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Racial Disparities in Childhood Asthma in the United States: Evidence From the National Health Interview Survey, 1997 to 2003

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ABSTRACT

OBJECTIVE. To examine differences in asthma prevalence and emergency department (ED) visits for asthma between non-Hispanic black and white children, and factors that might explain those differences, in a large, nationally representative sample covering the period 1997 to 2003.

METHODS. Bivariate and multivariate regression analyses (with logit and multinomial logit methods) were conducted with a sample consisting of all non-Hispanic black and white children (<18 years of age) from the 1997 to 2003 rounds of the National Health Interview Survey. Models included a progressively larger set of controls for factors that might explain racial differences in asthma prevalence and ED visits for asthma.

RESULTS. Being black was associated with a greater likelihood of currently having asthma and with a greater likelihood of having gone to the ED for asthma treatment in the past 1 year. Elevated asthma risks for black children were robust after controlling for a host of child and family characteristics that might explain them.

CONCLUSIONS. Black children are more likely to have asthma and to experience ED visits for asthma, compared with otherwise comparable white children, and these racial disparities cannot be explained by differences in measurable child or family characteristics. These results suggest that racial disparities in asthma continue to pose risks for black children, and they point to the need for additional research into potential explanations and remedies.

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Key Words
asthma, racial disparities, National Health Interview Survey, black, children, health

Abbreviations
NHIS—National Health Interview Survey
ED— emergency department
MSA—metropolitan statistical area

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Asthma is a leading chronic illness among children in the United States.[1,2] Although it affects individuals of all ages, races, ethnicities, and incomes, it afflicts black and poor children disproportionately.[3,4] The prevalence of asthma among young children, and particularly among low-income children of color, has continued to increase in the past 2 decades, despite increased scientific understanding of its causes and treatments.[5–8]

Medical researchers and social scientists have identified multiple contributors to asthma prevalence and severity, including environmental factors (eg, air pollution and cigarette smoke),[9] the child's own physiologic features (eg, low birth weight),[8,10] socioeconomic and demographic differences (eg, parental income and education), access to and use of medical care and health insurance,[1,11] and parents' history of asthma and their health and health-related behaviors (eg, depression, weight, and smoking).[12,13] Asthma's complex etiology, involving social and environmental influences, could explain the higher prevalence among economically and socially marginalized groups.[14] Despite this hypothesis, research has not accounted completely for the racial differences in asthma risk.[1,3] For instance, in most studies to date, black children demonstrated consistently higher asthma prevalence, compared with white children, even when income, education, and housing-related variables were considered.[15]

Many studies have documented the racial gap in asthma prevalence, but few have explained it. Those that come closest identify disparities in income,[15,16] preventive care,[17,18] urban residence,[19] and birth weight[20] as primary explanations for the differences. However, the findings are mixed. Some studies account completely for the disparities in prevalence,[19,21] whereas others do not. The most recent studies use data from the middle to late 1990s. Although this period corresponds to the increase in asthma prevalence since the 1980s, it indicates little about the continued increase after 2000[22] and whether racial disparities remain presently.

This study focused on race and asthma among non-Hispanic black and white children, with the use of a nationally representative sample from 1997 to 2003. We assessed the racial gaps in parental reports of doctor-diagnosed asthma and hospital emergency department (ED) visits for asthma in the past 1 year by exploring an extensive set of explanatory factors, including differences in socioeconomic and demographic characteristics, birth weight, health insurance, routine care, and maternal history of asthma, health, and health behaviors. We found racial differences in virtually all of these characteristics and tested whether these differences explained the greater prevalence of asthma and greater likelihood of ED visits for asthma among black children in the United States.

The approach we used in this study was first to measure racial differences in rates of lifetime asthma (ever been diagnosed with asthma), current asthma (lifetime asthma with an episode or attack of asthma in the past 1 year), and ED visits for asthma in the past 1 year, independent of other explanatory factors. We then examined which variables, when added to our statistical models, reduced or completely explained the racial disparities. The following research questions were addressed. (1) Are black children more likely than white children to have lifetime asthma and current asthma? (2) Are black children more likely than white children to have gone to a hospital ED for asthma in the past 1 year? (3) Do racial discrepancies in socioeconomic and demographic features, birth weight, health insurance, routine care, and maternal history of asthma, health, and health behaviors account for the racial differences in lifetime and current asthma prevalence and ED visits for asthma among US children?

METHODS

Sample

The data were from the National Health Interview Survey (NHIS), a cross-sectional, in-person, household interview administered annually by the Centers for Disease Control and Prevention, National Center for Health Statistics.[23] The NHIS sample represents the civilian noninstitutionalized population in the United States and provides a leading source of national statistics on child and adult health, including asthma prevalence.[5] In 1997, the NHIS was redesigned substantially and the questions on asthma were altered.[24] After the redesign, 1 child was selected randomly from participating households with children <18 years of age, and a knowledgeable adult was interviewed about that child's health. For the present analyses, we pooled NHIS child data from 1997 to 2003, for the most current asthma estimates available after the redesign.

Our objective was to explore whether racial disparities in childhood asthma exist in a large, nationally representative sample and, if so, what factors account for the discrepancies. We were particularly interested in non-Hispanic black children, whose estimated prevalence of asthma is consistently higher than that seen for non-Hispanic white children.[3] The primary sample consisted of 14 487 non-Hispanic black children and 49 042 non-Hispanic white children from 1997 to 2003 (n = 63 529). Children who were identified as Hispanic were excluded, as were children who were identified as some race other than white or black.

We also conducted analyses with several subsamples. We examined the subsample of children with public health insurance (n = 11 151), because low income and inadequate health insurance have been implicated in asthma severity.[2,11,25] We conducted analyses with the subsample of children who visited a primary physician when sick (n = 48 613) (as opposed to a clinic, health

center, or hospital ED or outpatient department), because these children might receive more consistent care for their asthma and/or have more accurate diagnoses. We stratified children according to whether they resided in a metropolitan statistical area (MSA), which is an indicator of living in an urban setting as opposed to a rural setting, to determine whether racial disparities existed in both urban and rural areas. We stratified children according to age (ie, separating children 0–3, 4–7, 8–11, and 12–17 years of age) to determine whether there were differences in racial disparities according to age group.

A final subset of analyses were conducted with children from the primary sample whose mothers were selected randomly to answer detailed questions about their own health (n = 30 963). With this sample, we learned additional information about the family, such as maternal asthma history and cigarette-smoking behavior. These factors are also associated with asthma risk and the risk of acute exacerbations of childhood asthma.[26–29]

Measures

Asthma prevalence and ED visits for asthma are measured in the NHIS with 3 questions. The first question asks, "Has a doctor or other health professional ever told you that [sample child] had asthma?" If the answer is yes, then this child is coded as having lifetime asthma. The second question asks about asthma episodes in the past 1 year among children ever diagnosed, "During the past 12 months, has [sample child] had an episode of asthma or an asthma attack?" If the answer is yes, then this child is coded as having current asthma. The third question asks about ED use, "During the past 12 months, did [sample child] have to visit an ED or urgent care center because of his/her asthma?" If the answer to this question is yes, then the child is coded as having an ED visit for asthma in the past 1 year. In addition, we used these 3 questions to create a categorical variable to indicate whether a child falls into 1 of 4 mutually exclusive categories, ie, no asthma diagnosis within the child's lifetime, has lifetime asthma but not current asthma, has current asthma but did not have an ED visit in the past 1 year, or had an ED visit for asthma in the past 1 year.

Socioeconomic and demographic covariates included the child's gender, child's age, mother's age, mother's education, number of children and parents in the household, geographic region (ie, Northeast, Midwest, South, or West), and household income. NHIS respondents were asked to identify their household income range. A problem with the NHIS income ranges is that they are not adjusted for price inflation; therefore, the ranges correspond to different real (ie, price-adjusted) incomes in different years. To handle this problem, we assigned incomes within each range for each household in the sample, with the use of yearly data from the 1997 to 2003 March Current Population Surveys. (Each household in the NHIS was assigned an income equal to the average income for all Current Population Survey families falling within the NHIS income category whose household head's education matched that of the NHIS household head's educational level. Averages in the Current Population Surveys were computed with sample weights.) We then adjusted incomes for inflation, with the use of the Consumer Price Index series from the Bureau of Labor Statistics (with the base year set to 1999).[30]

The 1997 to 2001 NHIS surveys included a variable for whether a family lived in a MSA. A MSA represents a county or group of neighboring counties that includes a city with ≥50 000 people. In subanalyses in which we stratified results according to MSA, we restricted our sample to the 1997 to 2001 survey years.

Other variables that were found to be correlated with asthma risk or ED use in past research and were included in our models included birth weight, type of health insurance (ie, public, private, or none), and source of routine health care (ie, clinic/health center, regular doctor, ED, other, or none). For a subset of children whose mother was the randomly selected household adult who answered specific questions about her own health, we also had information about the mother's health, including asthma history, depressive symptoms, BMI, and whether she smoked cigarettes (ie, currently, formerly, or never). To assess asthma history, mothers were asked whether they had ever been diagnosed as having asthma. Depressive symptoms were measured with the 6-item Composite International Diagnostic Interview-Short Form.[31] Each mother's BMI was calculated in the NHIS from her height and weight measurements.

Analyses

We conducted bivariate, logistic regression (logit), and multinomial logistic regression (multinomial logit) analyses. Bivariate χ^2 statistics were used to compare the means for black and white children for the asthma outcomes and for all independent variables in our models. These bivariate statistics gave us a first indication of the differences that existed between the 2 race groups. In a second bivariate test, we used nonparametric methods for regression analysis of current asthma with respect to household income, and we graphed the results according to race to compare trends according to income. We emphasize the relationship between race, income, and childhood asthma because of the strong correlations between income and health status[32] and between income and race. Research documents consistently that children in lower-income families are at higher risk of asthma.[1,33–35] We wanted to determine whether income seems to explain the racial differences in prevalence.

We next used logistic regression models to test other factors that might account for the higher prevalence of

asthma among black children. These models measured the relative risk that black children have current asthma (ie, were diagnosed as having asthma and had an asthma episode or attack in the past 1 year), compared with the reference group of white children. In a series of additive models, we examined how the relative risk for black children changed as more explanatory variables were added. We began by regressing current asthma with respect to a small set of demographic variables, ie, gender, age, and survey year. Prior research indicated that diagnosed asthma is more common among boys and older children[16] than among girls and younger children (although whether asthma can be diagnosed properly among very young children has been debated).[36] Asthma prevalence estimates vary according to year[5]; therefore, we also controlled for year in all of our models by including a set of indicator variables for the survey year.

In the second model, we added other socioeconomic and demographic variables, including income (measured as the natural logarithm of income); indicators for the level of maternal education, family structure, and region; the number of children in the household; and maternal age. We examined whether race was still associated with asthma prevalence after adjustment for these characteristics, which are often included in studies and have been shown to be related to asthma.[6,16,33]

In subsequent models, in addition to the control factors included previously, we adjusted sequentially for birth weight, health insurance status, and the child's source of routine medical care. Low birth weight is a risk factor for asthma[10] and is also more common among black children; therefore, we hypothesized that it would have an appreciable effect on the racial disparity in asthma prevalence. Health insurance and medical care are also tied to asthma risk and are differentially available to black and white children in the United States.[2,11,25]

We next conducted logistic regression analyses with several subsets of children. First, to test the hypothesis that poor-quality health insurance, or indeed poverty, explains the racial disparity in asthma prevalence, we conducted analyses limited to children with public health insurance. Second, to test whether black children are more likely to experience current asthma because they are less likely to have a regular doctor for sick care, we performed similar analyses for children who visited a primary physician when sick. Third, we stratified children according to age group, to test whether racial disparities differed according to age. Fourth, we divided children living in MSAs and non-MSAs, to test the hypothesis that the greater proportion of black children living in metropolitan or more-urban areas might explain racial differences in asthma prevalence.

In our final models, we conducted analyses for the subsample of children whose mothers provided detailed information about their own health, allowing us to measure maternal asthma, smoking, depression, and BMI. In one model, we added maternal asthma, which is a risk factor for children, possibly because it may indicate a genetic predisposition to asthma.[8,26] In the next model, we included maternal smoking, maternal depression, and maternal BMI. Prior research showed that maternal smoking and maternal depression are related to asthma prevalence and maintenance.[12,37] Maternal BMI was included because black mothers have higher average BMI values than do white mothers, and maternal BMI is associated strongly with children's obesity.[38] Previous research indicated that children's obesity and asthma are correlated,[26,39] although it is not clear whether children who are obese are at greater risk of developing asthma or vice versa. We could not control for children's BMI because the NHIS does not collect information on the weight or height of children.

After analyzing the logistic regression models for current asthma, we used multinomial logistic regression analysis to examine racial disparities in rates of lifetime asthma, current asthma, and ED visits for asthma in the past 1 year. Specifically, we tested the relative risk that black children, compared with white children, would fall into 4 mutually exclusive categories, ie, no asthma diagnosis within the child's lifetime, lifetime asthma with no episode or attack in the past 1 year, current asthma (an asthma diagnosis with an asthma attack or episode in the past 1 year) but no ED visit, or an asthma episode or attack in the past 1 year with an ED visit. We regressed this categorical variable with respect to each of the covariates used earlier in the logistic regression models, for the full sample and also for the subsamples of children described above. If we think of these categories as reflecting 3 different types of asthma cases, with increasing intensity of symptoms, then we can interpret them as measures of severity. However, we need to be cautious in this regard, because there may be other reasons why otherwise similar children would diverge with respect to ED use. Families may have different views regarding where they should go for asthma treatment or what type of episode necessitates an ED visit.

Weighting

The NHIS provides yearly sampling weights to approximate whole population variation. To ensure consistency and generalizability, we present weighted bivariate and multivariate results (as expected, weighting altered the bivariate results but did not affect the multivariate results substantially). We applied the weights by using the pweight command in Stata software (Stata Corp, College Station, TX).

RESULTS

Bivariate analyses revealed that black and white children in the NHIS differed considerably with respect to health and socioeconomic/demographic measures (Table 1).

TABLE 1 **Descriptive Statistics According to Race, 1997 to 2003**

Variable	Weighted Proportions/ Means	
	Black	Non-Hispanic White
Full sample	$n = 14\,487$	$n = 49\,042$
Child asthma, %		
Lifetime asthma (ever diagnosed)	15.7	11.5[a]
Current asthma in past 1 y (with or without ED visit)	7.6	5.3[a]
Asthma ED visit in past 1 y	3.9	1.3[a]
Socioeconomic and demographic characteristics		
Female child, %	49.4	48.7, NS
Child age, y	8.7	8.7, NS
No. of children in household	2.6	2.3[a]
Mother's age, y	30.9	34.9[a]
Single-parent household, %	53.2	18.1[a]
Two-parent household, %	39.5	80.2[a]
Neither parent in household, %	7.3	1.7[a]
Household income (1999 dollars)	39 230	66 794[a]
Unreported income, %	6.2	4.0[a]
Region, %		
Northwest	16.9	20.1[a]
Midwest	19.9	30.0[a]
South	55.5	33.1[a]
West	7.6	16.7[a]
MSA (1997–2001), %	85.9	75.0[a]
Non-MSA (1997–2001), %	14.1	25.0[a]
Maternal education, %		
8th grade or less	1.8	1.4[b]
Some high school	17.8	7.1[a]
High school diploma/GED	29.0	27.0[a]
Some college	21.3	19.5[a]
AA, technical degree	6.4	7.7[a]
AA, academic degree	3.0	4.7[a]
Bachelors degree	8.4	19.5[a]
Graduate degree	2.7	7.8[a]
Missing education information	11.2	5.5[a]
Birth weight, %		
Normal birth weight (>2000 g)	95.6	97.9[a]
Low birth weight (1500–2000 g)	2.2	1.2[a]
Very low birth weight (<1500 g)	2.1	0.8[a]
Health insurance and routine care, %		
Any private health insurance	47.5	78.2[a]
Public health insurance	38.2	12.6[a]
No health insurance	14.3	9.1[a]
No routine health care	2.6	1.8[a]
Clinic/health center routine care	26.6	15.2[a]
Regular doctor routine care	65.0	81.0[a]
ED routine care	4.5	0.9[a]
Other routine care	0.5	0.7[c]
Missing information on routine care	0.4	0.2[b]
Mother sample	$n = 7763$	$n = 23\,252$
Mother with asthma ever, %	11.9	11.0, NS
Mother's depressive symptom scale score	2.9	2.5[a]
Mother's BMI	28.9	25.4[a]
Mother current smoker, %	22.3	24.9[a]
Mother former smoker, %	8.3	18.5[a]
Mother never smoker, %	69.0	57.0[a]

NS indicates not significant; GED, general equivalency diploma; AA, associate in arts.
[a] $P < .001$, significance of differences across racial groups.
[b] $P < .01$.
[c] $P < .10$.

Black children were significantly more likely to have been diagnosed with asthma in their lifetimes, to have had an episode or attack in the past 1 year, and to have visited the ED because of asthma. Their families had considerably lower average incomes ($39 230 for black families, compared with $66 794 for white families). They were also less likely to have private health insurance or to see a regular doctor for routine medical care. Black children were more likely to have low or very low birth weights. Regarding maternal health, black mothers reported significantly more depressive symptoms and had higher BMI scores. They were significantly less likely to have ever smoked but were more likely to have asthma themselves, although this latter difference was not statistically significant. Black and white children in the sample did not differ significantly with respect to age or gender, although black mothers were younger, on average.

In Fig 1 we present graphically the conditional rate of current childhood asthma according to household income for black and white children. Lines on the graph show results of nonparametric regression analyses of current asthma with respect to income, estimated separately for black and white children.[40] Because these estimates were noisy for income ranges with relatively few observations, Fig 1 excludes incomes at the ends of the distribution and focuses on household incomes greater than $5000 and less than $70 000 (the 75th percentile of income in our sample). Two features of Fig 1 stand out. The first is a strong inverse relationship between current asthma prevalence and income. Children in higher-income families have a lower prevalence of current asthma, in both race groups. However, the second striking finding is that black children have higher overall asthma risk, regardless of income. Black children have higher asthma prevalence at all points in the income distribution; racial disparities in asthma do not occur only for children in poverty. In fact, the racial differences in asthma prevalence are most apparent among families at the lower and higher ends of the income distribution.

Figure 1 shows that asthma prevalence is consistently greater among black children, compared with white children, across all income levels. However, the results do not take into account the racial differences in socioeconomic and demographic, birth weight, health care, and maternal health characteristics shown in Table 1. Perhaps these factors, which differ across racial groups and may be associated with asthma, can explain the racial differences in asthma prevalence.

In Table 2, we present results from multivariate models and explore whether differences in confounding variables account for racial differences in asthma prevalence and ED visits for asthma. Table 2 presents the relative odds that black children, compared with white children, currently have asthma. Models 1 to 5 include all children in the sample. Models 6 and 7 replicate model 5 but only

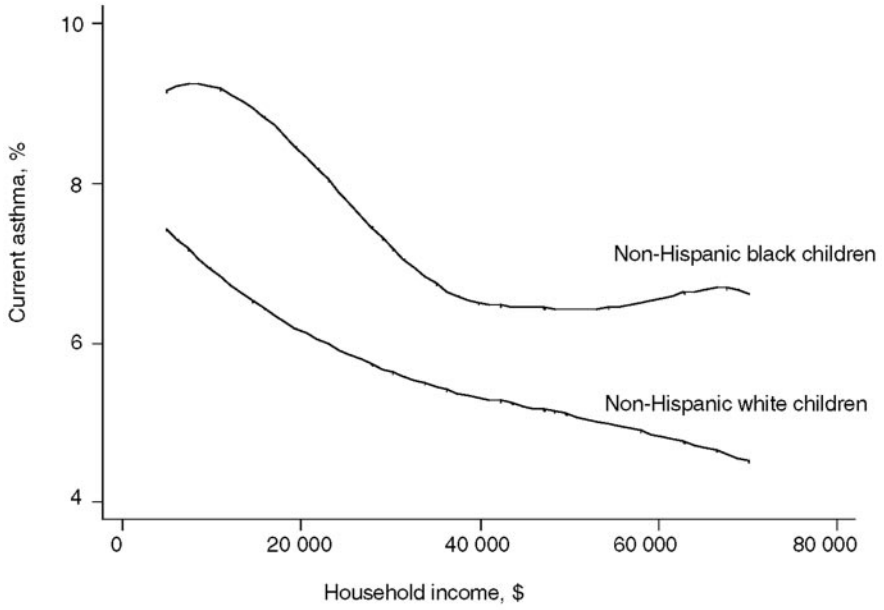

FIGURE 1
Proportions of US children (age: 0–17 years) with current asthma, according to race and income. Data (weighted) were from the NHIS (1997–2003).

for the subsample of children with public health insurance (model 6) and those who see a primary physician when sick (model 7). Models 8 to 10 are estimated for the subsample of children whose mothers were interviewed about their own health and for whom we have information about the mother's smoking behavior, asthma history, depressive symptoms, and BMI.

In model 1, which includes only controls for child's age, child's gender, and year, as well as race, we find that black children are 1.47 times as likely as white children to have current asthma. When we add additional controls for socioeconomic and demographic characteristics in model 2, the odds ratio decreases to 1.28, which indicates that differences in these characteristics do explain some of the racial disparity. However, a significant racial disparity remains and adding more controls does not eliminate it. When we add birth weight (model 3), the odds ratio is 1.26; when we add controls for insurance type and routine care (models 4 and 5), the odds ratio is 1.21. Limiting the sample to the subgroup of children with public health insurance (model 6) increases the ratio to 1.29 and, among children who see a primary physician when sick, black children are 1.24 times as likely as similar white children to have current asthma. Moving to the subsample of children for whom we have information on maternal health and health behavior produces a somewhat lower racial disparity (odds ratio: 1.18; model 8) but, as we add controls for maternal health and behavior, that disparity increases (to 1.22; model 10). Therefore, in each of the 10 models shown in Table 2, black children have greater odds of having current asthma than do otherwise comparable white children, even with controls for a host of child, family, and maternal characteristics.

Table 2 also shows the results from the multinomial logit models. These models estimate the odds that black children, compared with white children, would fall into 1 of the 3 listed categories, rather than never having had a diagnosis of asthma. The results in Table 2 indicate that black children have a much greater likelihood of having had an ED visit for asthma in the past 1 year, relative to white children. In model 1, with controls only for age, gender, and year, black children are 3.11 times as likely as white children to be in this category. Adding other demographic and socioeconomic controls reduces this racial disparity substantially (odds ratio: 2.19; model 2), but additional controls do not affect it much. Therefore, even in our fullest model (model 10), black children are 2.05 times as likely as white children to have had an ED visit for asthma in the past 1 year.

Are black children also over-represented in the other categories of asthma? Results shown in Table 2 indicate that black children do have a higher risk than white children of having been diagnosed with asthma but with no attack in the past 1 year, relative to not having a diagnosis of asthma at all (models 1–5). However, the racial disparity is much smaller here than for ED visits and this difference is no longer statistically significant when we limit our sample to the subgroup with public health insurance (model 6), although it is significant for children who see a doctor when sick (model 7). When we limit our analysis to the subsample with information on maternal health, this difference is only marginally significant in our fullest model (model 10) and is much smaller than for ED visits (odds ratio of 1.16 for asthma with no attack in the past 1 year, compared with 2.05 for ED visits). Finally, results in Table 2 indicate that black children are, if anything, less likely than white children to be in the category of having had an asthma attack in the past 1 year but without an ED visit (although most of

TABLE 2 **Relative Risk Ratios for Asthma Among Black Children, Compared With White Children, 1997 to 2003**

	Relative Risk Ratios (95% CI) for Models 1–10									
	1	2	3	4	5	6	7	8	9	10
Current asthma[a] (in past 1 y)	1.47[b] (1.35–1.60)	1.28[b] (1.16–1.41)	1.26[b] (1.14–1.39)	1.21[b] (1.10–1.33)	1.21[b] (1.10–1.34)	1.29[c] (1.07–1.54)	1.24[b] (1.11–1.39)	1.18[d] (1.03–1.35)	1.24[c] (1.07–1.43)	1.22[d] (1.04–1.42)
Asthma category[e]										
Lifetime asthma, no episode in past 1 y	1.38[b] (1.27–1.51)	1.21[b] (1.10–1.33)	1.20[b] (1.09–1.32)	1.17[c] (1.06–1.29)	1.17[c] (1.06–1.29)	1.09 (0.91–1.32)	1.21[c] (1.08–1.36)	1.08 (0.94–1.24)	1.10 (0.95–1.26)	1.16[f] (1.00–1.34)
Current asthma, no ED visit in past 1 y	0.97 (0.86–1.09)	0.92 (0.81–1.05)	0.92 (0.80–1.04)	0.88[f] (0.77–1.00)	0.90 (0.79–1.02)	0.85 (0.67–1.08)	0.95 (0.82–1.10)	0.90 (0.74–1.08)	0.93 (0.77–1.12)	0.89 (0.73–1.09)
ED visit for asthma in past 1 y	3.11[b] (2.72–3.56)	2.19[b] (1.87–2.55)	2.15[b] (1.84–2.50)	2.05[b] (1.75–2.39)	2.00[b] (1.71–2.34)	2.20[b] (1.69–2.87)	2.08[b] (1.73–2.49)	1.93[b] (1.54–2.43)	1.97[b] (1.57–2.48)	2.05[b] (1.60–2.62)
Model includes:										
Child age, gender, and year (model 1)	X	X	X	X	X	X	X	X	X	X
Other demographic variables[g] (model 2)		X	X	X	X	X	X	X	X	X
Birth weight (model 3)			X	X	X	X	X	X	X	X
Insurance type (model 4)				X	X		X	X	X	X
Routine care (models 5–8)					X	X	X	X	X	X
Maternal asthma (model 9)									X	X
Maternal smoking, depression, and BMI (model 10)										X
Sample includes										
All families ($n = 63\,529$)	X	X	X	X	X					
Families with public health insurance ($n = 11\,151$)						X				
Children who see regular doctor when sick ($n = 48\,613$)							X			
Families with mother as sample adult ($n = 30\,963$)								X	X	X

CI indicates confidence interval.

[a] Row shows results for logistic regression models explaining the relative odds that black children, compared with white children (0–17 years of age), have current asthma.

[b] $P < .001$.

[c] $P < .01$.

[d] $P < .05$.

[e] Row shows results for multinomial regression models, ie, lifetime asthma with no episode in past 1 year, current asthma with no ED visit in past 1 year, or ED visit for asthma in past 1 year (outcome categories are mutually exclusive; the reference category is never had an asthma diagnosis).

[f] $P < .10$.

[g] Other demographic variables include income, maternal education, 2-parent household, region, number of children in household, and maternal age.

the differences shown are not statistically significant). This result makes sense, because the categories are mutually exclusive and black children are over-represented in the other categories (in particular, asthma with an ED visit).

When we stratify children according to age group and residence in a MSA, additional patterns emerge. We see in Table 3 that younger black children and those living in MSAs are more likely than younger white children and white children living in MSAs to have current asthma. In these models, black children 0 to 3 years and 4 to 7 years of age have 1.42 and 1.45 greater odds of asthma, respectively. The racial disparities are smaller among children 8 to 11 years of age, although still significant (odds ratio: 1.28; model 3). There is no significant racial difference in current asthma among children 12 to 17 years of age (model 4). Black children who live in a MSA are 1.18 times as likely as white children who reside in a MSA to have current asthma. Black and white children who live in non-MSAs do not differ significantly in their risk of asthma. However, the small size of the sample of children not living in MSAs may make it difficult to detect differences.

In contrast to the patterns in the logistic regression results for current asthma, we see in the multinomial logit regression results in Table 3 that black children are significantly more likely than white children to have visited the ED for asthma, regardless of age and MSA residence. The odds ratios range from 1.91 (MSA, model 4) to 2.46 (ages 8–11, model 3). Although black children from all age and MSA/non-MSA subgroups are more likely to be in the ED category, black children 0 to 3 years and 8 to 11 years of age are also more likely than white children to have been diagnosed with asthma but without an episode in the past 1 year. In the multinomial logit regression models, black children 12 to 17 years of age and those living in a MSA are significantly less likely to be among the children who had an asthma episode but no ED visit in the past 1 year.

DISCUSSION

In this study, we set out to learn whether black children have greater asthma prevalence and a greater likelihood of ED visits for asthma and, if so, whether these racial disparities might be explained by differences across racial groups in factors such as socioeconomic and demographic characteristics, birth weight, health insurance, routine health care, and maternal health. Results controlling for a large set of characteristics with a large, nationally representative sample of children from the NHIS from 1997 to 2003 indicate that black children do have greater asthma prevalence than otherwise comparable white children. Even after controlling for an extensive set of characteristics that differ according to race and are correlated with asthma, black children are 20% more likely than white children to be diagnosed as having asthma and to have had an episode in the past 1 year. Moreover, black children have substantially greater likelihood of visiting an ED for asthma in the past 1 year. With controls for the same extensive set of characteristics, black children are twice as likely as white children to have had an ED visit for asthma in the past 1 year.

Because the outcome with the greatest racial disparity, ie, ED visits for asthma during the past 1 year, may be related to the type of health insurance or the source of routine care, we were careful to control for those factors in our analyses. We also estimated models limiting the sample to the subgroup of children with public health insurance and to the subgroup of children who see a primary physician when sick; however, even in these subgroups, racial disparities persisted. These results suggest that the excess ED visits experienced by black children are not attributable to different types of health insurance coverage or routine health care sources.

ED visits for asthma may be an indicator of more severe asthma episodes, but this is not the only possible explanation for them. It may be that black parents are more likely to take their children to the ED even when an attack is not more severe. However, when we re-

TABLE 3 Asthma Among Black Children, Compared With White Children, According to Age and MSA Size

	Relative Risk Ratios (95% CI) for Models 1–6					
	Ages 0–3 (n = 14 284)	Ages 4–7 (n = 13 148)	Ages 8–11 (n = 13 465)	Ages 12–17 (n = 22 603)	MSA (n = 40 716)	Non-MSA (n = 5991)
Current asthma[a] (in past 1 y)	1.42[b] (1.12–1.80)	1.45[c] (1.19–1.78)	1.28[d] (1.03–1.58)	1.03 (0.87–1.21)	1.18[d] (1.04–1.34)	1.26 (0.94–1.69)
Asthma category[e]						
Lifetime asthma, no episode last yr	1.53[b] (1.12–2.08)	1.20 (0.96–1.49)	1.22[d] (1.01–1.48)	1.09 (0.95–1.26)	1.01 (0.89–1.15)	1.27 (0.97–1.68)
Current asthma, no ED visit in past 1 y	0.93 (0.63–1.38)	1.15 (0.87–1.50)	0.94 (0.72–1.23)	0.79[d] (0.64–0.97)	0.84[d] (0.70–0.99)	0.99 (0.69–1.43)
ED visit for asthma in past 1 y	1.99[c] (1.46–2.70)	2.10[c] (1.57–2.80)	2.46[c] (1.67–3.62)	1.91[c] (1.43–2.54)	1.91[c] (1.57–2.32)	2.21[b] (1.32–3.69)

CI indicates confidence interval. Models include child age, gender, year, income, maternal education, 2-parent household, region, number of children in household, maternal age, birth weight, insurance type, and routine care. Information on MSA size was provided in years 1997 to 2001 of the NHIS (years 2002–2003 were excluded in these analyses).

[a] Row shows results of logistic regression models explaining the relative odds that black children, compared with white children (according to age and MSA size), have current asthma.

[b] $P < .01$.

[c] $P < .001$.

[d] $P < .05$.

[e] Row shows results of multinomial regression models, ie, lifetime asthma with no episode in past 1 year, current asthma with no ED visit in past 1 year, or ED visit for asthma in the past 1 year (outcome categories are mutually exclusive; the reference category is never had an asthma diagnosis).

peated our analyses with data available in the 2003 NHIS for overnight hospitalizations, we found similar patterns for black children, compared with white children, that again were not explained by other factors. Because parents may bring their child to an ED but do not make the decision about an overnight admission, these results suggest that black children may indeed be suffering from more severe cases of asthma than their white counterparts. It should be noted, however, that even this is not conclusive evidence of greater asthma severity among black children, because children who are brought to the ED may have a greater chance of being admitted for overnight stays regardless of their asthma severity.

As noted earlier, we must rely on the NHIS data on parents' reports regarding whether their child was diagnosed with asthma, as well as whether they had an episode or attack in the past 1 year. Clearly, it would be preferable if we obtained data directly from medical examinations, rather than relying on maternal reports. However, studies that compared parental reports with medical records indicated that discrepancies between parental reports and medical records were lower for asthma than for many other childhood health conditions.[41] Furthermore, medical records may themselves be prone to error.[42] Nevertheless, it is possible that parents differ systematically in how they define what constitutes an asthma attack or episode, and this may be related to taking a child to a physician or ED.

What might explain the racial disparities in asthma prevalence and ED visits for asthma? Although we found that differences in socioeconomic and demographic characteristics played some role, we were not able to explain all of the racial disparities. In addition to differences in parental attitudes or behaviors, one set of potentially relevant factors that we were not able to consider in detail has to do with the child's environment. The NHIS does not have detailed measures of the quality of the home or neighborhood; therefore, we could not control for these potentially important characteristics. Previous research indicated that features of the physical environment (eg, housing quality) and the social environment (eg, community violence) are associated with asthma severity.[43] Residential segregation that results in black children being concentrated in less-healthy or more-stressful neighborhoods could account for part of the racial disparities we cannot explain. However, it should be noted that the racial disparities in asthma we observe are not confined to children in poverty but extend well into the income distribution. Moreover, we found similar racial disparities among children living in rural areas and in urban areas. Therefore, racial differences in exposures to conditions in very poor environments are unlikely to account completely for racial disparities in asthma.

Another possible explanation concerns the quality of health care. Our finding that racial disparities in asthma are observed among children who receive public health insurance suggests that access to care alone cannot explain disparities. However, it is possible that black children receive lower-quality care, perhaps because the quality of health care is worse in areas in which higher concentrations of black families live. Previous research documented how geographic variations in health care quality produce racial disparities in health outcomes for the Medicare population.[44] Additional research on geographic variations in health care quality for children is required.

Another useful direction for future research is to examine how racial disparities in asthma prevalence and ED visits for asthma are changing over time. Although this is beyond the scope of this article, we did examine trends over time between 1997 and 2003 and we found that, if anything, racial disparities (holding constant other characteristics of children and families) are increasing with time, because they were greater in 2002 and 2003 than they were in the late 1990s (results not shown but available on request). These trends are certainly worth watching in the future.

Finally, we note that the latest waves of the NHIS include additional asthma questions that ask families about asthma education and maintenance activities, including the use of medication. These questions will be very useful for future work seeking to understand better why black children diagnosed as having asthma are so much more likely than white children to be treated in an ED. If health practices are part of the explanation, then this could point the way for pediatricians to play an important role in helping to narrow the racial disparities we documented here.

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