



United States Prevalence of Pediatric Asthma by Environmental Tobacco Smoke Exposure, 2016-2017

Luyu Xie, Folefac Atem, Andrew Gelfand, Cici Bauer & Sarah E. Messiah

To cite this article: Luyu Xie, Folefac Atem, Andrew Gelfand, Cici Bauer & Sarah E. Messiah (2019): United States Prevalence of Pediatric Asthma by Environmental Tobacco Smoke Exposure, 2016-2017, Journal of Asthma, DOI: [10.1080/02770903.2019.1709868](https://doi.org/10.1080/02770903.2019.1709868)

To link to this article: <https://doi.org/10.1080/02770903.2019.1709868>



Accepted author version posted online: 26 Dec 2019.



Submit your article to this journal [↗](#)



View related articles [↗](#)



View Crossmark data [↗](#)

Pediatric asthma prevalence by ETS exposure

United States Prevalence of Pediatric Asthma by Environmental Tobacco Smoke Exposure, 2016-2017

Luyu Xie, PharmD^{1,2}; Folefac Atem, PhD^{1,2}; Andrew Gelfand, MD³; Cici Bauer, PhD⁴; Sarah E. Messiah, PhD, MPH^{1,2*}

¹University of Texas Health Science Center at Houston, School of Public Health, Dallas Regional Campus, Dallas, Texas USA

²Center for Pediatric Population Health, Children's Health System of Texas and University of Texas Health Science Center, Dallas, Texas USA

³Department of Pediatrics, University of Texas Southwestern Medical Center, Dallas, Texas USA

⁴University of Texas Health Science Center at Houston, School of Public Health, Houston, Texas USA

***Correspondence:** Sarah E. Messiah, PhD, MPH, University of Texas Health Science Center at Houston, School of Public Health, Dallas Regional Campus, Center for Pediatric Population Health, Paul M. Bass Administrative and Clinical Center, UT Southwestern, 6363 Forest Park Road, BL10.204, Dallas, TX 75390, Tel. 972-546-2919, Fax 214-351-7006, Email: Sarah.E.Messiah@uth.tmc.edu; Sarah.Messiah@utsouthwestern.edu

ABSTRACT

Objectives. We sought to update the prevalence estimates of parent-reported asthma diagnosis by Environmental Tobacco Smoke (ETS) exposure in the United States (US) pediatric population.

Methods. This cross-sectional study included 71,811 families with children who participated in the 2016-2017 National Survey of Children's Health (NSCH). Weighted asthma prevalence estimates were calculated for ETS-exposed and non-exposed children. Chi-square analysis compared asthma prevalence between the two exposure groups and logistic regression analysis generated adjusted odds ratios (aORs) of asthma diagnosis by ETS exposure by sex, race/ethnicity, and household education and income level.

Results. Asthma prevalence estimates were significantly higher in ETS-exposed versus non-exposed children (10.7% vs. 7.8%, $p < 0.001$). Children with a smoker in the house are 30% more likely to have an asthma diagnosis versus children with no smokers in the house (aOR 1.29, 95% Confidence Interval [CI] 1.09-1.52). Significant predictors for ETS exposure included < high school education and lower family income. Conversely, non-Hispanic black and Hispanic black children were less likely to have ETS exposure versus non-Hispanic white children.

Conclusions. ETS exposure is a significant risk factor for asthma in the US pediatric population. Smoking cessation initiatives targeting non-Hispanic white parents from lower socioeconomic may improve children's chronic pulmonary health risk.

Key words: pediatric, asthma prevalence, ETS

Introduction

Asthma is one of the most common childhood chronic diseases: approximately 8 in 100 children suffer from asthma in the US on any given day.^{1,2} Asthma typically has an early childhood onset with signs and symptoms such as cough, wheezing, breathlessness and chest tightness, that often persist for life.³⁻⁵ Children with asthma have higher rates of using health care resources such as emergency department visits, hospitalizations and prescription drugs

compared to children who do not have asthma.^{6,7} In 2015 the total US annual health care expenditures attributable to pediatric asthma were approximately 6 billion dollars.⁸

Environmental Tobacco Smoke (ETS) has been shown to increase the risk for children to develop asthma.⁹⁻¹³ As such, the National Asthma Education and Prevention Program recommends patients with asthma should avoid ETS exposure to decrease the number of asthma attacks and prevent asthma exacerbations.⁴

There has been a decline in household ETS exposure among children from 1 in 4 (24.9%) in 2004 to 1 in 10 (11.4%) in 2014.¹⁴ Nevertheless, a significant proportion (11%) of the pediatric population is still at risk for ETS-related health effects.¹⁴ The majority of recent studies examining the associations of ETS exposure and asthma have used non-population based subsamples such as children living in urban settings, those who are obese or from ethnic minority backgrounds.¹⁵⁻¹⁷ Specifically, Kitsantas and colleagues reported obese adolescents exposed to ETS were 2 times more likely to have an asthma diagnosis compared with those without ETS exposure.¹⁵ Another study examined the association between ETS exposure and asthma risk among Latino and African-American children.¹⁷ The odds of having poorly controlled asthma was 53% higher in ETS-exposed children compared to non-exposed children.¹⁷

Hence, the purpose of this study was to analyze the most recent nationally representative data to provide updated national asthma prevalence estimates by ETS exposure in various demographic subgroups and examine the association between ETS exposure and asthma diagnosis using the combined 2016-2017 National Survey of Children's Health (NSCH) datasets. Based on previous studies, it was hypothesized that ETS exposure would be a risk factor for childhood-onset asthma.

Methods

Data Source and Sample Design

NSCH is a population-based, cross-sectional survey sponsored by US Health Resources and Services Administration's Maternal and Child Health Bureau. The purpose of this population-based survey is not to follow each child over time to collect serial outcome data; rather, it is designed to provide a snapshot of national and state-level data on physical and emotional health of children and adolescents ages 0-17 years. From 2003 to 2012, the national survey was conducted every 4 years by using telephone questionnaires. Starting in 2016, the NSCH has been significantly redesigned to increase response rates and merge the current needs and topics of pediatric health and is now conducted annually through online/mail-based surveys. Our study utilized 2016-2017 combined datasets to provide the most recent prevalence estimates.

The NSCH study consisted of two interviewing phases. First, households were randomly selected to complete an initial household screener, and then a main child-specific, topical questionnaire was delivered to the households with children. The parent can randomly choose a child to complete the second survey. A total of 71,811 households with age-eligible children completed the survey in 2016 ($n = 50,212$) and 2017 ($n = 21,599$). To obtain population-based estimates, each child was assigned a weight, which was composed of a base sampling weight and adjustment of both screener and topical nonresponse, selection of a single child within responded household, and various characteristics of children in different states. The overall weighted response rate was 40.7% for 2016 and 37.4% for 2017, respectively.

Measures

Asthma. The parent served as a proxy for their child when reporting asthma information by answering, "has a doctor or other health care provider ever told you that this child has asthma?"

According to the responses to this question, the primary variable of asthma diagnosis was classified as a yes/no dichotomous variable, which was used as the dependent variable when assessing the association between asthma diagnosis and ETS exposure. Asthma severity were assessed by asking “is your child’s asthma mild, moderate or severe?” Previous research shows that parent report is nearly as accurate as, or even more accurate than the child’s medical record documentation of asthma diagnosis.^{19,20}

Environmental Tobacco Smoke. ETS exposure was assessed by the following 2 questions: “does anyone in household use cigarettes, cigars or pipe tobacco?” and “does anyone smoke inside of home?” If a parent answered yes to either the first or second question, the child was classified as ETS-exposed. If a parent answered no to both questions, their child was categorized as non-exposed.

Covariates

Child age, gender, race/ethnicity and socioeconomic factors, such as parent education level and family income, were included as covariates based on previous studies suggesting these factors may influence asthma diagnosis and smoking behaviors of parents.^{9-11,13}

Statistical Analysis

Chi square tests were utilized to compare the asthma prevalence (Y/N) by ETS-exposure (Y/N) for categorical variables, such as gender, race/ethnicity, education and family income. Two sample t tests were used to examine the age differences between ETS-exposed and non-exposed children with asthma. Weighted prevalence estimates and 95% confidence intervals (95% CI) were calculated for asthma diagnosis and ETS exposure as well as other sample characteristics in overall population and demographic subgroups. Specifically, univariate and multivariate logistic regression models were used to obtain the unadjusted odds ratios (ORs) and

adjusted odds ratios (aORs), respectively to predict the odds of an asthma diagnosis by ETS exposure category. A second multivariate logistic regression model was created to identify predictors of ETS exposure.

ETS exposure, the primary independent predictor of asthma was entered as a binary variable with two levels (Y/N), and no ETS exposure was the reference. Age was analyzed as a continuous variable to ensure model precision. Gender was analyzed as a binary variable with male as the reference. Race/ethnicity was analyzed as a categorical variable with four levels (non-Hispanic white, non-Hispanic black, Hispanic and other) with non-Hispanic as the reference. Education was also analyzed as a categorical variable with four levels (college degree or above, some college or technical school, high school degree or GED, and less than high school), and parents with college degree or above was the reference. All statistical analyses were performed in SAS v 9.4 (SAS Institute Inc, Cary, North Carolina). The complex sampling plan (strata, cluster and weight) provided in the NSCH SAS codebook was applied to all analyses.²¹

Results

The analytical population consisted of 71,811 US children and adolescents aged 0-17 years old with a mean age of 8.6 years. (Table 1) The number of males was slightly higher than females (51.1% vs. 48.9%). More than half of pediatric population in this sample was non-Hispanic white (51.4%), followed by Hispanic (24.7%), non-Hispanic black (13.1%) and other races (10.8%), respectively. Almost half of households reported at least one parent with a college degree or above (49.1%) while 30% reported family income above 400% Federal Poverty Level (FPL). Parents reported that 8.2% of children had an asthma diagnosis and 15.3% of households had at least 1 smoker.

Table 2 presents the estimated prevalence of parent-reported asthma diagnosis by ETS exposure among the US pediatric population by demographic characteristics. In contrast to non-exposed children, asthma prevalence estimates were higher in the ETS-exposed children in the overall population and every demographic subgroup. Specifically, the overall weighted prevalence of asthma diagnosis was 10.7% in ETS-exposed children, which was significantly higher than 7.8% in non-exposed children ($p < 0.001$). Additionally, there were significant differences in the weighted estimates of asthma prevalence between ETS-exposed and non-exposed subgroups, including girls (9.1% vs. 6.7%, $p = 0.009$), boys (12.1% vs. 8.9%, $p = 0.003$), non-Hispanic Whites (8.8% vs. 6.1%, $p < 0.001$), other/multi-race children (14.4% vs. 6.8%, $p = 0.003$), parents with less than high school education (17.4% vs. 9.1%, $p = 0.008$), and family income 200-399% FPL (10.5% vs. 6.9%, $p = 0.005$). However, the mean age of children with asthma did not differ in two exposure groups (10.3 years vs. 10.2 years, $p = 0.907$). Furthermore, a post-hoc chi-square analysis showed that among ETS-exposed children, 21.1% (95% CI 16.6-25.5) had severe asthma and 18.9% (95% CI 16.3-21.6) had mild asthma ($p = 0.001$).

Children who living with at least a smoker were 40% more likely to have asthma diagnosis compared to those who do not live with smokers (OR 1.41, 95% CI 1.21-1.64, $p < 0.001$) (Table 3). After controlling for other potential confounders, including age, gender, race/ethnicity, education level and family income, the odds of an asthma diagnosis were about 30% higher in ETS-exposed than non-exposed children. (aOR 1.29, 95% CI 1.09-1.52, $p = 0.003$).

Table 4 summarizes the sociodemographic predictors of ETS exposure in US households. Parents with lower education level (less than high school, high school degree, or some college)

were 2-3 times more likely to smoke compared with parents with a college degree and above (aOR 2.58, 95% CI 1.99-3.33, aOR 3.78, 95% CI 3.23-4.42, and aOR 2.82, 95% CI 2.47-3.21, respectively). Subsequently, our study suggests that family income is another significant predictor for ETS exposure. Compared to children living in wealthier family (family income $\geq 400\%$ FPL), those living in poverty (family income $< 99\%$ FPL) had more than 2 times higher odds of ETS exposure (aOR 2.17, 95% CI 1.83-2.58).

Notably, child age was not a significant predictor for parental smoking behavior (aOR 1.01, 95% CI 1.0- 1.02, $p = 0.16$). Additionally, non-Hispanic black and Hispanic parents were 60% (aOR 0.6, 95% CI 0.51-0.71) and 39% (aOR 0.39, 95% CI 0.33-0.46) less likely to be an active smoker versus non-Hispanic white parents, respectively.

Discussion

Results from this analysis showed that ETS-exposed children had higher asthma prevalence estimates than non-exposed participants (10.7 vs 7.8%, $p < 0.001$). Multivariate logistic regression showed children with a smoker in the house were 30% more likely to have asthma diagnosis versus children with no smoker in the house. Previous work with various sub-samples (150~1500 children) showed the odds of having asthma increased 1.5 to 2 times in children had previous ETS exposure.¹⁰⁻¹³ Results here provided the most recent population- level prevalence estimates of asthma among US children from diverse backgrounds. Specifically, we found that lower socioeconomic status (parent/caregiver with $<$ high school education and lower family income) was the significant predictors for ETS exposure. Conversely, non-Hispanic Black and Hispanic children were less likely to have ETS exposure versus non-Hispanic white children.

These findings have implications for future tobacco control efforts in the US as well as community-and clinic-based pediatric asthma prevention efforts.

Additionally, results here from 2016-2017 NSCH datasets also showed 1 in 6 (15.3%) US household had at least 1 smoker, which was very similar to the 2017 prevalence estimates reported by CDC²⁴, but slightly higher than the ETS rates produced from the 2013-2014 National Health and Nutrition Examination Survey (NHANES).¹⁴ This indirect comparison may indicate the rate of ETS exposure among US children is on the rise again, but more analyses are needed to verify this trend.

Existing evidence shows that lower parental socioeconomic status, especially lower education level, is a significant predictor for ETS exposure among children.^{15,18,23,24} Similarly, the population-level results here show that parents with lower education levels and less family income were more likely to smoke. As a result, the asthma prevalence estimates of their children were substantially higher than their socioeconomic counterparts. These findings indicate parental socioeconomic status indeed influences smoking behaviors and child health outcomes. These findings provide important information and specific risk behaviors to target in the clinical setting when parents accompany their child to pediatric care visits.

To date, there were no conclusive explanations for the disparities of asthma diagnosis by race/ethnicity. Our study suggested the non-Hispanic White and other multi-racial children with ETS exposure were significantly more likely to have asthma diagnosis, while there were no statistically significant differences among non-Hispanic Black or Hispanic children. One explanation may be an inherent survival bias associated with the study sample. That is, the children with less severe asthma are more likely to be ETS-exposed while those with more severe symptoms were less likely to have ETS exposure. Another explanation could be the

differences in the uncontrolled living environment. For instance, children living in households with other environmental hazards in addition to ETS, such as molds, dusts, air pollutions or other allergens, may have a higher chance of asthma diagnosis due to these compound exposures.⁹ Indeed, ETS consists of more than 7,000 chemicals, and hundreds of them are toxic, especially for children who have incompletely developed immune system.²⁵ The exact pathophysiological associations between ETS and asthma remain unclear, but one well-accepted plausible mechanism is that tobacco smoke alters inflammatory reactions and changes the immune system, and the risk of asthma attacks increases in those who had ETS exposure as a result.²⁶

Also, there may be a selection bias concerning the analytical sample's Hispanic participants. According to CDC, the asthma prevalence varies by Hispanic sub-groups with Puerto Ricans having almost twice the asthma prevalence rates versus Central and South Americans.²⁷ If Puerto Ricans were more represented in the survey, then perhaps asthma prevalence estimates would be higher for the overall Hispanic population. Unfortunately, Hispanic sub-group information was not available for analysis which limited conclusions.

Interestingly, analysis here showed both non-Hispanic black and Hispanic race/ethnicity were protective factors for ETS exposure among children and adolescents. This conclusion was supported by Anand and colleagues²⁸ who reported Hispanic children are the least likely (17% less likely) to be exposed to second hand smoke compared to non-Hispanic Black and White children. In addition, the current smoking rates were lowest among Hispanics (9.9%) and non-Hispanic blacks (14.9%) versus non-Hispanic Whites (15.2%).²⁴ These findings suggest smoking cessation programs should target non-Hispanic white parents in particular.

Several study limitations should be mentioned. Other than the nature of cross-sectional study (and thus causality cannot be implied), all information was reported by parents instead of

physicians or confirmed by electronic health records, so it may be prone to recall and report bias. However, the prevalence estimates in our study were similar to previous studies and CDC's reports,^{1,2,24} confirming the validity and accuracy of our analyses. Objective measurements, such as biomarkers for ETS exposure were unavailable in 2016-2017 NSCH datasets, therefore the in vivo concentrations of active ingredients of side stream smoking are unknown. Another limitation of our study is the lack of information on the number of tobacco products consumed per day or specified information on the household smokers. Hence, we could not investigate any possible dose-response relationships between the quantity of tobacco products and asthma severity. Other environmental factors⁹ such as mold, were not controlled in our model due to unavailable information, which may potentially lead to overestimated odds.

Although the temporality of relationships between ETS exposure and asthma diagnosis cannot be established due to the cross-sectional study design, our study can serve as the first step to provide evidence and guidance for future prospective cohort studies, and to inform ETS prevention efforts among families with children in particular. Finally, the relatively low response rates (40.7% for 2016 and 37.4% for 2017) should be taken into consideration. Even though this could contribute to potential sample bias, the well-calibrated sample weights assigned by NSCH can decrease bias resulting from nonresponse and generalize our study results to the US pediatric population.

Conclusions

Population-level results reported here show that ETS exposure is a significant risk factor for pediatric asthma diagnosis in the US. The prevalence of parent-reported asthma diagnosis in ETS-exposed children and adolescents is significantly higher than that of non-exposed pediatric

participants. Smoking cessation initiatives targeting non-Hispanic white parents from lower socioeconomic (education and income) may improve children's chronic pulmonary health risk in the US.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Funding: This project was not supported by any grants/funding.

Data availability: The data that support the findings of this study are openly available in Data Resource Center for Child & Adolescent Health at <https://www.childhealthdata.org/learn-about-the-nsch/NSCH>

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Funding: This project was not supported by any grants/funding.

Data availability: The data that support the findings of this study are openly available in Data Resource Center for Child & Adolescent Health at <https://www.childhealthdata.org/learn-about-the-nsch/NSCH>

References

1. Akinbami, LJ, Simon AE, Rossen, LM. Changing Trends in Asthma Prevalence Among Children. *Pediatrics*. 2016;137(1):1–7.
2. CDC (Centers for Disease Control and Prevention). Most Recent Asthma Data. 2019. Retrieved [11/01/19] from: https://www.cdc.gov/asthma/most_recent_data.htm.
3. Brand PL, Mäkelä MJ, Szeffler SJ, Frischer T, Price D. Monitoring asthma in childhood: Symptoms, exacerbations and quality of life. *Eur Respir Rev*. 2015;24(136):187-193.
4. National Asthma Education and Prevention Program. Third Expert Panel on the Diagnosis and Management of Asthma. Bethesda (MD): National Heart, Lung, and Blood

Institute (US). 2007; Aug. Report No.: 07-4051. Available from:
<https://www.ncbi.nlm.nih.gov/books/ NBK7232/>.

5. Papadopoulos NG, Arakawa H, Carlsen KH, Custovic A, Gern J, Lemanske R, et al. International consensus on (ICON) pediatric asthma. *Allergy*. 2012; 67(8): 976–997.
6. Akinbami LJ, Schoendorf KC. Trends in childhood asthma: prevalence, health care utilization, and mortality. *Pediatrics*. 2002; 110(2):315-322.
7. Zahran H, Bailey C, Damon S, Garbe P, Breyse P. Vital Signs: Asthma in Children — United States, 2001–2016. *MMWR Morb Mortal Wkly Rep*. 2018; 67(5):149-155.
8. Sullivan PW, Ghushchyan V, Navaratnam P, Friedman HS, Kavati A, Ortiz B, et al. The national cost of asthma among school-aged children in the United States. *Ann Allergy Asthma Immunol*. 2017; 119(3):246-252.e1.
9. Subbarao P, Mandhane PJ, Sears MR. Asthma: epidemiology, etiology and risk factors. *CMAJ*. 2009; 181(9): E181–E190.
10. U.S. Department of Health and Human Services. Children and Secondhand Smoke Exposure. Excerpts from The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. 2007. Available from https://www.cdc.gov/tobacco/data_statistics/sgr/2006/pdfs/childrens-excerpt.pdf
11. Dekker HT, Voort AMMS, de Jongste JC, Reiss IK, Hofman A, Jaddoe VWV, et al. Tobacco Smoke Exposure, Airway Resistance, and Asthma in School-age Children: The Generation R Study. *Chest*. 2015; 148(3): 607-617.

12. Polosa R, Knoke JD, Russo C, Piccillo G, Caponnetto P, Sarva M, et al. Cigarette smoking is associated with a greater risk of incident asthma in allergic rhinitis. *J Allergy Clin Immunol.* 2008; 121(6):1428-1434.
13. Tsai CH, Huang JH, Hwang BF, Lee YL. Household environmental tobacco smoke and risks of asthma, wheeze and bronchitic symptoms among children in Taiwan. *Respir Res.* 2010; 11(1): 11.
14. Zhang X, Johnson N, Carrillo G, Xu X. Decreasing trend in passive tobacco smoke exposure and association with asthma in U.S. children. *Environ Res.* 2018 Oct;166:35-41. doi: 10.1016/j.envres.2018.05.022. Epub 2018 May 31.
15. Kitsantas P, Aguisanda F. Association of asthma with obesity among adolescents exposed to environmental tobacco smoke. *J Asthma.* 2016;53(1):25-9.
16. Wu TD, Eakin MN, Rand CS, Brigham EP, Diette GB, et al. In-Home Secondhand Smoke Exposure Among Urban Children With Asthma: Contrasting Households With and Without Residential Smokers. *J Public Health Manag Pract.* 2019 Mar/Apr;25(2):E7-E16.
17. Neophytou AM, Oh SS, White MJ, Mak ACY, Hu D, et al. Secondhand smoke exposure and asthma outcomes among African-American and Latino children with asthma. *Thorax.* 2018 Nov;73(11):1041-1048.
18. Protano C, Cammalleri V, Antonucci A, Ungureanu AS, Santilli F, et al. Further Insights on Predictors of Environmental Tobacco Smoke Exposure during the Pediatric Age. *Int J Environ Res Public Health.* 2019 Oct 23;16(21). pii: E4062.
19. Pless CE, Pless IB. How Well They Remember: The Accuracy of Parent Reports. *Arch Pediatr Adolesc Med.* 1995;149(5):553-558.

20. Senturia YD, Bauman LJ, Coyle YM, Morgan W, et al. The use of parent report to assess the quality of care in primary care visits among children with asthma. *Ambul Pediatr*. 2001 Jul-Aug;1(4):194-200.
21. CAHMI (Child and Adolescent Health Measurement Initiative). “2016-2017 National Survey of Children’s Health (2 years Combined Data Set): Child and Family Health Measures, National Performance and Outcome Measures, and Subgroups, SAS Codebook, Version 1.0”, Data Resource Center for Child and Adolescent Health supported by Cooperative Agreement U59MC27866 from the U.S. Department of Health and Human Services, Health Resources and Services Administration (HRSA), Maternal and Child Health Bureau (MCHB). 2019. Retrieved [01/03/19] from www.childhealthdata.org.
22. Akinbami, LJ, Kit BK, Simon AE. Impact of environmental tobacco smoke on children with asthma, United States, 2003-2010. *Academic pediatrics*. 2013;13(6): 508–516.
23. Kit BK, Simon AE, Brody DJ, Akinbami LJ. US prevalence and trends in tobacco smoke exposure among children and adolescents with asthma. *Pediatrics*. 2013; 131(3):407-14.
24. CDC. Current Cigarette Smoking Among Adults in the United States. 2019. Retrieved [11/07/19] from: https://www.cdc.gov/tobacco/data_statistics/fact_sheets/adult_data/cig_smoking/index.htm
25. CDC. Secondhand smoke, children in the home. 2018. Retrieved [11/07/19] from: https://www.cdc.gov/tobacco/basic_information/secondhand_smoke/children-home/index.htm.

26. Tamimi A, Serdarevic D, Hanania NA. The effects of cigarette smoke on airway inflammation in asthma and COPD: therapeutic implications. *Respir Med.* 2012; 106(3):319-328.
27. CDC. Smoking & tobacco use. 2018. Retrieved [11/07/19] from: <https://www.cdc.gov/tobacco/index.htm>
28. Anand V, Downs SM. Racial, Ethnic, and Language Disparities in Children's Exposure to Secondhand Smoke. *Pediatric Allergy Immunol Pulmonol.* 2013; 26(3): 144–151.

Table 1. Characteristics of study sample, 2016-2017 NSCH (n = 71,811)

	Unweighted sample size	Weighted mean or %	95% CI
Age			
Mean, years	71,811	8.6	8.5-8.7
Gender			
Male, %	36,800	51.1	50.2-52.0
Female, %	35,011	48.9	48.0-49.8
Race/Ethnicity			
Non-Hispanic White, %	50,219	51.4	50.6-52.3
Non-Hispanic Black, %	4,236	13.1	12.4-13.7
Hispanic, %	7,993	24.7	23.8-25.7
Other, %	9,363	10.8	10.3-11.2

Highest education level in the household			
College degree or higher, %	44,332	49.1	48.2-50.0
Some college or technical school, %	16,049	22.4	21.7-23.1
High school degree or GED, %	8,690	19.6	18.8-20.4
Less than high school, %	1,543	8.9	8.1-9.7
Family income			
≥400% FPL, %	30,834	30.1	29.4-30.8
200-399% FPL, %	22,073	27.0	26.2-27.7
100-199%FPL, %	11,253	21.7	20.9-22.5
0-99% FPL, %	7,651	21.2	20.4-22.1
Asthma diagnosis			
Yes, %	5,687	8.2	8.7-7.7
No, %	62,352	91.7	91.3-92.2
Environmental tobacco smoke			
ETS-exposed, %	10,105	15.3	14.7-15.9
Non-exposed, %	60,558	84.7	84.1-85.3

Note: NSCH, National Survey of Children's Health; CI, confidence interval; ETS, environmental tobacco smoke

Table 2. Weighted prevalence estimates of parent-reported asthma diagnosis in ETS-exposed versus non-exposed children by demographic subgroups, 2016-2017 NSCH

	Asthma diagnosis			
	ETS-exposed Weighted mean or % (95% CI)	Non-exposed Weighted mean or % (95% CI)	Test Statistics (df) ^a	<i>p</i> -value ^a
Overall	10.7 (9.3-11.9)	7.8 (7.3-8.3)	92.26 (1)	<0.001
Age				
Mean, years	10.3 (9.8-10.8)	10.2 (9.9-10.5)	0.12	0.91

(5599)				
Gender				
Male, %	12.1 (10.2-14.1)	8.9 (8.0-9.7)	55.03 (1)	0.003
Female, %	9.1 (7.4-10.8)	6.7 (6.1-7.4)	36.55 (1)	0.009
Race/Ethnicity				
Non-Hispanic White, %	8.8 (7.6-10.0)	6.1 (5.7-6.6)	77.39 (1)	<0.001
Non-Hispanic Black, %	17.4 (11.8-23.0)	14.1 (12.1-16.1)	4.36 (1)	0.28
Hispanic, %	9.1 (6.3-11.8)	8.4 (6.9-10.0)	0.38 (1)	0.69
Other, %	14.4 (9.6-19.3)	6.8 (5.6-8.0)	92.30 (1)	0.003
Highest education level in the household				
College degree or higher, %	8.7 (6.4-11.0)	6.6 (6.1-7.0)	22.32 (1)	0.07
Some college or technical school, %	11.6 (9.4-13.9)	9.5 (8.1-10.9)	12.27 (1)	0.12
High school degree or GED, %	9.1 (6.9- 11.4)	9.1 (7.5-10.6)	0.01 (1)	0.96
Less than high school, %	17.4 (11.9-22.8)	9.1 (6.1-12.1)	14.64 (1)	0.008
Family income				
≥400% FPL, %	6.9 (4.8-9.0)	6.3 (5.7-7.0)	1.24 (1)	0.61
200-399% FPL, %	10.5 (8.0-12.9)	6.9 (6.1-7.6)	48.55 (1)	0.005
100-199% FPL, %	10.9 (8.2-13.6)	8.2 (6.9-9.4)	15.79 (1)	0.07
0-99% FPL, %	12.5 (9.9-15.1)	11.3 (9.5-13.1)	1.62 (1)	0.47

Note: NSCH, National Survey of Children's Health; df, degree of freedom; ETS, environmental tobacco smoke; CI, confidence interval; GED, General Education Diploma; FPL, federal poverty level.

^a Chi-square tests for overall, gender, race/ethnicity, highest education level in the household and family income variable; t tests with equal variance for age variable.

Table 3. Unadjusted and adjusted odds ratios and 95% confidence intervals to predict asthma diagnosis by ETS exposure in the US pediatric population, 2016-2017 NSCH

	Unadjusted odds		Adjusted odds	
	OR (95% CI) ^a	p-Value	aOR (95% CI) ^b	p-Value
ETS				
Non-exposed (ref)	1.0		1.0	
Exposed	1.41 (1.21-1.64)	<0.001	1.29 (1.09-1.52)	0.003

Age		1.07 (1.06-1.09)	<0.001
Gender			
Male (ref)		1.0	
Female		0.73 (0.64-0.84)	<0.001
Race/Ethnicity			
non-Hispanic White (ref)		1.0	
non-Hispanic Black		2.07 (1.73-2.48)	<0.001
Hispanic		1.22 (1.01-1.47)	0.04
Other		1.25 (1.03-1.52)	0.02
Highest education level in the household			
College degree and higher (ref)		1.0	
Some college or technical school		1.19 (1.01-1.40)	0.04
High school degree or GED		0.96 (0.80-1.17)	0.71
Less than high school		1.02 (0.74-1.40)	0.89
Family income			
≥400% FPL (ref)		1.0	
200-399% FPL		1.09 (0.94-1.28)	0.26
100-199% FPL		1.20 (1.0-1.46)	0.05
0-99% FPL		1.60 (1.29-1.97)	<0.001

Note: NSCH, National Survey of Children's Health; ETS, environmental tobacco smoke; OR, odds ratio; CI, confidence interval; GED, General Education Diploma; FPL, federal poverty level; ref, reference.

^a Univariate logistic regression.

^b Multivariate logistic regression, adjusted for ETS exposure, age, gender, race/ethnicity, education level, family income.

Table 4. Adjusted odds and 95% Confidence Intervals to predict ETS exposure factors among the US pediatric population, 2016-2017 NSCH

ETS exposure	
Adjusted Odds ^a (95% CI)	p -value

Age	1.01 (1.0-1.02)	0.16
Gender		
Male (ref)	1.0	
Female	0.97 (0.88-1.08)	0.59
Race/Ethnicity		
non-Hispanic White (ref)	1.0	
non-Hispanic Black	0.60 (0.51-0.71)	<0.001
Hispanic	0.39 (0.33-0.46)	<0.001
Other	0.94 (0.82-1.08)	0.40
Highest education level in the household		
College degree or higher (ref)	1.0	
Some college or technical school	2.82 (2.47-3.21)	<0.001
High school degree or GED	3.78 (3.23-4.42)	<0.001
Less than high school	2.58 (1.99-3.33)	<0.001
Family income		
≥400% FPL (ref)	1.0	
200-399% FPL	1.51 (1.33-1.72)	<0.001
100-199% FPL	1.90 (1.63-2.21)	<0.001
0-99% FPL	2.17 (1.83-2.58)	<0.001

Note: NSCH, National Survey of Children's Health; ETS, environmental tobacco smoke; OR, odds ratio; CI, confidence interval; GED, General Education Diploma; FPL, federal poverty level; ref, reference.

^a Multivariate logistic regression, adjusted for age, gender, race/ethnicity, education level, family income.