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Socioeconomic Status and Childhood Asthma in Urban Minority Youths

The GALA II and SAGE II Studies

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***Rationale*: The burden of asthma is highest among socioeconomically disadvantaged populations; however, its impact is differentially distributed among racial and ethnic groups.**

***Objectives*: To assess the collective effect of maternal educational attainment, annual household income, and insurance type on childhood asthma among minority, urban youth.**

***Methods*: We included Mexican American (n = 485), other Latino (n = 217), and African American (n = 1,141) children (aged 8–21 yr) with and without asthma from the San Francisco Bay Area. An index was derived from maternal educational attainment, annual household income, and insurance type to assess the collective effect of socioeconomic status on predicting asthma. Logistic regression stratified by racial and ethnic group was used to estimate adjusted odds ratios (aOR) and their 95% confidence intervals (CI). We further examined whether acculturation explained the socioeconomic-asthma association in our Latino population.**

***Measurements and Main Results*: In the adjusted analyses, African American children had 23% greater odds of asthma with each decrease in the socioeconomic index (aOR, 1.23; 95% CI, 1.09–1.38). Conversely, Mexican American children have 17% reduced odds of asthma with each decrease in the socioeconomic index (aOR, 0.83; 95% CI, 0.72–0.96) and this relationship was not fully explained by acculturation. This association was not observed in the other Latino group.**

***Conclusions*: Socioeconomic status plays an important role in predicting asthma, but has different effects depending on race and ethnicity. Further steps are necessary to better understand the risk factors through which socioeconomic status could operate in these populations to prevent asthma.**

AT A GLANCE COMMENTARY

Scientific Knowledge on the Subject

Low income and educational status are associated with asthma prevalence. However, there is poor understanding of the collective effect of socioeconomic indicators on asthma and a paucity of research examining those effects among different racial and ethnic groups.

What This Study Adds to the Field

Using a large sample of Latino and African American children in the San Francisco Bay Area, we found that socioeconomic status imparts an opposite effect among these racial and ethnic groups. African American children had increased odds of asthma down the socioeconomic gradient. However, among Mexican American children, the odds of asthma increased along the socioeconomic gradient.

Keywords: asthma; health status disparities; minority health; educational status; poverty

Asthma affects nearly 10% of children in the United States and disproportionately affects disadvantaged minority populations (1). Prevalence of children with current asthma is two times higher in African American (16%) and Puerto Rican (16.9%)

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Author Contributions: N.T. was responsible for analyzing the data with supervision and input from L.N.B., K.B.-D., L.A.R., S.S.O., C.R.G., J.G., and E.G.B. N.T. and M.M. wrote the first version of this manuscript. E.A.N. assisted with subsequent drafts and the subanalyses included in this manuscript. H.J.F., D.S., R.K., L.N.B., E.B.-B., A.D., K.M., S.S., M.A.L., L.K.W., W.R.-C., P.C.A., S.T., J.R.R.-S., and E.G.B. planned and supervised the collection of data from the various recruitment regions in the initial cohort. N.T. and E.G.B. had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors contributed to interpretation of results, and provided revisions and approval of the final manuscript.

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children compared with non-Hispanic whites (8.2%) (2). In contrast, Mexican Americans have one of the lowest asthma prevalence (6.5%) and have less severe disease compared with all other racial and ethnic groups (2). Given the heterogeneity of asthma prevalence across minority groups, evaluating the effect of socioeconomic status (SES) on asthma separately in African Americans and Latino subgroups is critical.

Latinos are comprised of a high proportion of immigrants and are traditionally thought of as an economically disadvantaged population (3, 4). African American and Latinos, as a group, have greater than twice the odds of living in poverty compared with non-Hispanic whites (3). However, Latinos often have better health outcomes compared with other minority groups and have health outcomes that are similar to their non-Hispanic white counterparts (4, 5). The healthy migrant effect (6, 7), cultural characteristics (8, 9), and acculturation (10–12) have been used to help explain this paradox. The "Hispanic paradox" may explain the low asthma prevalence and less severe disease seen in Mexican Americans (13). However, the high asthma prevalence among Puerto Ricans provides evidence that the Hispanic paradox may not apply to all Latino subgroups, again highlighting the importance of evaluating these groups separately.

Individuals with low SES have limited healthcare options and little control over changing their personal environment to reduce exposure to important risk factors for asthma (14). Several studies suggest inadequate health coverage and subsequent lack of contact with or low quality of health care may lead to undiagnosed asthma, especially among minorities living in urban environments (15–17). In addition, having health insurance coverage is associated with achieving tobacco cessation (18), reduced rates of low birth weight (19), and increased likelihood of allergy immunotherapy (20), all which have been shown to reduce the risk of asthma (21–23). Low SES, often measured by educational attainment and household income, is associated with high exposure to secondhand smoke, poor housing quality, and increase exposure to traffic-related air pollution, each of which is an important predictor of asthma (24–26).

Despite the number of studies assessing the association of SES indicators with asthma (15, 25, 27–30), there is still insufficient knowledge in understanding the collective effect of SES on childhood asthma among different racial and ethnic groups. Effective multicomponent interventions are dependent on understanding the full impact of SES on asthma and identifying the racial and ethnic groups that are most affected by social and environmental stressors. To our knowledge, this is the first comprehensive study to evaluate both the independent and the collective contribution of maternal educational attainment, annual household income, and insurance status on predicting childhood asthma among African American, Mexican American, and non-Mexican Latino children.

METHODS

Study Population

Participants from the present study were enrolled through the Genes-Environment and Admixture in Latino Americans (GALA II) study and the Study of African Americans, Asthma, Genes and Environments (SAGE II). Combined, GALA II and SAGE II are the largest on-going minority pediatric asthma case-control studies designed to examine the complex genetic and socioenvironmental determinants of asthma prevalence, control, and severity among minority children and adolescents. The GALA II and SAGE II studies recruited Latino and African American children, respectively, with and without asthma from urban regions in the mainland United States and Puerto Rico using a combination of community and clinic-based recruitment. The current analysis was restricted to children living in the San Francisco Bay Area to control the effect of regional differences in socioeconomic structure. All participants were 8–21 years old and had no history of other lung or chronic illnesses (other than atopy and allergy-related diseases in the cases). We included participants greater than 18 years old, who may report their own income rather than household income. However, limiting the analysis to participants 18 years old and younger did not change the results significantly; therefore, we did not restrict the analysis based on age. Asthma was defined as physician diagnosis and report of symptoms and medication use within 2 years before recruitment. Eligible control subjects had no reported history of asthma, lung disease, or chronic illness, and no reported symptoms of wheezing or shortness of breath (*see* Table E1 in the online supplement). Within each catchment area, control subjects were matched by hospital or community clinic site (*see* Tables 1 and E2 for distribution). Those in the third trimester of pregnancy, with greater than or equal to 10 pack-year smoking history, and current smokers were not eligible. For this analysis, we excluded participants with more than 1 pack-year of reported smoking.

The parents and all four grandparents of the participants must have self-identified as African Americans (SAGE II) or Latino (GALA II) to be eligible for the study. Race and ethnicity for the current analysis was categorized as follows: African American, Mexican American, and other Latino (various Latino subgroups represented $<15\%$ of the study population and included Colombian, Cuban, Salvadoran, Guatemalan, Honduran, and Nicaraguan). All local institutional review boards approved the study and all parents and participants provided appropriate written consent or assent.

Exposure Assessment

Trained interviewers administered comprehensive questionnaires to the parents or caretakers of the participants to collect basic sociodemographic information, medical histories, and environmental exposure-related information. The primary exposures for this analysis were maternal educational attainment, annual household income, and insurance type. Education is considered a stable measure of SES (31), income is indicative of current access to resources (32, 33), and insurance status is a marker of access to healthcare services (34). Additional detail on the method of measuring each socioeconomic indicator is provided in the online supplement. We derived a composite socioeconomic index (SES index) (35–38) for each participant by summing the ordinal rank scores as follows: maternal educational level was categorized into low (less than high school, score = 1), medium (some high school, score = 2), and high (high school graduate or higher, score = 3). Reported annual income was divided into tertiles based on the study population distribution as seen in Table 1, with the lowest income level receiving a score of 1 and the highest income level a score of 3. Medical insurance coverage was scored as follows: no health insurance (score = 1), government-subsidized insurance with care through community health centers (score = 2), and government-subsidized insurance through a health maintenance organization (HMO) or privately owned HMO or other private insurance (score = 3). Thus, SES index scores can vary between 3 and 9, with higher values indicating higher SES. After collapsing extreme low and high scores to limit the effect of outliers, the SES index used for our analysis ranged from 4 to 8.

By 2012, there were 881 and 1,516 eligible participants (cases and control subjects) from the San Francisco Bay Area in GALA II and SAGE II, respectively. Participants were excluded from the analysis if they had no self-reported maternal educational level (n = 48), annual household income (n = 393), or insurance status history (n = 25); had missing demographic information (n = 83); or reported at least 1-pack year of smoking (n = 6). The final analytical sample size was 701 (338 cases and 363 control subjects) from GALA II and 1,141 (702 cases and 439 control subjects) from SAGE II. We stratified the analyses by self-reported racial and ethnic origin (485 Mexican Americans, 216 other Latinos, and 1,141 African Americans).

Statistical Analysis

Race- and ethnicity-stratified models were used based on previous research showing that risk factors for asthma vary across race and ethnic groups (2, 39, 40). Baseline differences between cases and control subjects were determined using *t* tests and chi-squared statistics. We performed unadjusted and adjusted logistic regression models to estimate the strength of the association between the SES index and having asthma (yes/no). The adjusted model included age, sex, current secondhand

TABLE 1. CHARACTERISTICS OF CHILDREN IN THE GALA II AND SAGE II STUDIES: 2006–2012

	Mexican Americans (GALA II)			Other Latinos (GALA II)			African Americans (SAGE II)		
	Control Subjects	Cases	*P* Value	Control Subjects	Cases	*P* Value	Control Subjects	Cases	*P* Value
N	258	227		105	112		439	702	
Age, median (IQR)	14.7 (11.5–17.8)	13.2 (10.4–15.9)	<0.001	14.7 (11.9–18.2)	12.4 (10.0–14.7)	<0.001	15.8 (12.4–18.4)	13.5 (10.8–16.4)	<0.001
Sex, male, n (%)	102 (39.5)	127 (55.9)	<0.001	50 (47.6)	67 (59.8)	0.10	187 (42.6)	358 (51.0)	0.007
Ethnicity									
Mexican	258 (100.0)	227 (100.0)		—	—		—	—	
Mixed Latino	—	—		36 (34.3)	64 (57.7)		—	—	
Central American	—	—		69 (65.7)	46 (41.1)		—	—	
South American	—	—		0 (0.0)	1 (0.9)		—	—	
Caribbean Latino	—	—		0 (0.0)	1 (0.9)		—	—	
Maternal education, n (%)*			0.02						
Low	126 (48.8)	82 (36.1)		36 (34.3)	34 (30.4)		7 (1.6)	24 (3.4)	
Medium	45 (17.4)	44 (19.4)		18 (17.1)	21 (18.8)		42 (9.6)	79 (11.3)	
High	87 (33.7)	101 (44.5)		51 (48.6)	57 (50.9)		390 (88.8)	599 (85.3)	
Annual household income, n (%)									<0.001
<$25,000	132 (51.2)	106 (46.7)		60 (57.1)	69 (61.6)		132 (30.1)	282 (40.2)	
$25,000–75,000	82 (31.8)	84 (37.0)		21 (20.0)	27 (24.1)		118 (26.9)	223 (31.8)	
>$75,000	44 (17.1)	37 (16.3)		24 (22.9)	16 (14.3)		189 (43.1)	197 (28.1)	
Insurance status, n (%)†						0.03			<0.001
No insurance	26 (10.1)	16 (7.0)		11 (10.5)	3 (2.7)		29 (6.6)	16 (2.3)	
Public	152 (58.9)	121 (53.3)		62 (59.0)	87 (77.7)		134 (30.5)	277 (39.5)	
Public through HMO	23 (8.9)	33 (14.5)		7 (6.7)	4 (3.6)		58 (13.2)	87 (12.4)	
HMO	51 (19.8)	46 (20.3)		16 (15.2)	13 (11.6)		173 (39.4)	282 (40.2)	
Other private insurance	6 (2.3)	11 (4.8)		9 (8.6)	5 (4.5)		45 (10.3)	40 (5.7)	
Recruitment site									
Community health center	183 (70.9)	146 (64.3)		82 (78.1)	95 (84.8)		206 (46.9)	332 (47.3)	
HMO facility	75 (29.1)	81 (35.7)		23 (21.9)	17 (15.2)		233 (53.1)	370 (52.7)	
Smokers in household, n (%)			0.03						
No smokers	187 (72.5)	188 (82.8)		88 (83.8)	92 (82.1)		293 (66.7)	495 (70.5)	
One smoker	56 (21.7)	30 (13.2)		14 (13.3)	18 (16.1)		102 (23.2)	149 (21.2)	
Two or more smokers	15 (5.8)	9 (4.0)		3 (2.9)	2 (1.8)		44 (10.0)	58 (8.3)	
Family history of atopy, n (%)‡	105 (40.7)	154 (67.8)	<0.001	53 (50.5)	78 (69.6)	0.006	305 (69.5)	637 (90.7)	<0.001
Atopic, n (%)			<0.001			<0.005			<0.001
Total IgE >100 IU/ml	66 (25.6)	135 (59.5)		34 (32.4)	65 (58.6)		118 (16.9)	441 (62.8)	
Missing	41 (15.9)	3 (1.3)		17 (16.2)	2 (1.8)		125 (28.5)	15 (2.1)	
Composite SI, median (IQR)§	5.5 (4–6)	5 (5–7)	0.01	6 (5–7)	6 (5–7)		8 (6–8)	7 (6–8)	0.001
Acculturation, n (%)‖			<0.001			<0.001			
First generation	87 (33.7)	38 (16.7)		44 (41.9)	12 (10.8)		—	—	
Second generation	145 (56.2)	155 (68.3)		50 (47.6)	78 (70.3)		—	—	
Third generation	26 (10.1)	34 (15.0)		11 (10.5)	21 (18.9)		—	—	

Definition of abbreviations: CI = confidence interval; HMO = health maintenance organization; IQR = interquartile range; OR = odds ratio; SI = socioeconomic status index.

*Maternal education categorized into low (less than high school graduate), medium (high school graduate), and high (some college or higher).

† Public = government-subsidized insurance with care through community health centers; public through HMO = government-subsidized insurance with care through HMO.

‡ Family history of atopy (asthma, allergic rhinitis, or eczema) in the participant's siblings, parent, or grandparent.

§ Composite socioeconomic index: derived from reported maternal education attainment level, annual household income, and insurance status.

‖ Derived from the participant's generation status in the United States. Foreign-born participants were assigned first generation, participants born in the United States and with at most one parent born outside the United States were assigned second generation, and participants and both parents born in the United States were assigned third generation.

smoke exposure, and family history of atopy. A detailed description of our criteria for covariate selection is included in the online supplement. To determine whether the association between the SES index and asthma was modified by race and ethnicity, we combined our data across race and ethnicity and included an interaction term between the SES index and race and ethnicity in the adjusted model. An α level of 0.05 was used to assess statistical significance of main effect associations, whereas an α level of 0.10 was used to determine significant interactions. To estimate the race- and ethnic-specific prevalence of asthma in the United States, we created a counterfactual dataset in which all subjects did not have asthma while preserving the original values for all other covariates. We regressed using the originally described models on the counterfactual dataset and outputted the predicted probabilities. These probabilities were summed within each racial and ethnic group to calculate the prevalence. The results were standardized to current childhood asthma prevalence (2) among different racial and ethnic groups and a smooth lowess regression line was applied.

We examined the role of acculturation in the Mexican American and other Latino group as an explanatory pathway for the association

between SES and asthma. Acculturation was derived from the participant's generation status in the United States based on the child's and parent's birth country (*see* Table E3) (41). To determine if the effect observed was explained by acculturation we added the variable as a covariate to the multivariable regression model. Lastly, we completed a subanalysis to determine if the observed SES effects were different among participants with high and low total IgE, because previous literature has suggested that risk factors for atopic versus nonatopic asthma likely differ and may even have opposing associations dependent on atopic status (42–44). A total of 89% (n = 1,640) of our study population had total IgE information available. We used a total IgE of 100 IU/ml or greater as a proxy for atopic status. African Americans with missing total IgE data tended to be participants without asthma and had a higher SES index. The few African American participants with asthma who were missing total IgE data had lower SES indices. There were no differences noted in the Mexican Americans and other Latinos population with and without total IgE data. All analyses were conducted with R v2.15 (45).

RESULTS

The baseline study characteristics are in Table 1. All participants with asthma were younger and more likely to be male compared with their healthy counterparts, regardless of race and ethnicity. African American and other Latino participants without asthma were more likely to be not insured or less insured compared with participants with asthma ($P < 0.05$). Among the African American participants, most mothers completed high school or attended college and this did not differ by having asthma. However, children with asthma had an overall lower annual household income compared with children without asthma ($P < 0.001$). Regardless of asthma status, privately owned HMO was the most common type of insurance reported, followed by government-subsidized insurance with care through community health centers. Lastly, the SES index was significantly lower among children with asthma compared with those without asthma in the African American participants ($P = 0.001$). Overall, the Mexican American and other Latino children had a lower median annual household income, lower proportion of mothers of Mexican American and other Latino children who completed high school, were less insured, and had a lower SES index compared with African American participants. Within the Mexican American group, mothers of children with asthma completed high school and attended college at significantly higher rates than those without asthma ($P = 0.01$).

Probability of Asthma

The results for the adjusted models for the SES index and individual SES indicator are displayed in Table 2. Figure 1 shows the adjusted odds of asthma along the SES index for each racial and ethnic group. We found a statistically significant increase in the odds of asthma with each decrease in the SES index (adjusted odds ratio [aOR], 1.23; 95% confidence interval [CI], 1.09–1.38) among African Americans; conversely, a direct relationship was observed between the SES index and asthma (aOR, 0.83 for each decrease in index; 95% CI, 0.72–0.96) among Mexican Americans. We found a similar pattern for increased chance of asthma along the socioeconomic gradient in the other Latino group; however, this did not reach statistical significance ($P = 0.35$). Compared with the Mexican American participants with a similar SES index, African American participants had 1.47 (95% CI, 1.23–1.77) greater odds of having asthma (interaction, $P < 0.001$). We also found nonsignificant increase in the odds of asthma when we compared other Latino and Mexican American participants (aOR, 1.17; 95% CI, 0.91–1.50; interaction $P = 0.22$) with a similar SES index. Figure 2 shows the predicted prevalence (%) of asthma based on the 2011 asthma prevalence for each racial and ethnic group in the United States (2) along the SES index.

Among African American participants with high total IgE (≥100 IU/ml), there was no association observed between the SES score and asthma (aOR, 0.89; 95% CI, 0.74–1.08). However, among those with low total IgE, we found 1.25 increased odds of asthma with each unit decrease in the SES score (95% CI, 1.04–1.51) (Table 3). In our Mexican American and Other Latino groups, there was no difference in the association between the SES score in asthma by total IgE level.

Mexican American children whose mothers did not attend high school had reduced odds of asthma (aOR, 0.66; 95% CI, 0.42–1.04); among African Americans, maternal educational level was associated with increased odds of asthma (aOR, 2.76; 95% CI, 1.12–7.59). Going from the highest income tertile to the lowest income

TABLE 2. ADJUSTED ODDS* OF ASTHMA BY SOCIOECONOMIC INDICATOR ACCORDING TO RACE AND ETHNICITY

	Mexican American		Other Latino		African American	
Socioeconomic Indicator	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Composite SI† (high to low)	0.84 (0.74–0.96)	0.83 (0.72–0.96)	1.05 (0.87–1.27)	0.90 (0.72–1.12)	1.20 (1.08–1.34)	1.23 (1.09–1.38)
Maternal education‡						
Low	0.56 (0.38–0.83)	0.66 (0.42–1.04)	0.86 (0.47–1.57)	0.77 (0.38–1.53)	2.23 (1.00–5.66)	2.76 (1.12–7.59)
Medium	0.84 (0.51–1.40)	0.83 (0.48–1.45)	1.06 (0.51–2.23)	0.97 (0.43–2.21)	1.22 (0.83–1.83)	0.89 (0.57–1.39)
High	Referent	—	—	—	—	—
Low income§	0.97 (0.68–1.39)	1.02 (0.64–1.62)	1.46 (0.88–2.45)	0.71 (0.34–1.43)	1.66 (1.36–2.04)	1.68 (1.30–2.16)
Insurance type‖						
No insurance	0.34 (0.10–1.06)	0.21 (0.05–0.79)	0.49 (0.08–2.57)	0.51 (0.07–3.12)	0.62 (0.29–1.30)	0.60 (0.26–1.33)
Public	0.43 (0.15–1.18)	0.19 (0.05–0.62)	2.50 (0.82–8.46)	1.49 (0.41–5.76)	2.33 (1.45–3.74)	1.63 (0.95–2.79)
Public through HMO	0.78 (0.24–2.37)	0.49 (0.13–1.72)	1.03 (0.19–5.41)	0.63 (0.10–3.71)	1.69 (0.98–2.91)	1.10 (0.61–1.97)
HMO	0.49 (0.16–1.40)	0.27 (0.07–0.88)	1.46 (0.40–5.77)	1.07 (0.26–4.66)	1.83 (1.15–2.93)	1.61 (0.97–2.67)
Other private	Referent	—	—	—	—	—

Definition of abbreviations: CI = confidence interval; HMO = health maintenance organization; OR = odds ratio; SI = socioeconomic status index.

* Covariates include age, sex, secondhand smoke exposure, and family history of atopy.

† Composite socioeconomic status index: derived from reported maternal education attainment level, annual household income, and insurance status; adjusted OR reported as odds of asthma with each decrease in the index.

‡ Maternal education categorized into low (less than high school), medium (some high school), and high (high school graduate or higher).

§ Reported adjusted OR represents odds of asthma going from the lowest income tertile to the highest income tertile.

‖ Public = government-subsidized insurance with care through community health centers; public through HMO = government-subsidized insurance with care through HMO; HMO = privately owned HMO.

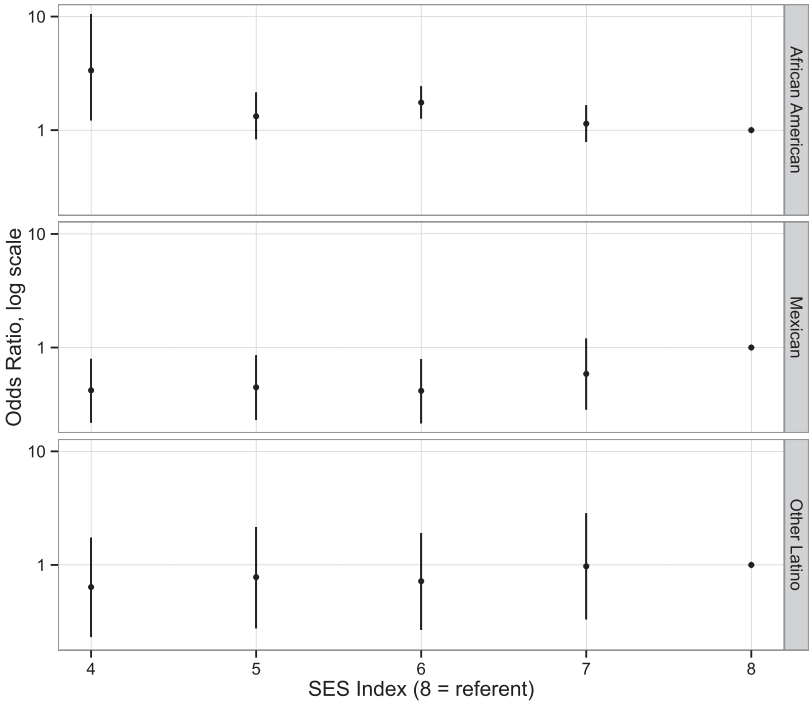

Figure 1. The adjusted odds ratio for asthma along the SES Index by race and ethnicity. Adjusted for age, sex, and secondhand smoke exposure. SES = socioeconomic status.

tertile was associated with 1.68 (95% CI, 1.30–2.16) increased odds of asthma among African American participants. Compared with Mexican Americans with government-subsidized insurance with care through community health centers, African American participants with similar type of insurance have 9.59 (95% CI, 2.88–34.12) greater odds of asthma (interaction, $P < 0.001$). Similarly, there was a significantly increased odds of asthma among other Latinos compared with Mexican Americans with government-subsidized insurance with care through community health centers (aOR, 5.62; 95% CI, 1.12–30.73; interaction, $P = 0.04$).

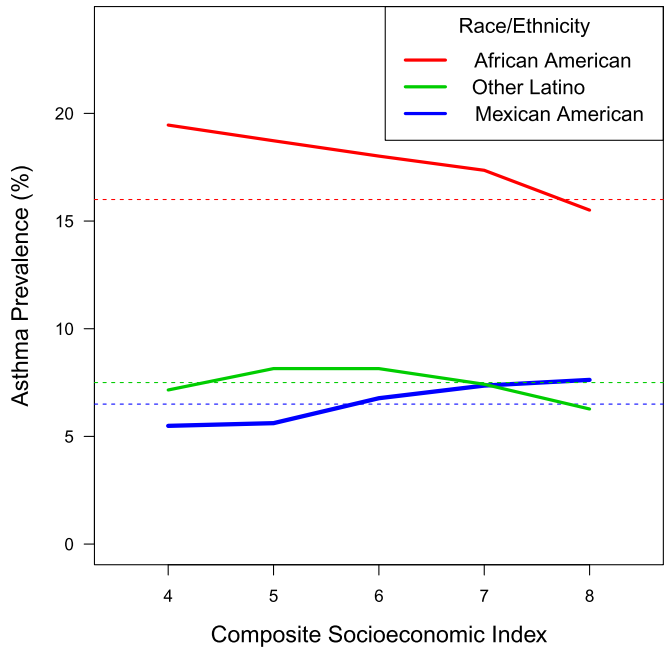

Figure 2. The predicted prevalence (%) of asthma based on the current asthma prevalence for each racial and ethnic group in the United States along the SES index. SES = socioeconomic status.

Mitigation by Acculturation in Latinos

Acculturation was independently associated with asthma in Mexican Americans and other Latinos after adjusting for SES, sex, age, and secondhand smoke exposure (*see* Table E4). Despite the observed effect of higher acculturation on predicting current asthma, the addition of this covariate only partially explained the observed association between the SES index and asthma in Mexican Americans. In other Latinos, the nonsignificant positive association observed between SES index and current asthma was explained by acculturation (Figure 3).

DISCUSSION

In our study of African American, Mexican American, and other Latino children, the combined contribution of maternal educational attainment, annual household income, and insurance type imparts opposing effects on predicting current asthma among these three minority groups. The findings among our African American participants are consistent with previous findings (28–30). However, to our knowledge, this is the first study to show increasing odds of current asthma along the socioeconomic gradient among Mexican American children in the United States. We observed a similar nonsignificant association among our other Latino children. These associations were partially explained by acculturation. Previous studies have demonstrated either an increased risk of asthma (46–48) or no associated risk (27) of asthma with lower SES in Latinos. Studies with an increased risk of asthma have primarily focused on Caribbean Spanish populations (46, 48).

We found mother's educational attainment level to be the most influential predictor of current asthma among our Mexican American participants, and this is likely the main driving force behind the relationship between SES and asthma. In our study population, low educational attainment by the mother was associated with a preference for speaking Spanish in both the child and mother. We also found a trend for asthma to be associated with higher healthcare coverage in both Mexican American and other Latino participants. It is well known that Latinos, as a group, are underinsured. This is particularly true among Mexican Americans, where 16% of children younger than

TABLE 3. ASSOCIATION ODDS RATIO* BETWEEN ASTHMA AND SOCIOECONOMIC INDEX† BY TOTAL IgE AND RACE AND ETHNICITY

Race and Ethnicity	Total IgE < 100 IU/ml Adjusted OR (95% CI)	Total IgE > 100 IU/ml Adjusted OR (95% CI)
Mexican American	0.89 (0.72–1.09)	0.84 (0.66–1.06)
Other Latino	0.79 (0.53–1.13)	0.69 (0.47–0.99)
African American	1.25 (1.04–1.51)	0.89 (0.74–1.08)

Definition of abbreviations: CI = confidence interval; OR = odds ratio.

*Covariates include age, sex, secondhand smoke exposure, and family history of atopy.

† Composite socioeconomic status index: derived from reported maternal education attainment level, annual household income, and insurance status; adjusted OR reported as odds of asthma with each decrease in the index.

18 years are uninsured compared with the national average of 10% (49). With less interaction with the healthcare system and limited ability to navigate the complexities of medical care because of language barriers and less formal educational training, there is greater risk of underdiagnosis in this group (50). However, in our population outcome misclassification was minimized by using thorough screening to ensure healthy control subjects had no asthma-related symptoms or medication use over their lifetime.

Asthma is particularly vulnerable to acute and chronic changes in psychological stress. Psychosocial stress may enhance airway inflammation by immunomodulation of cell function, thus impacting lung function and lead to asthma (51). The body's ability to adapt to stress through activation of the sympathetic nervous system, hypothalamus-pituitary-adrenal axis, and metabolic system is known as allostasis (52). As allostatic load increases, this ability to effectively respond to stress deteriorates and results in poor health outcomes. Lower SES, and thus higher exposure to social stress, may contribute to a higher allostatic load leading to asthma. This pathway is consistent with our findings among our African American population with lower levels of SES. We found the SES effect to be the strongest among African Americans with low total IgE (□100 IU/ml). This suggests that the psychosocial stress imparted from social class plays a larger role among African Americans with nonatopic asthma compared with those with atopic asthma. Our findings are supported by previous literature, which have demonstrated that risk factors related to low SES have a stronger effect among those with nonatopic asthma in other populations (42, 53).

However, among Latinos as a group changes in coping mechanisms (8) and acculturative stress (54) may lead to higher allostatic load and partially explain the effect of increasing SES on asthma. Regardless of Latino subgroup, we observed that acculturation was independently associated with increasing SES. This coupled with our finding that acculturation partially mitigates the observed effect of SES on asthma among Mexican Americans and other Latinos, supports that acculturation may play an important role in the development of asthma among Latinos. This is supported by several studies demonstrating that low acculturation is associated with lower prevalence of asthma (11, 12). Acculturation reflects changes in behaviors to reflect the host country and also reflects the duration of time spent in the United States exposed to known risk factors for asthma. Latino children often live in neighborhoods with high levels of air pollution and incur high levels of exposure to pesticides and toxic industrial chemicals (55). Further investigations into the characteristics associated with asthma and rising SES in Mexican Americans are needed, because this will provide insight into potentially modifiable risk factors for asthma.

Our study has several limitations and the results should be interpreted within the context of these limitations. The case-control design of the GALA II and SAGE II studies prevents us from making any conclusions about temporal relationship between the cumulative effect of the SES indicators and asthma. Longitudinal studies are necessary to confirm the temporal sequence of the results and to better elucidate the impact of SES on the course of asthma. We also did not have a non-Hispanic white referent group, which limits the results of our study to urban African American and Latino populations. The determination of race and ethnicity was based on self-report, which may lead to misclassification. This was limited in our African American population by limiting eligibility to those with all four grandparents who also self-identified as African American. Although similar eligibility criteria were applied to our GALA II participants, misclassification of Latino subgroup ethnicity may have occurred. In addition, we grouped the non-Mexican Latinos together as other Latinos when examining the effects of SES on different racial and ethnic groups. Most participants within this group self-identified as mixed-Latino or Central American. We

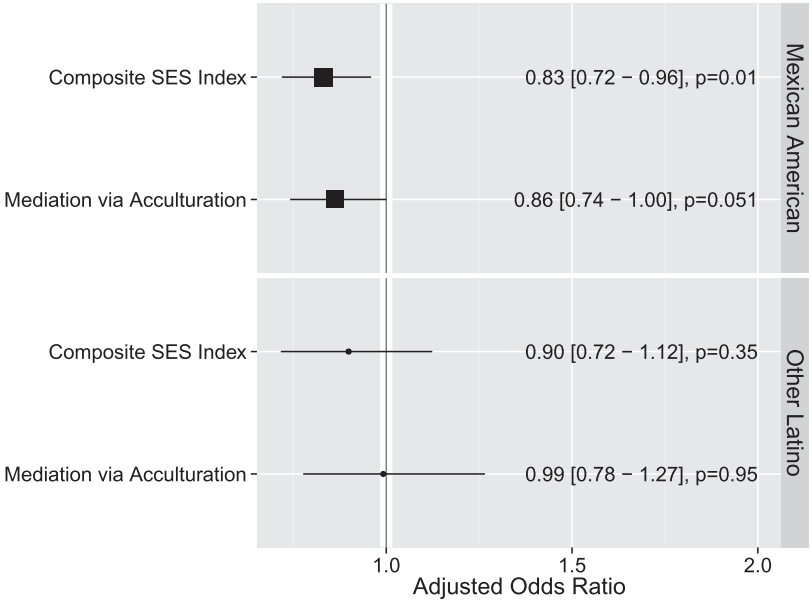

Figure 3. The adjusted odds of current asthma for each decrease in the composite socioeconomic index stratified by Latino Subgroup (Composite SES Index). Mediation via acculturation shows the odds of current asthma for each decrease in the Composite SES Index with the addition of acculturation to the multivariable regression model. All models adjusted for age, sex, and secondhand smoke exposure. SES = socioeconomic status.

performed a sensitivity analysis to determine if the effect size of the SES index on asthma differed between these two groups and found the index to perform similarly in both populations, thus making it reasonable to aggregate these populations for the purpose of this study.

Nonresponse to survey items regarding individual or household income is a common problem that plagues health disparities research. It is estimated that nonresponse can range from 20–50% (56) and our study falls within this range with approximately 20% of nonresponse to our income question. This seems to have occurred at random because the proportion of individuals with missing income data occurs equally across case and control status, the other SES indicators (maternal educational attainment and insurance status), and race and ethnicity groups (African Americans, Mexican Americans, and other Latinos).

We were also limited to the information that the selected socioeconomic indicators capture. It has been previously suggested that the impact of SES on asthma is partially imparted through exposure to air pollution (57, 58). In fact, we recently demonstrated that early life exposure to nitrogen dioxide, a traffic-related air pollutant, was associated with childhood asthma and the association was greatest in African Americans (59), the same population examined in this study. We consider the mediating effects of early life and current nitrogen dioxide exposure in our African American population and found no significant change in the association between SES and asthma. Another limitation was the consideration of obesity as an explanatory mechanism for how low SES may increase the odds of asthma in our African American population because most epidemiology studies have shown an association between obesity and asthma (60, 61). Unfortunately, information regarding body mass index was not available on greater than 50% of our control subjects. A more in-depth assessment into neighborhood-level effects, beyond air pollution, and exposure to violence would have provided a more holistic understanding of the different experiences of African American, Mexican American, and other Latino children.

With our study we confirmed previously reported findings of increased odds of asthma with each step down the socioeconomic gradient in African American children. However, we are the first to report increased odds of childhood asthma along the socioeconomic gradient among Mexican American children. By better understanding the relationship between SES and asthma among different racial and ethnic groups, we can take steps further to identify important, modifiable risks for asthma in previously unrecognized high-risk populations.

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