴ Although at-risk rates of asthma attack prevalence (which remove the contribution of prevalence differences between groups) suggest that exacerbations are not more frequent in black vs white children, black children have nearly twice as many emergency department (ED) visits and hospitalizations for asthma and 4 times more asthma-related deaths.⁵

Although previous studies have examined risk factors for asthma exacerbations in children in outpatient settings,⁶ fewer studies have studied factors associated with asthma-related ED use in black vs white children. Although some studies suggest that disparities in ED use may be attributed to socioeconomic hardship variables (ie, limited household income or lower educational attainment)^{7,8} or community characteristics (ie, population density or limited health care access),⁹ other studies have found that asthma may be intrinsically more severe in black children¹⁰ and may be associated with differing biological features.¹¹ However,

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there are limited prospective studies of ED use in children with well-phenotyped asthma. Given recent federal efforts to reduce asthma-related racial disparities in US children,¹² the purposes of this study were to compare asthma features in non-Hispanic black vs white children residing in metropolitan Atlanta, Georgia, and to determine whether differing features predict future ED use for asthma after adjustment for socioeconomic status and residential population features. The results indicate that black children with persistent asthma have differing risk factors for ED use compared with white children that are possibly related to the home environment and might require tailored management approaches.

Methods

Self-reported non-Hispanic black and white children 6 through 17 years of age with persistent asthma treated with daily controller medications who resided in Fulton County or DeKalb County were recruited year-round from an outpatient asthma clinic in Atlanta, Georgia. Each participant had a history of 12% or greater reversibility in the forced expiratory volume in 1 second (FEV₁) after bronchodilator administration or airway hyperresponsiveness to methacholine, evidenced by a provocative concentration of methacholine of 16 mg/mL or less. Exclusion criteria included residence outside metropolitan Atlanta (defined as living outside the perimeter of Interstate 285), premature birth before 35 weeks' gestation, or other comorbid airway disorders, such as aspiration or vocal cord dysfunction. Permission to proceed with this study was granted by the Emory University Institutional Review Board. Informed written consent and assent were obtained from caregivers and participants, respectively.

Study Design and Procedures

Participants completed a single research characterization visit. Informed consent was obtained at the beginning of the visit. Children had no signs of acute respiratory illnesses at the time of characterization. The visit was postponed if an asthma exacerbation treated with systemic corticosteroids was reported within the preceding 4 weeks. Medical records were reviewed for asthma-related ED visits for 12 months after the initial study visit. Children were also telephoned at 6 and 12 months to assess for ED use outside our facility.

Children withheld bronchodilator medication before the study visit (ie, ≥ 4 hours for short-acting bronchodilators and ≥ 12 hours for long-acting bronchodilators). Spirometry (KoKo PDS, Ferraris, Louisville, Colorado) was performed at baseline and after bronchodilator reversibility testing with 4 inhalations of albuterol sulfate (90 μ g per inhalation). The best of 3 forced vital capacity (FVC) maneuvers was interpreted according to population reference equations.¹³ Allergy skin prick testing was performed after a 3-day antihistamine withhold using 12 allergen extracts: tree mix (*Quercus alba*, *Ulmus americana*, *Platanus acerifolia*, *Salix caprea*, *Populus deltoides*), grass mix (*Cynodon dactylon*, *Lolium perenne*, *Phleum pratense*, *Poa pratensis*, *Sorghum halepense*, *Paspalum notatum*), weed mix (*Artemisia vulgaris*, *Chrysanthemum leucanthemum*, *Taraxacum vulgare*, *Solidago virgaurea*), common ragweed (*Ambrosia artemisiifolia*), *Alternaria alternata*, *Aspergillus fumigatus*, *Cladosporidium herbarum*, dog dander, cat dander, German cockroach (*Blattella germanica*), *Dermatophagoides farinae*, and *Dermatophagoides pteronyssinus* (Greer Laboratories, Lenoir, North Carolina). Histamine and saline served as positive and negative controls, respectively. Test results were considered positive if a wheal of 3-mm diameter or greater and flare of 10 mm or more compared with the control were present 15 minutes after application. Venipuncture was performed for total serum IgE and blood eosinophils, which were quantified by a local laboratory (Children's Healthcare of Atlanta, Atlanta, Georgia). Medical history questionnaires assessed health care use during the

previous 12 months, symptoms during the previous 4 weeks, current medications, and current demographic features and exposures, such as tobacco smoke. Asthma-related quality of life during the preceding 2 weeks was also assessed with the Asthma Quality of Life Questionnaire (AQLQ), which has established measurement properties.^{14,15} Self-reported asthma characteristics and medical history information, such as asthma medications, previous health care use, and payer status, were verified by a review of medical records. The geographic coordinates of each participant's residential address were mapped in Geographic Information System software (ArcGIS Online, June 2016 Version Update, Esri, Redlands, California). The ArcGIS geocoder function was used to determine the exact geographic coordinate based on the residential street and house number. The map that contained all residential locations was then overlaid with the US median household income in 2015 and the US total crime index in 2016 available through Esri US data, which were derived from the US Census Bureau data and the Applied Geographic Solutions national CrimeRisk database, respectively. The total crime index represents the combined risks of rape, murder, assault, robbery, burglary, larceny, and vehicle theft compared with the national mean of 100. Other features of participant's zip code were obtained from US Census Bureau data and the American Community Survey available through the congressional district lookup feature at www.insidegov.com.

Statistical Analysis

Data were analyzed with SPSS Statistics, version 24 (IBM, Armonk, New York). Variables that were not normally distributed were logarithmically transformed before analysis. Both *t* tests and χ^2 tests were used to test for differences between black and white children. Cox proportional hazards regression was used to determine time to ED use adjusting for season of enrollment. For predictor analyses, redundant variables, such as lung function values and zip code features, were reduced with orthogonal varimax factor analysis. Cut points for blood eosinophils and FEV₁ were based on clinical relevance and practice guidelines.¹⁶ Univariate logistic regression was first performed on selected clinical predictors to obtain crude odds ratios (ORs) to estimate the probability of ED use. Race-specific models for black and white children were generated. Univariate predictors with a *P* < .15 were further reduced with multivariate forward conditional logistic regression. The log likelihood test was used to evaluate whether variables should remain in the model. Final estimates were adjusted for payer status (public vs private insurance) and zip code education level (percentage of adults with bachelor's degree). Results are presented as ORs 95% CIs.

Results

Two hundred sixty-five children with persistent asthma treated with daily asthma controller medications (inhaled corticosteroids, 239 [90.2%]; montelukast, 26 [9.4%]) were enrolled from metropolitan Atlanta. Children were enrolled year-round with no significant differences in season of enrollment (January–March, 72 [27.2%]; April–June, 80 [30.2%]; July–September, 50 [18.9%]; October–December, 63 [23.8%]; *P* = .21). The zip codes of enrolled participants had a mean (SD) population of 37,536 (16,450) people and 12.9% (5.1%) unemployment rates. In addition, 31.0% (15.5%) of individuals 25 years and older residing in these zip code areas had attained a bachelor's degree and 24.4% (11.2%) of households had incomes less than \$25,000/per year. However, racial differences in zip code features were noted. Black children were more likely than white children to reside in disadvantaged zip codes with higher unemployment rates, lower educational attainment, and lower income (Table 1 and Fig 1A). Black children were also exposed to more crime (Fig 1B). Other demographic features of participating

Table 1
Demographic Characteristics of the Participants at Enrollment^a

Characteristic	All participants (N = 265)	White (n = 92)	Black (n = 173)	P Value for white vs black
Age, mean (SD), y	11.5 (2.9)	11.5 (2.9)	11.5 (2.9)	>.99
Male sex	152 (57.4)	35 (38.0)	117 (67.6)	<.001
Public insurance	171 (64.5)	32 (34.8)	139 (80.3)	<.001
Tobacco smoke exposure	48 (18.3)	14 (15.2)	34 (20.0)	.22
Other conditions				
Obesity (BMI >95th percentile)	67 (25.4)	21 (22.8)	46 (26.7)	.49
Atopic dermatitis	149 (56.9)	44 (47.8)	105 (61.8)	.03
Historical recurrent sinusitis	111 (42.4)	41 (44.6)	70 (41.2)	.60
Historical pneumonia	148 (56.5)	49 (53.3)	99 (58.2)	.31
Residential (zip code) features, mean (SD)				
Population, in thousands	37.5 (16.5)	34.0 (18.1)	39.4 (15.2)	.009
Unemployment, %	12.9 (5.1)	9.3 (2.7)	14.8 (5.1)	<.001
Bachelor's degree, %	31.0 (15.5)	33.9 (18.4)	29.4 (13.6)	.02
Rented homes, %	37.5 (15.7)	31.4 (13.0)	40.8 (16.1)	<.001
Families in poverty, %	24.4 (11.2)	18.8 (8.0)	27.4 (11.5)	<.001

Abbreviation: BMI, body mass index.

^aData are presented as number (percentage) of participants unless otherwise indicated.

children are given in Table 1. Although there were no differences in age or environmental tobacco smoke exposure, black children were more likely to be male, have public insurance, and have physician-diagnosed atopic dermatitis (Table 1).

Asthma Features

Asthma features are listed in Table 2. Compared with white children, black children had an earlier age of asthma symptom onset and more urgent health care use for asthma in the preceding year despite treatment with more asthma controller medications. Black children also had higher blood eosinophil percentages, higher total serum IgE concentrations, more prevalent aeroallergen sensitization, and increased airflow obstruction with lower baseline FEV₁ and FEV₁/FVC values and higher absolute FEV₁ reversibility after bronchodilator administration (Table 2). Although the frequency of self-reported asthma symptoms in the preceding 4 weeks was not different between groups (Fig 2A), asthma-related quality of life was significantly more impaired in black children as reflected by lower total AQLQ scores (5.24 [1.18] vs 5.74 [1.24], $P = .02$) that were largely attributed to the burden of asthma symptoms and the environment (Fig 2B).

ED Use During the Study Period

Ninety-one (34.3%) of the 265 children enrolled had an ED visit for an asthma exacerbation within 12 months of enrollment. Twenty-one children (22.6%) were hospitalized. ED use was disproportionately higher in black (38.7%) vs white (26.1%) children ($P = .04$) and children with public (40.4%) vs private (23.4%) insurance ($P = .005$), irrespective of race. A significant interaction between race and payer status was also observed, with the highest odds of an ED visit observed in black children with public insurance compared with white children with private insurance (OR, 2.42; 95% CI, 1.22–4.81; $P = .01$). Zip code socioeconomic features were also associated with ED use. The odds of ED use were significantly greater for children residing in zip codes with greater unemployment (OR for each percentage increase, 1.10; 95% CI, 1.04–1.16; $P < .001$), lower educational attainment (OR for each percent increase in bachelor's degree attainment, 0.98; 95% CI, 0.96–0.99; $P = .009$), and a higher percentage of families living below the poverty threshold (OR for each percentage increase, 1.03; 95% CI, 1.01–1.05; $P = .03$). The proportion of children who visited an ED during the study, stratified by race and payer status, is also illustrated in Figure 3A–C.

Predictors of ED Use

Univariate (unadjusted) predictors of ED use are given in Table 3. Whereas ED use in the previous year was associated with an ED visit during the study period irrespective of race, other predictors, including patterns of specific aeroallergen sensitization, differed by race (Table 3). In multivariate analyses, different predictors were identified for black vs white children even after adjustment for potential confounding effects of payer status and regional (ie, zip code) educational attainment (Table 4). In white children, an ED visit in the previous year and sensitization to dust mites and pets were associated with ED use during the study period. White children were also more likely than black children to report having a cat (27.5% vs 9.5%, $P = .001$) or dog (58.2% vs 34.3%, $P < .001$) inside the home. However, in black children, the variables associated with ED use during the study period included an ED visit in the previous year, the number of asthma controller medications, FEV₁ less than 80% predicted, blood eosinophil count greater than 4%, and mold sensitization (Table 4).

Discussion

Although racial disparities in asthma prevalence and outcomes are apparent in US children, the responsible factors are multifactorial and not well understood. In this prospective study of children with persistent asthma residing in metropolitan Atlanta, we identified differences in the geographic residential features (ie, zip code population attributes) and household socioeconomic features (ie, payer status) of black vs white children that were each independently associated with future ED visits. After adjustment for these potentially confounding factors, many clinical predictors of ED use, such as aeroallergen sensitization profiles, still differed between black and white children. For example, whereas dust mite sensitization and pet sensitization (and a higher prevalence of indoor pet ownership) predicted ED use in white children, mold sensitization predicted ED use in black children. However, other predictors of ED use did not differ by race. Similar to the recent multicenter study by Teach et al,⁶ our results confirm that previous ED visits are a strong predictor of future ED use but additionally demonstrate that this variable is a predictor in both races.

Although the regional and prospective nature of this analysis resulted in limited sample sizes for modeling and a corresponding lack of precision in the adjusted results, the findings confirm and extend other studies of inner-city populations that have demonstrated multifactorial reasons for asthma-related healthcare use.^{9,17,18} In one study of asthma hospitalizations and deaths in

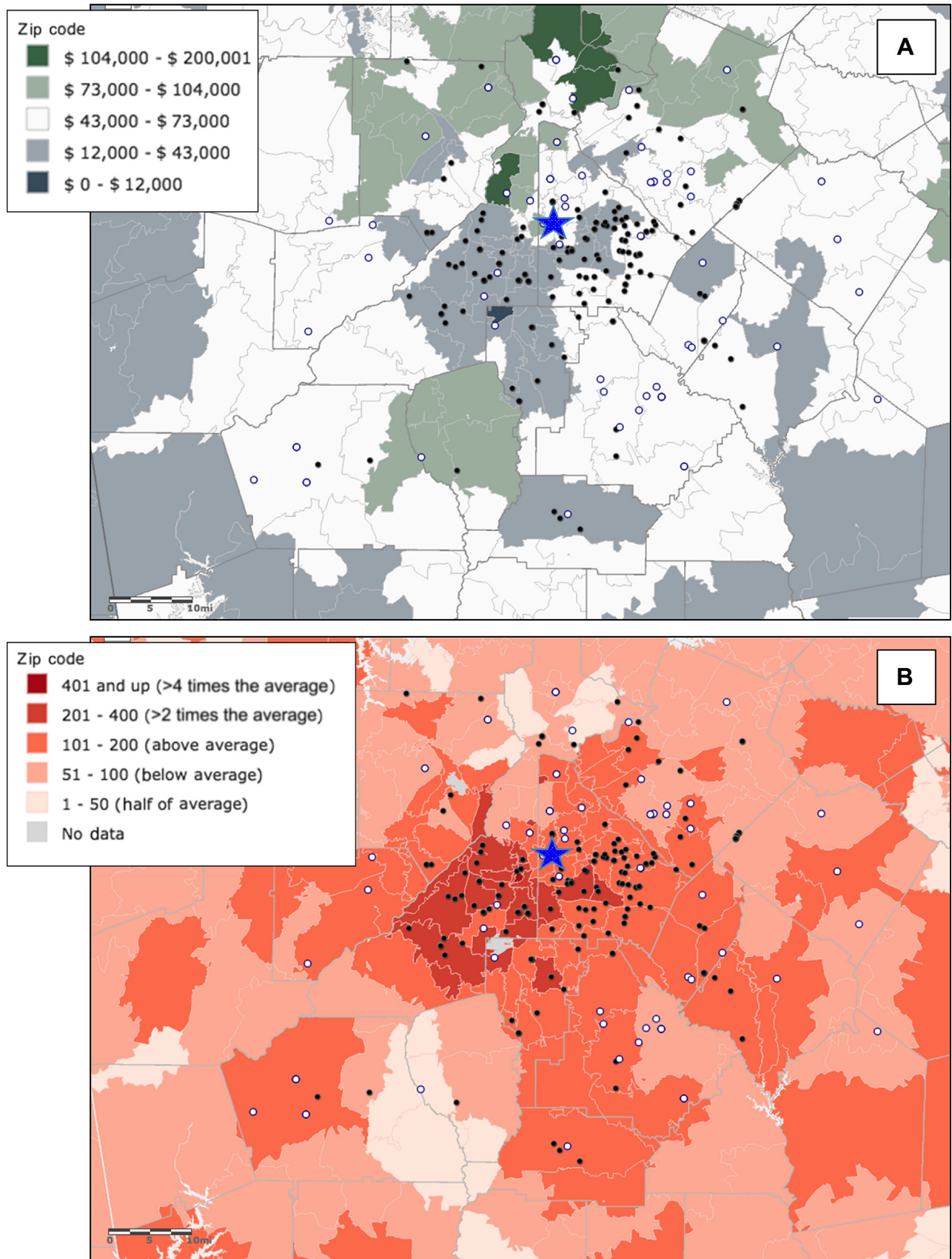


Figure 1. Residences of children with overlays of median household income (A) and total crime indexes (B) by zip code. The crime index value for the United States as a whole is 100; values of 200 indicate twice the national average. Black and white circles represent black and white children, respectively. The blue star represents the location of the clinic and emergency department.

Table 2
Characteristics of Asthma in the Participants^a

Characteristic	All participants (N = 265)	White (n = 92)	Black (n = 173)	P Value for white vs black
Age at symptom onset, median (IQR), y	1 (1–4)	3 (1–6)	1 (0.7–3)	<.001
Health care use for asthma				
Emergency department visit (previous year)	153 (57.7)	36 (39.1)	117 (67.6)	<.001
Hospitalization (previous)	90 (34.1)	15 (16.3)	75 (43.6)	<.001
Intubation (ever)	61 (23.1)	4 (4.3)	57 (33.1)	<.001
Daily asthma controller medications				
No. of controller medications, median (IQR)	3 (2–3)	2 (2–3)	3 (2–3)	.008
High-dose inhaled corticosteroid ^b	150 (56.6)	32 (34.8)	118 (68.2)	<.001
Systemic corticosteroid	19 (7.2)	6 (6.5)	13 (7.5)	.77
Long-acting β -agonist	179 (67.5)	51 (55.4)	128 (74.0)	.002
Montelukast	199 (75.1)	61 (66.3)	138 (79.8)	.02
Omalizumab	8 (3.0)	2 (2.2)	6 (3.5)	.56
Blood eosinophils, median (IQR), % ^c	5.0 (2.3–8.0)	3.5 (1.6–7.2)	5.2 (3.2–8.7)	<.001
Serum IgE, median (IQR), kU/L ^c	227 (80–698)	139 (22–562)	253 (145–786)	.002
Aeroallergen sensitization				
Positive aeroallergen test results, median (IQR) (No. of 12)	3 (1–5)	2 (0–5)	3 (1–6)	.03
Pollen sensitization	93 (35.1)	27 (29.3)	66 (38.2)	.02
Mold sensitization	76 (28.7)	22 (23.9)	54 (31.2)	.04
Dust mite sensitization	129 (48.7)	39 (42.4)	90 (52.0)	.003
Dog or cat sensitization	73 (27.5)	28 (30.4)	45 (26.0)	.97
Cockroach sensitization	57 (21.5)	16 (17.4)	41 (23.7)	.06
Prebronchodilator lung function, mean (SD)				
FVC, % predicted	102 (16)	104 (15)	101 (17)	.29
FEV ₁ , % predicted	91 (18)	94 (17)	89 (19)	.03
FEV ₁ /FVC, % predicted	89 (12)	92 (12)	88 (12)	.03
FEV ₁ /FVC, actual ratio	0.78 (0.10)	0.80 (0.10)	0.77 (0.10)	.004
Postbronchodilator lung function, mean (SD)				
FVC, % predicted	108 (16)	107 (14)	110 (17)	.17
FEV ₁ , % predicted	103 (16)	104 (15)	103 (17)	.86
FEV ₁ /FVC, % predicted	95 (11)	97 (13)	94 (10)	.10
FEV ₁ /FVC, actual ratio	0.83 (0.08)	0.85 (0.07)	0.82 (0.08)	.003
FEV ₁ reversibility, mean (SD), % change from baseline	16.0 (15.7)	11 (10)	18 (18)	.001

Abbreviations: FEV₁, forced expiratory volume in 1 second; FVC, forced vital capacity; IQR, interquartile range.

^aData are presented as number (percentage) of participants unless otherwise indicated.

^bHigh-dose inhaled corticosteroid is defined as a daily dose of greater than 440 or greater than 880 μ g of fluticasone propionate equivalent for children 6 through 11 years old and children 12 through 17 years old, respectively.

^cP values obtained after logarithmic transformation.

New York City, the rate of hospital admission was nearly 5 times higher in blacks than whites and was further associated with striking differences in neighborhood features. In that study, nearly 75% of the geographic variation in the asthma hospitalization rate was associated with median household income and the percentage of the population that was black.¹⁷ A separate study similarly observed 88-fold variation in asthma hospital admission rates across a single county that was strongly associated with black race and neighborhood socioeconomic variables, such educational

attainment, car access, and population density.⁹ Financial and social hardship variables, such as unemployment, lack of home ownership, and single or not married status, have also been associated with hospital readmission in regional populations of children.^{7,8} A large, retrospective analysis of the National Health Interview Survey further demonstrated on a national level that living in an inner-city environment per se may have less of an effect on key asthma outcomes than non-Hispanic black race or individual household variables, such as those described above.¹⁹

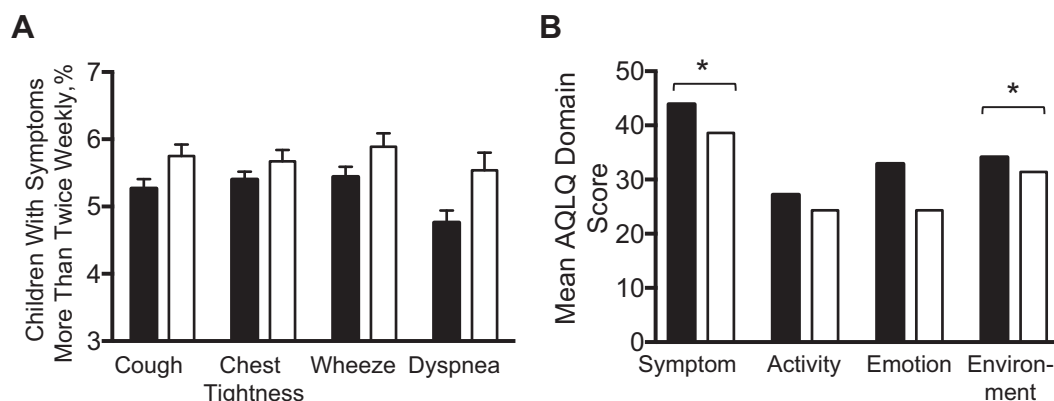


Figure 2. The percentage of children with symptoms more than twice weekly (A) and individual domain scores for the Asthma Quality of Life Questionnaire (AQLQ) (B). Black and white bars represent black and white children, respectively. * $P < .05$.

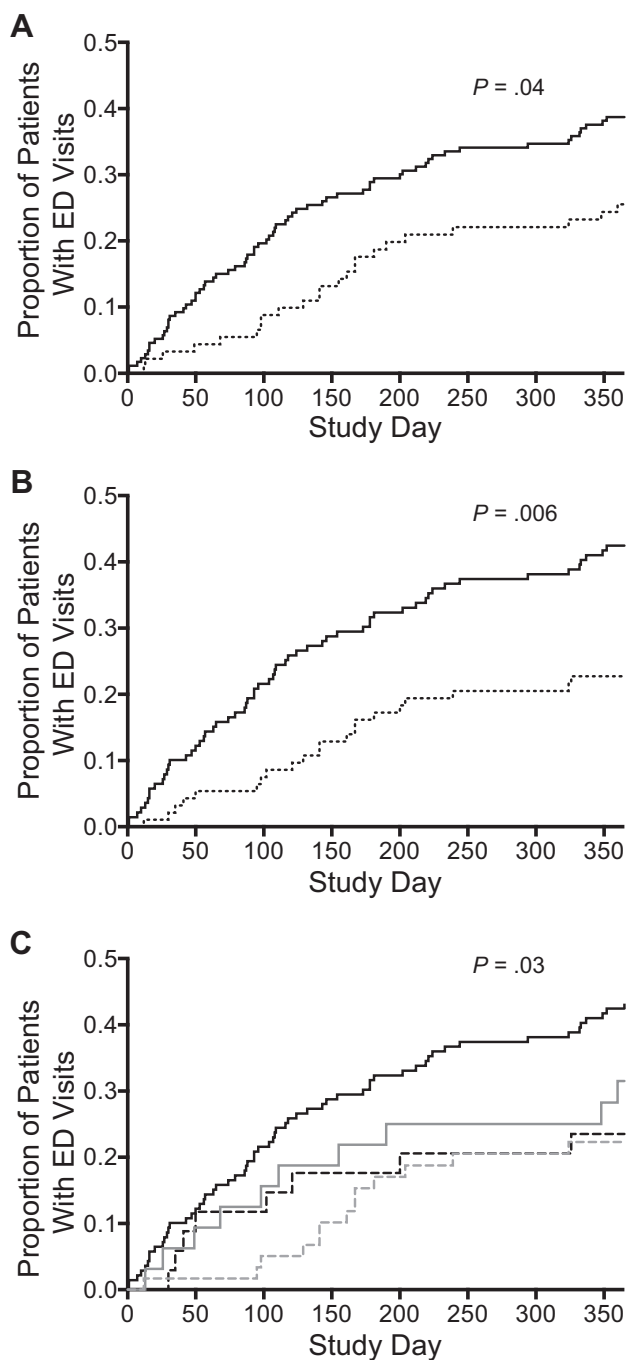


Figure 3. Proportion of participants with an emergency department (ED) visit during the study, stratified by black (solid line) vs white race (dashed line) (A), public (solid line) vs private insurance (dashed line) (B), and white and black children with public insurance (gray and black solid lines, respectively) vs white and black children with private insurance (gray and black dashed lines, respectively) (C).

Separating biological factors from socioeconomic and residential features in the analysis of asthma-related racial disparities is challenging, but some evidence exists to support the hypothesis of greater intrinsic disease severity in blacks. In a relatively large analysis of adults with well-phenotyped asthma enrolled in the National Heart, Lung, and Blood Institute's Severe Asthma Research Program, serum IgE was significantly associated with asthma severity in blacks but not in whites.¹¹ In that same study, blacks with severe asthma compared with whites with severe asthma also had lower lung function as reflected by FEV₁ and a

Table 3

Univariate (Unadjusted) Predictors of ED Use

Predictor	White children (n = 92)		Black children (n = 173)	
	OR (95% CI)	P Value	OR (95% CI)	P Value
Age at symptom onset	0.75 (0.60–0.92)	.006	0.89 (0.77–1.02)	.087
ED visit for asthma (previous year)	8.33 (2.86–24.28)	<.001	3.25 (1.56–6.78)	.002
Intubation for asthma (ever)	0.96 (0.09–9.51)	.96	1.36 (0.71–2.59)	.35
No. of controller medications	1.37 (0.86–2.19)	.18	2.05 (1.38–3.02)	<.001
Blood eosinophil count >4%	1.68 (0.63–4.49)	.30	2.20 (1.07–4.50)	.03
Serum IgE >150 kU/L	1.69 (0.61–4.62)	.30	1.48 (0.71–3.05)	.29
Pollen sensitization	1.75 (0.63–4.88)	.28	1.99 (0.98–4.07)	.06
Mold sensitization	1.98 (0.68–5.74)	.21	2.21 (1.08–4.53)	.03
Dust mite sensitization	3.75 (1.28–11.03)	.02	2.18 (0.97–4.89)	.06
Dog or cat sensitization	3.67 (1.30–10.34)	.01	1.63 (0.78–3.41)	.19
Cockroach sensitization	0.93 (0.27–3.32)	.92	2.10 (0.99–4.46)	.053
FEV ₁ <80% of predicted	3.44 (0.98–11.99)	.05	2.98 (1.49–5.97)	.002

Abbreviations: BMI, body mass index; CI, confidence interval; ED, emergency department; FEV₁, forced expiratory volume in 1 second; OR, odds ratio.

stronger family history of asthma. Other genetic studies suggest that black patients may have unique asthma-associated variants that increase the risk of asthma susceptibility^{20–23} and potentially asthma severity as reflected by lung function values.²⁴ Indeed, studies have found an inverse association between lung function and ancestry, with a decrease in FEV₁ of approximately 50 to 100 mL for each 20% increase in African ancestry.^{25,26} A separate analysis further noted that every 20% increase in African ancestry was associated with a 4.3-fold increased rate of exacerbation in males.²⁷

Home environmental assessments were not performed in the study, which is a potential limitation. Therefore, the nature and degree of the allergen exposures in our participants are not clear. Our observation of differing aeroallergen sensitization profiles suggests that there may be racial differences in the home environment of black vs white children that contribute to asthma outcomes. Others have similarly reported a higher prevalence of cat or dog ownership in white vs black households that may be attributed to higher income.^{28,29} Although a pooled analysis of birth cohorts found that pet ownership did not modify the risk of asthma onset in children,³⁰ sensitized children who own pets may be at

Table 4

Multivariate (Adjusted) Predictors of ED Use^a

Predictor	Adjusted OR (95% CI)	P Value
White children		
ED visit (previous year)	7.03 (2.36–20.91)	<.001
Dust mite sensitization	5.04 (1.45–17.51)	.01
Dog or cat sensitization	3.09 (1.08–8.88)	.04
Black children		
ED visit (previous year)	2.99 (1.42–6.29)	.004
No. of controller medications	2.02 (1.36–3.02)	<.001
FEV ₁ <80% of predicted value	2.91 (1.43–5.92)	.003
Blood eosinophils >4%	2.25 (1.09–4.62)	.03
Mold sensitization	2.32 (1.07–4.65)	.03

Abbreviations: BMI, body mass index; CI, confidence interval; ED, emergency department; FEV₁, forced expiratory volume in 1 second; OR, odds ratio.

^aAdjusted for payer status (public vs private insurance) and zip code education level (percentage of adults with a bachelor's degree).

higher risk for severe asthma exacerbation requiring intensive care.³¹ Cat and dog ownership also contributes to higher indoor endotoxin concentrations, which have been associated with wheezing and increased respiratory medication use.³² Indoor dust mite and mold exposures are other risk factors that have also been linked to exacerbations of asthma in children.^{6,33,34} However, neither dust mite prevention strategies^{35,36} nor remediation of root causes of home moisture and mold have had a clear effect on asthma outcomes in children, in part because of the limited quality of available evidence.³⁷

Although we assessed payer status and zip code features in the present study, the lack of detailed information on household income and household education is a potential limitation. In a recent study of 686 black children with asthma, low household income was the strongest individual socioeconomic predictor of poor asthma control.³⁸ However, a composite socioeconomic index that consisted of maternal education level, annual household income, and insurance status also predicted worse asthma outcomes in black children that were not limited to the very poor alone.³⁸ We also did not collect information on residential relocation during the study period, which could affect aero-allergen exposures or residential geographic features. Access to care is also an important issue that was not adequately addressed with our study design. In a recent study of children presenting to an ED in Baltimore, Maryland, for asthma-related care, nearly one-third of parents reported access to care (ie, inability to receive a same-day appointment with a pediatrician or work conflicts) as a major factor in their decision to seek emergency care.³⁹

Another limitation is the lack of prescription adherence monitoring in our participants, which could have contributed to ED use during the study period. A large study of 2,499 children in the National Health and Nutrition Examination survey during 3 periods between 1988 and 2008 noted significantly lower preventive asthma medication use in black vs white children, children without health insurance, and adolescents (ie, 12 to 19 year old) vs younger age groups.⁴⁰ Other studies have similarly found that black patients are less likely to adhere to asthma prescriptions than whites,⁴¹ perhaps because of negative inhaled corticosteroid beliefs and greater endorsement of complementary and alternative medicine,⁴² although asthma prescription adherence is still quite low even in insured, predominantly white populations when measured by electronic claims.⁴³ It is also possible that prescribing practices by health care professionals may have differed between the racial groups. Previous studies have found that black vs white children enrolled in the Medicaid system may be less likely to receive preventative treatments, such as inhaled corticosteroids.⁴⁴ A separate study of adults with asthma similarly noted that black vs white patients were less likely to meet eligibility criteria for Medicare prescription drug benefits, in part because of decreased prescription use in blacks.⁴⁵ Similarly, in the present study, black vs white children had more atopic features and greater disease severity, yet there were no differences in the receipt of anti-IgE therapy between groups.

In conclusion, the results of this study reveal differences in asthma features and asthma-related ED use between black and white children residing in metropolitan Atlanta. Because exposures and sensitization patterns clearly differ among cities, validation in other populations is needed before the results can be generalized to other areas. Given that poor asthma outcomes are also observed in black children living in rural areas with more limited access to primary and ED care,⁴⁶ other studies in rural populations are also needed. Nonetheless, our findings of racial differences in children living in metropolitan Atlanta suggest that strategies to eliminate allergen exposure in the home and improve

asthma control may require tailoring for different racial groups in this area. However, an in-depth individualized assessment and personalized approach to asthma care is also needed to improve outcomes.

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