Effect of secondhand smoke on asthma control among black and Latino children

Sam S. Oh, PhD, MPH,[a,b] Haig Tcheurekdjian, MD,[c,d] Lindsey A. Roth, MA,[a] Elizabeth A. Nguyen, BS,[a] Saunak Sen, PhD,[e] Joshua M. Galanter, MD,[a] Adam Davis, MA, MPH,[f] Harold J. Farber, MD, MSPH,[g] Frank D. Gilliland, MD, PhD,[h] Rajesh Kumar, MD, MS,[i] Pedro C. Avila, MD,[j] Emerita Brigino-Buenaventura, MD,[k] Rocio Chapela, MD,[l] Jean G. Ford, MD,[m] Michael A. LeNoir, MD,[n] Fred Lurmann, MS,[o] Kelley Meade, MD,[f] Denise Serebrisky, MD,[p] Shannon Thyne, MD,[q] William Rodriguez-Cintron, MD,[r] Jose R. Rodriguez-Santana, MD,[s] L. Keoki Williams, MD, MPH,[t,u] Luisa N. Borrell, DDS, PhD,[v] and Esteban G. Burchard, MD, MPH[a] *San Francisco, Oakland, Los Angeles, Vallejo, and Petaluma, Calif, Cleveland, Ohio, Houston, Tex, Chicago, Ill, Mexico City, Mexico, Baltimore, Md, Bronx, NY, San Juan, Puerto Rico, and Detroit, Mich*

Background: Among patients with asthma, the clinical effect and relative contribution of maternal smoking during pregnancy (*in utero* smoking) and current secondhand smoke (SHS) exposure on asthma control is poorly documented, and there is a paucity of research involving minority populations.
Objectives: We sought to examine the association between poor asthma control and *in utero* smoking and current SHS exposure among Latino and black children with asthma.
Methods: We performed a case-only analysis of 2 multicenter case-control studies conducted from 2008-2010 with similar protocols. We recruited 2481 Latino and black subjects with asthma (ages 8-17 years) from the mainland United States and Puerto Rico. Ordinal logistic regression was used to estimate the effect of *in utero* smoking and current SHS exposures on National Heart, Lung, and Blood Institute–defined asthma control.
Results: Poor asthma control among children 8 to 17 years of age was independently associated with *in utero* smoking (odds ratio [OR], 1.5; 95% CI, 1.1-2.0). *In utero* smoking through the mother was also associated with secondary asthma outcomes, including early-onset asthma (OR, 1.7; 95% CI, 1.1-2.4), daytime symptoms (OR, 1.6; 95% CI, 1.1-2.1), and asthma-related limitation of activities (OR, 1.6; 95% CI, 1.2-2.2).
Conclusions: Maternal smoking while *in utero* is associated with poor asthma control in black and Latino subjects assessed at 8-17 years of age. (J Allergy Clin Immunol 2012;129:1478-83.)

Key words: *Secondhand smoke, prenatal exposure delayed effects, asthma, health status disparities*

Tobacco smoke exposure is unsafe at any level.[1] Although the percentage of Americans exposed to secondhand smoke (SHS) has markedly decreased over the last several decades, the decrease has been unequal across demographic groups.[1,2] In particular, children are the most likely to be exposed to SHS,[2] primarily through their caregivers.[3]

Negative outcomes attributed to tobacco smoke exposure *in utero* (ie, maternal smoking during pregnancy) and in early life include stillbirth, sudden infant death syndrome, acute respiratory tract infections, decreased lung function, and childhood wheezing.[1,4-11] SHS is a major risk factor for asthma and a key aspect for successful asthma management.[12] The National Heart, Lung, and Blood Institute (NHLBI) defines asthma control as the "extent to which the various manifestations of asthma are reduced or removed by treatment."[12] Uncontrolled asthma

From [a]the Department of Medicine and [b]the Center for Tobacco Control Research and Education, University of California, San Francisco; [c]the Departments of Medicine and Pediatrics, Case Western Reserve University, Cleveland; [d]Allergy/Immunology Associates, Inc, Cleveland; [e]the Department of Epidemiology and Biostatistics, University of California, San Francisco; [f]Children's Hospital and Research Center Oakland; [g]the Department of Pediatrics, Section of Pulmonology, Baylor College of Medicine and Texas Children's Hospital, Houston; [h]the Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles; [i]Children's Memorial Hospital and the Feinberg School of Medicine, Northwestern University, Chicago; [j]the Division of Allergy-Immunology, Feinberg School of Medicine, Northwestern University, Chicago; [k]the Department of Allergy & Immunology, Kaiser Permanente–Vallejo Medical Center, Vallejo; [l]Instituto Nacional de Enfermedades Respiratorias (INER), Mexico City; [m]the Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore; [n]Bay Area Pediatrics, Oakland; [o]Sonoma Technology, Inc, Petaluma; [p]the Pediatric Pulmonary Division, Jacobi Medical Center, Bronx; [q]the Department of Pediatrics, University of California, San Francisco; [r]Veterans Caribbean Health Care System, San Juan; [s]Centro de Neumologia Pediatrica, San Juan; [t]the Center for Health Services Research, Henry Ford Health System, Detroit; [u]the Department of Internal Medicine, Henry Ford Health System, Detroit; and [v]the Department of Health Sciences, Graduate Program in Public Health, Lehman College, City University of New York, Bronx.

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Corresponding author: Sam S. Oh, PhD, MPH, Departments of Bioengineering & Therapeutic Sciences and Medicine, UCSF/Mission Bay/Lung Biology Center, Rock Hall, Rm 582, 1550 4th Street, San Francisco, CA 94158-2911. E-mail: Sam.Oh@ucsf.edu.

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Abbreviations used
FVC: Forced vital capacity
GALA II: Gene-Environments and Admixture in Latino Asthmatics
NHLBI: National Heart, Lung, and Blood Institute
OR: Odds ratio
SAGE II: Study of African Americans, Asthma, Genes, & Environments
SHS: Secondhand smoke

significantly affects quality of life and incurs substantial medical expenses and opportunity costs in missed days of work and school and premature deaths estimated at $56 billion in the United States in 2007.[13,14] Among patients with asthma, SHS exposure is a risk factor for asthma exacerbations and the development of severe asthma.[15,16] Therefore avoidance of SHS exposure is an important component of asthma prevention and control.

Although extensive research has demonstrated the effect of smoking on asthma risk in young children, the clinical effect and relative contribution of *in utero* smoking and current SHS exposure on asthma control is poorly documented, and there is a paucity of research involving minority populations.[6,17] The objective of the current study was to investigate the contribution of *in utero* smoking and current SHS exposure toward poor asthma control among 2481 Latino and black children.

METHODS

Study design and recruitment

Subjects were recruited from the Study of African Americans, Asthma, Genes, & Environments (SAGE II) and the Gene-Environments and Admixture in Latino Asthmatics (GALA II) study. Both studies began in 2008 and are parallel, ongoing case-control studies with similar protocols and questionnaires. Subjects are recruited from 5 urban study centers across the mainland United States and Puerto Rico (see Table E1 in this article's Online Repository at www.jacionline.org). Target sample sizes (cases and control subjects) for GALA II and SAGE II are 4000 and 2000 subjects, respectively. Subjects recruited into the GALA II and SAGE II studies were 8 to 21 years old with physician-diagnosed asthma and no history of other lung or chronic illnesses; active smokers were excluded. Parents and grandparents self-identified as Latino (GALA II) or black (SAGE II); self-identification of race/ethnicity was required of study participants. The study population for the current analysis was limited to children 8 to 17 years old with no history of smoking, representing 1858 cases from GALA II and 623 cases from SAGE II who were recruited through November 2011. Inclusion/exclusion criteria are detailed in Table E2 (available in this article's Online Repository at www.jacionline.org).

We ascertained demographic, environmental, and medical histories using in-person questionnaires with the children's parents/caretakers; selected questions are reproduced in Table E3 (available in this article's Online Repository at www.jacionline.org). The primary exposures for our analysis were *in utero* smoking and current SHS exposure. Current SHS exposure was most correlated with exposure occurring after age 6 years (Pearson $r = 0.55$) and least with exposure in the first 2 years of life (Pearson $r = 0.37$). Additionally, postnatal SHS exposure was most correlated with exposure at adjacent time points (eg, correlation between ages 0-2 and ages 3-6 years = 0.75). Our final regression models therefore included postnatal SHS terms for ages 0 to 2 years and current SHS exposure to maximize exposure assessment and minimize multicollinearity. Race/ethnicity was categorized as follows: black, Mexican, Puerto Rican, and other Latino (Latino subgroups representing <10% of the study population). Socioeconomic status indicators included family income and the child's father's employment status.

To assess and account for asthma control medications children might have been using, we asked subjects' parents to identify their child's asthma control medication or medications from a picture library of asthma control medications. We grouped their responses into one of 4 categories: none, monotherapy, combination therapy, and oral corticosteroids. Children using either leukotriene modifiers or inhaled corticosteroids were classified as receiving monotherapy, combination therapy was used to describe the concomitant use of 2 or more medications (except for oral corticosteroids), and children using oral corticosteroids were classified into a separate category.

Clinical outcomes

The NHLBI measure of asthma control is a composite score and an accepted standard for measuring asthma control.[12] We used NHLBI-defined criteria to classify children with asthma as having controlled, partially controlled, or uncontrolled disease (see Table E4 in this article's Online Repository at www.jacionline.org for a more detailed description of criteria and cut points). The component measures of asthma control, assessed retrospectively over the week preceding subject recruitment and interview, included daytime and nighttime symptoms, asthma-related limitation of activities, use of rescue medication, and spirometric lung function measures. An FEV_1/forced vital capacity (FVC) ratio of less than 85% was used as our lung function criterion because it is more sensitive than FEV_1 in children.[12] Estimates using either criterion produced similar results. Secondary outcomes included early-onset (<4 years of age) asthma, presence of daytime/nocturnal symptoms, asthma-related activity limitations, FEV_1 less than 80% of predicted value, and an FEV_1/FVC ratio of less than 85%.

Statistical analysis

Only children with asthma were included in the analyses. Statistical methods are detailed in the Methods section in this article's Online Repository at www.jacionline.org. After verifying the proportional odds assumption, we used ordinal logistic regression to calculate odds ratios (ORs) and 95% CIs to estimate the association of *in utero* smoking and current SHS with asthma control while controlling for eczema, use of asthma control medication, exposure to home indoor allergens, IgE level, socioeconomic status, race/ethnicity, age, sex, and study center. To account for potential differences between mainland and island Puerto Rican subjects, we classified Puerto Rican subjects based on their recruitment site (ie, mainland vs island Puerto Ricans). Because our outcome variable (asthma control) was a 3-level ordinal variable (controlled asthma, partially controlled asthma, and uncontrolled asthma), we used ordinal logistic regression to compare the odds of exposure between one level of asthma control and a worse level of asthma control (ie, a single OR was used to compare controlled vs partially controlled asthma or partially controlled vs uncontrolled asthma). All analyses were conducted with SAS version 9.2 software (SAS Institute, Inc, Cary, NC).

This study was approved by the institutional review boards at each study center. All subjects (or their parents) provided written informed consent.

RESULTS

Characteristics of children with asthma are presented in Table I. Nearly half of the GALA II subjects were Puerto Rican (47.2%), followed by Mexican (31.8%) and other Latino ethnicities (21.0%). All SAGE II subjects were non-Hispanic black. *In utero* smoke exposure during the first trimester was slightly higher among Puerto Ricans (5.8%) compared with Mexican (3.2%) and other Latino (3.3%) children and substantially higher among black children (17.7%). Smoking cessation during pregnancy among Puerto Rican and black mothers was uncommon (65% and 71%, respectively, reported smoking during their third trimester; see Fig E1 in this article's Online Repository at www.jacionline.org). In contrast, smoking cessation during pregnancy was greater for Mexican mothers and other Latino mothers (72% and 54%, respectively, stopped smoking by the second trimester), and more mothers continued to stop smoking as