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Child Tobacco Smoke Exposure and Healthcare Resource Utilization Patterns

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Abstract

Background: The objective was to examine the relationship between healthcare resource utilization patterns in tobacco smoke-exposed children (TSE group) compared with unexposed children (non-TSE group).

Methods: We matched 380 children in the TSE group with 1,140 children in the non-TSE group based on child age, sex, race, and ethnicity using propensity scores. Healthcare resource utilization variables included respiratory-related procedures, diagnostic testing, disposition, and medications. Logistic and linear regression models were built.

Results: Child mean age was 4.9 (SD=0.1) years, 50.5% were female, 55.5% black, and 73.2% had public insurance/self-pay. Compared to the non-TSE group, the TSE group was at increased odds to have the following performed/obtained: nasal bulb suctioning, infectious diagnostic tests, laboratory tests, and radiologic tests. The TSE group was more likely to be admitted to the

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hospital, and more likely to receive steroids and intravenous fluids during their visit. Among asthmatics, the TSE group was more likely to receive steroids, albuterol, or ipratropium alone, or a combination of all three medications during their visit, and be prescribed albuterol alone or steroids and albuterol.

Conclusion: Tobacco smoke-exposed children are more likely to have higher resource utilization patterns, highlighting the importance of screening and providing TSE prevention and remediation interventions.

Introduction

Nicotine addiction is a common substance use disorder that directly affects caregivers and their children due to tobacco smoke exposure (TSE) (1). Approximately 38% of children ages 3–11 years (2) and 32% of children ages 12–19 years are exposed to tobacco smoke (3). We know that even brief TSE can be hazardous to children (4) The U.S. Surgeon General outlines numerous health consequences associated with TSE such as cough, respiratory-related illnesses, and asthma (5,6).

Emergency Departments (EDs) commonly serve hard-to-reach populations that have a high TSE prevalence, a high number of visits for respiratory conditions, and limited access to preventive care (7–9). In 2010, child TSE resulted in more than 101,570 annual ED visits, amounting to nearly $63 million (10). National research indicates that tobacco smoke-exposed children are up to 3.5 times more likely to seek care at EDs than unexposed children (11). Caregivers who bring their child to the pediatric ED (PED) have smoking rates as high as 48% (12,13), far exceeding the national average of 14% (14). However, we do not know the contribution of TSE on healthcare resource utilization patterns among this vulnerable population. Prior work indicates that TSE may increase rates of healthcare utilization, clinical interventions, and hospitalizations among tobacco smoke-exposed children (15–18).

Research on the contribution of child TSE specific to PED healthcare resource utilization patterns is lacking. The study objective was to assess the relationship between healthcare resource utilization patterns in tobacco smoke-exposed children compared with unexposed children who presented to a PED. We hypothesized that children in the TSE group would have higher healthcare resource utilization than children in the non-TSE group. For the current study, healthcare resource utilization was defined as PED/Urgent Care (UC)-based resources used during the child's visit in order to assess the potential healthcare resource-related burden that TSE may place on these settings. While acknowledging that illness severity may not be exclusive of the amount of resources children received during their visit, we assessed variables that may serve as proxies of illness severity since more severe illnesses may necessitate the need to receive more resources. Specifically, PED/UC-based resource utilization categories assessed were: oxygen saturation; respiratory-related procedures (e.g., supplemental oxygen sources); diagnostic testing (e.g., influenza test); disposition (e.g., admitted to the hospital); and medications administered during the visit (e.g., ipratropium) and prescribed for home administration (e.g., antibiotics).

Methods

Participants and Procedures

We used a retrospective, cross-sectional design (N=1,520) to analyze self-reported TSE and electronic medical record (EMR) data obtained from two studies conducted at a large, urban freestanding Midwestern Children's Hospital. These studies included 380 children who were exposed to tobacco smoke (TSE group) and 1,140 children who were not exposed to tobacco smoke (non-TSE group). We obtained IRB approval for this study.

Data Sources/Collection

TSE group data were derived from a completed randomized controlled trial (RCT) of a smoking cessation intervention that enrolled 750 children 0–17 years of age who presented to the hospital's PED or UC. More RCT study details are available elsewhere (19). Briefly, the PED is one of the busiest in the U.S. with over 165,000 outpatient encounters annually. Children were eligible for the TSE group if they met all of the following criteria: 1) presented to the PED or UC with a potential TSE-related chief complaint as defined by the U.S. Surgeon General (5,6); 2) were triaged in the PED with a "non-urgent" or "urgent" chief complaint with practitioners' confirmation that patients were clinically stable with minimal risk of clinical deterioration; 3) were accompanied by a caregiver who smoked inside or outside the home; and (4) did not smoke combustible tobacco products or vape nicotine products. A list of potential TSE-related chief complaints was used to assess eligibility including: cold symptoms, congestion, cough, croup/stridor, difficulty breathing, fast breathing, ear drainage, ear pain, ear pulling, eye irritation, flu-like symptoms, nasal congestion, sinus pressure, sore throat, tonsillitis, upper respiratory-related symptoms, and wheezing.

Non-TSE group data were obtained from a convenience sub-sample of 1,140 PED patients from 0–17 years of age who were enrolled in another study at the same PED/UC. More details on this study are described elsewhere (20,21). Briefly, a healthcare provider used prompts for assessing TSE status that asked if any of the primary caregivers smoked and whether the child lived with anyone who smokes. Eligible children for the non-TSE group had a negative TSE status.

We matched the 380 children in the TSE group and 1,140 children in the unexposed group by child age, sex, race and ethnicity using propensity score matching via nearest neighbor search, while keeping PED/UC location and PED visit date within a 12-month time period similar between groups. It is especially important to match based on race/ethnicity since there are differences in the metabolism of TSE in certain racial/ethnic groups due to genetic variations (22).

We extracted and analyzed data from all PED patients' EMRs on healthcare resource utilization. We used a 1:3 ratio for optimal power in analyses to detect differences between the two groups. EMRs provided access to rich data allowing us to retrospectively match participants in a time- and cost-efficient manner. In combination with the self-reported data included, the use of EMRs can enhance data validity (e.g., documented past medical history [PMH]) and reliability whereas the enrollment of cohorts with large sample sizes may result

in self-report limitations including selection, recall, and reporting biases (23). EMR data have been used in similar work (24).

Measures

TSE—Children were classified by their TSE status into two groups: TSE and non-TSE.

Healthcare Resource Utilization Outcome Variables

We abstracted data from children's EMRs on healthcare resource utilization related to the index study visit as listed below. PED/UC-based healthcare resources were our outcomes of interest in order to assess the potential healthcare resource-related burden TSE places on the PED/UC sites. We assessed variables that may serve as proxies of illness severity. PED/UC-resource utilization variables were: oxygen saturation; respiratory-related procedures; diagnostic testing; disposition; and medications administered during the visit and prescribed for home administration.

PED Temperature and Oxygen Saturation—We assessed maximum temperature obtained during the visit continuously and based on a common cut point to determine fever (i.e., ≥100.4 degrees). We extracted children's lowest oxygen saturation level and assessed this measure based on a cut point of low versus high. The practice threshold for supplemental oxygen sources is <90%, but higher thresholds are required by some conditions ranging up to <94% (25). Thus, we examined 93% as a cutpoint and also examined these differences continuously and categorically (i.e., 90%, 91%, 92%, 94%).

PED Respiratory-Related Procedures—We extracted whether children received any supplemental oxygen source via a nasal cannula, hand-held nebulizer, blowby, oxymask, and/or aerosol mask. All sources were collapsed into one variable due to a low number of those who received oxygen in both groups (n=14). We assessed whether children ≤3 years old received baby booger grabber ([BBG], i.e., nasal bulb suctioning device) suctioning.

PED Diagnostic Testing—We extracted whether the following bacterial and viral tests were obtained: influenza; strep; monospot; and blood culture. We assessed whether children had the following laboratory tests obtained: renal profile and complete blood count. We assessed whether children had the following radiologic tests: chest and lateral airway x-ray.

PED Disposition—Disposition included discharge to home and admitted to the hospital.

Medication—We extracted whether the following commonly prescribed medications in the PED for respiratory-related and non-respiratory-related illnesses were given to patients during their visit: antipyretics; antibiotics; and steroids. We examined whether intravenous (IV) fluids were administered. For children with a PMH of asthma, we assessed the following medications: steroids; albuterol; ipratropium; and a combination of these three medications. We assessed the number of albuterol and ipratropium treatments given.

We extracted whether children were prescribed the following medications for home administration: antibiotics (oral, ophthalmic drops or otic drops) and steroids. We also

assessed whether asthmatics were prescribed: steroids; albuterol; and both steroids and albuterol.

Patient Characteristics

We extracted sociodemographics: child age, sex, race, ethnicity, and insurance type. We divided children into age groups that have similar TSE patterns (26): 0–1 (infants), 2–4 (toddlers), 5–9 (school-aged children), and 10–17 (pre-adolescents and adolescents). Due to the distribution of age in our sample, we assessed TSE patterns in 0, 1, 2–4, 5–9, and 10–17 year olds. Race included white, black, and other (i.e., Asian, other race, and multiple races). Ethnicity included non-Hispanic and Hispanic. Insurance type was categorized as private and public insurance/self-pay.

EMRs were reviewed to assess potential TSE-related PMHs: asthma; bronchiolitis; pneumonia; and prematurity. We computed a composite variable to assess PMHs documented (0 vs. 1–3 PMHs). We extracted potential TSE-related surgical history of: tonsillectomy; adenoidectomy; and PE tubes. Since most children who had a tonsillectomy had an adenoidectomy, we collapsed these into one variable.

Statistical Analysis

Analyses were conducted using R (version 3.3.0). We delimited our sample to a 12-month period based on PED/UC visit date and PED/UC location prior to matching child TSE groups. Propensity score methods were used to match children for TSE group membership based on their age, sex, race and ethnicity. We built unadjusted logistic regression models to assess the relationships between child characteristics and TSE groups. To examine the associations between matched TSE groups and healthcare resource utilization indicators, we used logistic regression for categorical outcome variables and linear regression for continuous outcome variables. In these logistic and linear regression models, we adjusted for sociodemographics and PMH. We present adjusted odds ratios (aORs) and 95% confidence intervals (CIs) from the logistic models and effect sizes (beta) and 95%CIs from the linear models. All analyses were two-sided with a $p<0.05$ indicating statistical significance.

Results

Of the 1,520 children, mean age (M (SD)) was 4.9 (0.1) years (Table 1). The majority of children were female (50.5%), had public insurance or were self-pay (73.2%), and were black (55.5%) and non-Hispanic (98.4%). Nearly one-in-four (24.3%) children had 1–3 TSE-related PMHs documented.

Child Characteristics and TSE

Children who were 1 years old (OR=0.29, 95%CI=0.20, 0.43, $p<0.001$), 2–4 years old (OR=0.48, 95%CI=0.34, 0.69, $p<0.001$), 5–9 years old (OR=0.42, 95%CI=0.29, 0.60, $p<0.001$), and 10–17 years old (OR=0.44, 95%CI=0.30, 0.64, $p<0.001$) were at significantly reduced odds to be in the TSE group compared to children who were <1 years old (see Table 1). Those with public insurance/self-pay were at 6.28 increased odds to be in the TSE group (95%CI=4.19, 9.40, $p<0.001$). Children with 1–3 PMHs were at significantly increased odds

to be in the TSE group (OR=1.33, 95%CI=1.02, 1.73, p=0.03) than children with no PMH. Regarding specific PMH, children with PMH of asthma were at increased odds to be in the TSE group (OR=1.49, 95%CI=1.08, 2.05, p=0.02) than children without this PMH (see Table 1).

TSE and PED Temperature

The child TSE group (M=99.2, SD=0.07) was more likely to have a higher temperature (β=0.18, 95%CI=0.01, 0.34, p=0.04) than the child non-TSE group (M=99.0, SD=0.04), after adjusting for covariates. No difference was found between TSE groups using a temperature cut point of 100.4 degrees (Table 2).

TSE and PED Oxygen Saturation

The TSE group (M=97.7, SD=0.18) was more likely to have lower oxygen saturation (β= −0.75, 95%CI= −1.34, −0.16, p=0.01) than the non-TSE group (M=98.2, SD=0.20). The TSE group was less likely to have an oxygen saturation >93 (OR=0.19, 95%CI=0.06, 0.54, p=0.002). Sensitivity analyses indicated similar results with the TSE group less likely to have higher oxygen saturation levels (i.e., >90, >91, >92, and >94).

TSE and PED Respiratory-related Procedures

Children in the TSE group ≤3 years old were 7.79 times more likely to have BBG suctioning performed (95%CI=4.80, 12.63, p<0.001) than the non-TSE group (see Table 2).

TSE and PED Diagnostic Testing

The TSE group was 2.68 times more likely to have an infectious diagnostic test obtained (95%CI=1.93, 3.70, p<0.001), and were more likely to have a higher number of tests obtained (M=0.3, SD=0.02; β=0.15, 95%CI=0.10, 0.19, p<0.001) than the non-TSE group (M=0.1, SD=0.01). The TSE group was more likely to have an influenza test (aOR=5.27, 95%CI=1.54, 18.04, p<0.001), strep test (aOR=1.94, 95%CI=1.37, 2.74, p<0.001), monospot test (aOR=5.24, 95%CI=1.03, 26.57, p=0.045), and blood culture test (aOR=9.20, 95%CI=2.88, 29.37, p<0.001) obtained than the non-TSE group. The TSE group was 5.72 times more likely to have laboratory tests obtained (95%CI=2.27, 14.43, p<0.001), and 4.73 times more likely to have radiologic tests obtained (95%CI=2.92, 7.65, p<0.001). The TSE group was 4.23 times more likely to have a chest x-ray obtained (95%CI=2.57, 6.95, p<0.001) and 10.44 times more likely to have a lateral airway x-ray (95%CI=2.20, 49.50, p=0.003) obtained than the non-TSE group (see Table 2).

TSE and PED Disposition

The TSE group was 24.17 times more likely to be admitted to the hospital (95%CI=6.90, 84.59, p<0.001) than the non-TSE group (see Table 2), while controlling for the covariates.

TSE and Medications

The TSE group was 7.24 times more likely to receive steroids during their visit (95%CI=4.22, 12.44, p<0.001) than the non-TSE group (Table 3). The TSE group was more likely to receive IV fluids during their visit (aOR=24.49, 95%CI=6.68, 89.70, p<0.001) than

the non-TSE group. No group differences were found based on receiving antipyretics and antibiotics during their visit. Additionally, no differences were found between TSE groups and medications given as prescriptions.

Specific to asthmatic children (n=204), those in the TSE group were 27.29 times more likely to receive steroids during their visit (95%CI=8.06, 92.47, p<0.001) than asthmatics in the non-TSE group (see Table 3). The asthmatic TSE group was 15.59 times more likely to receive albuterol (95%CI=5.43, 44.78, p<0.001), but no differences (β=1.16, 95%CI= −0.51, 2.83, p=0.19) were found based on number of albuterol treatments between the asthmatic TSE (M=2.8, SD=0.38) and non-TSE groups (M=2.0, SD=0.45). The asthmatic TSE group was 16.18 times more likely to receive ipratropium during their PED visit (95%CI=3.76, 69.54, p<0.001), and more likely to receive a higher number of ipratropium treatments (M=2.9, SD=0.08; β=1.79, 95%CI=1.27, 2.31, p=0.002) than the asthmatic non-TSE group (M=1.7, SD=0.67). The asthmatic TSE group was 14.37 times more likely to receive a combination of steroids, albuterol, and ipratropium medications while in the PED (95%CI=5.50, 37.52, p<0.001). In terms of home prescriptions, the TSE group was more likely to be prescribed albuterol only (aOR=7.00, 95%CI=2.23, 22.02, p<0.001) and both albuterol and steroids (aOR=6.33, 95%CI=2.17, 18.43, p<0.001; see Table 3).

Discussion

This retrospective, cross-sectional study examined the associations between TSE and healthcare resource utilization patterns among PED patients. As hypothesized, the child TSE group was more likely to have higher healthcare resource utilization and have clinical findings suggestive of increased illness severity. Specific to respiratory-related outcomes, the TSE group was less likely to have high oxygen saturation levels, but were nearly eight times more likely to have BBG suctioning performed than the non-TSE group after adjusting for potential confounders. The TSE group was at increased odds of having infectious diagnostic tests, laboratory tests, and radiologic tests obtained. These findings align with prior studies that indicate a relationship between TSE and respiratory-related outcomes including wheeze symptoms, decreased lung function (18,27), and an overall higher frequency of respiratory-related diseases (28,29). The present study's findings underscore the need to adhere to the American Academy of Pediatrics' recommendations for PED/UC healthcare professionals to universally screen for TSE in children, and provide cessation counseling to parental smokers to help them quit (4). A prior study that surveyed American Academy of Pediatrics' members indicates that most pediatricians do not assist with smoking cessation, and standardized efforts need to be made available to pediatricians to protect children from TSE-related dangers (30). In addition to providing comprehensive medical treatment and interventions for children with TSE, it is crucial to provide families who have household members who smoke with public health interventions that will decrease the healthcare burden associated with childhood TSE.

Our results varied on TSE and medications administered in the PED and prescribed. Although the TSE group was more likely to have a higher mean temperature, this difference was not clinically significant as evidenced by our finding that there was no difference in the administration of antipyretics. We also found that the TSE group was at increased odds of

being administered IV fluids during their PED visit than the non-TSE group. Future studies should examine if this difference is related to specific illness categories or physiological changes associated with child TSE. Of note, the TSE group was over seven times more likely to receive steroids during their PED visit. It is possible that this is because TSE can result in increased airway hyperresponsiveness and inflammatory changes in children which results in wheezing and asthma-like symptoms (31), which are often treated with steroids. Additionally, we found no differences based on antibiotics given in the PED or for home administration. Our findings align with prior research that found no differences in the administration of antibiotics among PED patients with TSE who had pneumonia diagnoses, but found differences in the administration of steroids among PED patients with TSE who had asthma diagnoses (24).

Concerning asthmatic children, those in the TSE group were more likely to receive steroids, albuterol, or a combination of steroid, albuterol, and ipratropium medications during their visit. Additionally, the asthmatic TSE group was seven times more likely to be prescribed albuterol only, and over six times more likely to be prescribed both albuterol and steroids for home use. Optimal guidelines indicate that short-acting inhalation treatments such as albuterol are given for mild asthma exacerbations, and a combination of albuterol, ipratropium, and steroids are commonly given for moderate to severe asthma exacerbations (32), highlighting the potential increased severity of asthma in the TSE group. These findings were similar to prior PED research that indicated tobacco smoke-exposed asthmatic patients were more likely to receive steroids (24). However, our study also identified a difference between TSE and receipt of albuterol during the PED visit. ED treatment of asthmatic patients should include these first-line medications along with providing education on removing triggers in the child's environment such as home TSE to reduce potentially preventable visits (32). While enhancements have been made in asthma therapies and guidelines that aim to improve asthma control and reduce the related healthcare burden, there is room for improvement on referring pediatric patients to a pediatric asthma specialist (33). One strategy recommended in some of the guidelines (34,35) is to implement an effective specialist referral system. Improved care coordination between PEDs/UCs and specialty care could be enhanced via electronic referrals that outline when it is best to refer a pediatric asthma patient to a specialist, for example (36). Increased referrals would lead to improved pediatric asthma outcomes and overall patient health while decreasing the related healthcare burden placed on PEDs/UCs and other outpatient settings (33).

Of note, the TSE group was over 24 times more likely to be admitted to the hospital than the non-TSE group, underscoring possible TSE-related illness severity. This supports research that reports higher hospital admissions in smoke-exposed children (11,24), and greater illness severity in these hospitalized patients compared to unexposed patients (15,17). Hospitalizations, especially those related to respiratory illness, present a unique and feasible opportunity to counsel parents and families on TSE-related consequences and the importance of eliminating TSE from children's environments (37). Health information technology, such as clinical decision support systems, may increase the standardization and quality of such efforts in the healthcare system (38).

We found children who were 1 years old, 2–4 years old, 5–9 years old, and 10–17 years old were less likely to be exposed to tobacco smoke than children who were <1 years old, aligning with other PED work that reported a negative association between age and biochemically validated TSE (39). Children <1 years old may have higher TSE rates due to their inability to leave tobacco polluted environments. Children with public insurance or self-pay were more likely to be in the TSE group, comparable to prior studies (2,24). Nearly three-quarters of children included in the present study were public insurance recipients, a proxy of low income. Future research should assess whether stratifying by health insurance type would further delineate associations between TSE and healthcare resource utilization patterns. Additionally, children with 1–3 TSE-related PMHs and PMH of asthma were more likely to be in the TSE group than children with no TSE-related PMH or no PMH of asthma, respectively.

Limitations

We conducted a retrospective study using EMR data to assess healthcare resource utilization indicators. We were limited to data available in the EMR and were unable to include all clinical aspects of care during the PED visit. While EMR data utilization has many benefits including minimizing common self-report limitations (23), collecting healthcare resource utilization information prospectively and using these data in combination with EMR data may increase data validity. We used rigorous analytic methods, but were unable to confer temporal or longitudinal relationships due to the cross-sectional design. The original study inclusion criteria differed between the two TSE groups. The TSE child group was recruited and enrolled into the RCT if they lived with a smoker and presented to the PED with a TSE-related chief complaint (e.g., cough), whereas the non-TSE group was recruited and enrolled irrespective of TSE status and chief complaint. To avoid selection bias, we consecutively enrolled the first PED patients who had complete data available for analysis into the TSE group, and then matched them with the non-TSE group using propensity score matching via the nearest neighbor search matching algorithm. Additionally, we did not biochemically validate TSE, which may have been misclassified. We used an optimal 1:3 TSE to non-TSE group ratio and were able to detect differences that we would have expected not to find if many children in the non-TSE group were misclassified.

Conclusions

This study indicates tobacco smoke-exposed children are more likely to experience higher healthcare resource utilization, highlighting the importance of screening for TSE and providing prevention and remediation interventions for PED patients and their families. These findings lend support to the existing literature base that indicates EDs are a much needed setting for TSE reduction interventions (13,40). Standardized tobacco control initiatives in these venues could be highly advantageous for all tobacco smoke-exposed children by potentially reducing increased healthcare resource utilization patterns, including those indicative of illness severity. This may help already overburdened healthcare facilities by decreasing resource utilization attributed to TSE. For example, all children and their families presenting to the PED/UC who are hospitalized should be screened for TSE, and those who screen positive should be offered TSE reduction initiatives. Targeting children

with potential TSE-related chief complaints (e.g., cough) and illnesses (e.g., asthma) may also help to reduce related morbidity and potentially preventable future healthcare visits.

Future research should distinguish between how overall TSE, defined as secondhand smoke and thirdhand smoke, influences child health and healthcare resource utilization, and the types of prevention interventions that should be implemented in the PED setting to protect children from TSE. Future research should also consider the evaluation of the number of healthcare visits including a comprehensive examination of repeat clinic, UC, emergency care visits and hospital admissions across many healthcare sites and associated costs over time. Longitudinal studies using objective measures to assess the impact child TSE has on related morbidity, healthcare resource utilization and healthcare costs over time, would highly enrich this area of study.

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Impact:

- Tobacco smoke exposure may affect the healthcare resource utilization patterns of children.
- Evidence is lacking concerning these associations among the highly vulnerable pediatric emergency department patient population.
- This study examined the association between tobacco smoke exposure and healthcare resource utilization patterns among pediatric emergency department patients.
- Tobacco smoke exposure increased the risk of pediatric patients having respiratory-related procedures, respiratory-related and non-respiratory-related testing, medications administered during the pediatric emergency department visit, and medications prescribed for home administration.
- Tobacco smoke-exposed patients were more likely to be admitted to the hospital compared to unexposed patients.

Table 1.

Child Characteristics by TSE Group

Child Characteristic	Overall (N=1,520) *n* (%)[a]	Non-TSE (*n*=1,140) *n* (%)[b]	TSE (*n*=380) *n* (%)[b]	Univariate Regression OR	95% CI
Age					
0 years	234 (15.4)	138 (12.1)	96 (25.3)	Ref	Ref
1 year	313 (20.6)	260 (22.8)	53 (13.9)	0.29***	(0.20, 0.43)
2–4 years	345 (22.7)	258 (22.6)	87 (22.9)	0.48***	(0.34, 0.69)
5–9 years	346 (22.8)	268 (23.5)	78 (20.5)	0.42***	(0.29, 0.60)
10–17 years	282 (18.5)	216 (19.0)	66 (17.4)	0.44***	(0.30, 0.64)
Sex					
Male	753 (49.5)	564 (49.5)	189 (49.7)	Ref	Ref
Female	767 (50.5)	576 (50.5)	191 (50.3)	0.99	(0.78, 1.25)
Race					
White	537 (35.9)	405 (35.9)	132 (35.6)	Ref	Ref
Black	832 (55.5)	620 (55.0)	212 (57.1)	1.05	(0.82, 1.35)
Other	129 (8.6)	102 (9.1)	27 (7.3)	0.81	(0.51, 1.30)
Ethnicity					
Non-Hispanic	1,496 (98.4)	1,126 (98.8)	370 (97.4)	Ref	Ref
Hispanic	24 (1.6)	14 (1.2)	10 (2.6)	2.17	(0.96, 4.94)
Insurance Type					
Private Insurance	407 (26.8)	379 (33.3)	28 (7.4)	Ref	Ref
Public Insurance/Self-Pay	1,111 (73.2)	759 (66.7)	352 (92.6)	6.28***	(4.19, 9.40)
PMH of Any TSE-related Illness					
0 PMH	1,150 (75.7)	878 (77.0)	272 (71.6)	Ref	Ref
1–3 PMH	370 (24.3)	262 (23.0)	108 (28.4)	1.33*	(1.02, 1.73)
PMH of Asthma					
No	1,316 (86.6)	1,001 (87.8)	315 (82.9)	Ref	Ref
Yes	204 (13.4)	139 (12.2)	65 (17.1)	1.49*	(1.08, 2.05)
PMH of Bronchiolitis					
No	1,481 (97.4)	1,110 (97.4)	371 (97.6)	Ref	Ref
Yes	39 (2.6)	30 (2.6)	9 (2.4)	0.90	(0.42, 1.91)
PMH of Pneumonia					
No	1,496 (98.4)	1,125 (98.7)	371 (97.6)	Ref	Ref
Yes	24 (1.6)	15 (1.3)	9 (2.4)	1.82	(0.79, 4.19)
PMH of Prematurity					
No	1,433 (94.3)	1,081 (94.8)	352 (92.6)	Ref	Ref
Yes	87 (5.7)	59 (5.2)	28 (7.4)	1.46	(0.91, 2.32)
Surgical History of Tonsillectomy/Adenoidectomy					
No	1,431 (94.1)	1,076 (94.4)	355 (93.4)	Ref	Ref

Child Characteristic	Overall (N=1,520) *n* (%)[a]	Non-TSE (*n*=1,140) *n* (%)[b]	TSE (*n*=380) *n* (%)[b]	Univariate Regression OR	95% CI
Yes	89 (5.9)	64 (5.6)	25 (6.6)	1.18	(0.73, 1.91)
Surgical History of PE Tubes					
No	1,507 (99.1)	1,129 (99.0)	378 (99.5)	Ref	Ref
Yes	13 (0.9)	11 (1.0)	2 (0.5)	0.54	(0.12, 2.46)

Abbreviations: TSE, tobacco smoke exposure; PMH, past medical history; OR, odds ratio; CI, confidence interval; Ref, reference group.

*** $p<0.001$;

* $p<0.05$.

[a] Percent refers to column percent.

[b] Percent refers to row percent.

Table 2.

TSE and Child Temperature and Oxygen Saturation, Respiratory-related Procedures, Diagnostic Testing, and Disposition

Temperature				
	<100.4 degrees	**≥100.4 degrees**		**Regression[b]**
TSE Group	***n* (%)[a]**	***n* (%)[a]**	**aOR**	**95% CI**
Temperature				
Non-TSE	982 (86.4)	154 (13.6)	Ref	Ref
TSE	317 (83.4)	63 (16.6)	1.17	(0.83, 1.66)
Oxygen Saturation				
	≤93%	**>93%**		**Regression[b]**
TSE Group	***n* (%)[a]**	***n* (%)[a]**	**aOR**	**95% CI**
Oxygen Saturation				
Non-TSE	7 (2.0)	344 (98.0)	Ref	Ref
TSE	18 (7.0)	239 (93.0)	0.19**	(0.06, 0.54)
Respiratory-related Procedure Performed during PED Visit				
	No	**Yes**		**Regression[b]**
TSE Group	***n* (%)[a]**	***n* (%)[a]**	**aOR**	**95% CI**
Supplemental Oxygen Source[c]				
Non-TSE	346 (98.6)	5 (1.4)	Ref	Ref
TSE	248 (96.5)	9 (3.5)	2.04	(0.63, 6.55)
BBG Suctioning				
Non-TSE	1,075 (94.3)	65 (5.7)	Ref	Ref
TSE	307 (80.8)	73 (19.2)	7.79***	(4.80, 12.63)
Diagnostic Testing Obtained during PED Visit				
	No	**Yes**		**Regression[b]**
TSE Group	***n* (%)[a]**	***n* (%)[a]**	**aOR**	**95% CI**
Infectious Diagnostic Test[d]				
Non-TSE	1,021 (89.6)	119 (10.4)	Ref	Ref
TSE	282 (74.2)	98 (25.8)	2.68***	(1.93, 3.70)
Influenza Test				
Non-TSE	1,135 (99.6)	5 (0.4)	Ref	Ref
TSE	371 (97.6)	9 (2.4)	5.27**	(1.54, 18.04)
Strep Test				
Non-TSE	1,026 (90.0)	114 (10.0)	Ref	Ref
TSE	304 (80.0)	76 (20.0)	1.94***	(1.37, 2.74)
Monospot Test				
Non-TSE	1,137 (99.7)	3 (0.3)	Ref	Ref

TSE	375 (98.7)	5 (1.3)	5.24*	(1.03, 26.57)
Blood Culture Test				
Non-TSE	1,135 (99.6)	5 (0.4)	Ref	Ref
TSE	368 (96.8)	12 (3.2)	9.20***	(2.88, 29.37)
Laboratory Test[e]				
Non-TSE	1,131 (99.2)	9 (0.8)	Ref	Ref
TSE	365 (96.1)	15 (3.9)	5.72***	(2.27, 14.43)
Radiologic Test[f]				
Non-TSE	1,097 (96.2)	43 (3.8)	Ref	Ref
TSE	331 (87.1)	49 (12.9)	4.73***	(2.92, 7.65)
Chest X-Ray				
Non-TSE	1,100 (96.5)	40 (3.5)	Ref	Ref
TSE	337 (88.7)	43 (11.3)	4.23***	(2.57, 6.95)
Lateral Airway X-Ray				
Non-TSE	1,137 (99.7)	3 (0.3)	Ref	Ref
TSE	373 (98.2)	7 (1.8)	10.44**	(2.20, 49.50)

	Disposition			
	Discharge to Home	**Admit to Hospital**		**Regression**[b]
TSE Group	***n* (%)**[a]	***n* (%)**[a]	**aOR**	**95% CI**
Disposition				
Non-TSE	1,101 (99.7)	3 (0.3)	Ref	Ref
TSE	353 (93.1)	26 (6.9)	24.17***	(6.90, 84.59)

Abbreviations: TSE, tobacco smoke exposure; aOR, adjusted odds ratio; CI, confidence interval; Ref, reference group.

*** $p<0.001$;

** $p<0.01$;

* $p<0.05$.

[a] Percent refers to row percent unless noted otherwise;

[b] Regression controlling for PED patient age, sex, race, ethnicity, insurance type, and any TSE-related PMH;

[c] Supplemental oxygen sources included nasal cannula, hand-held nebulizer, blowby, oxymask, and aerosol mask;

[d] Infectious diagnostic tests obtained included influenza test, strep test, monospot test, and blood culture test;

[e] Laboratory tests obtained included renal profile and complete blood count;

[f] Radiologic tests obtained included an x-ray of the chest or lateral airway.

Table 3.

TSE and Medications Administered during the PED Visit and Prescriptions Given to Children

	Medications Given			
	No	Yes	Regression[b]	
TSE Group	*n* (%)[a]	*n* (%)[a]	aOR	95% CI
Medications Administered during the Visit among all Patients (N=1,520)				
Antipyretics[c]				
Non-TSE	862 (75.6)	278 (24.4)	Ref	Ref
TSE	293 (77.1)	87 (22.9)	0.98	(0.73, 1.31)
Antibiotics				
Non-TSE	1,101 (96.6)	39 (3.4)	Ref	Ref
TSE	372 (97.9)	8 (2.1)	0.72	(0.32, 1.61)
Steroids				
Non-TSE	1,113 (97.6)	27 (2.4)	Ref	Ref
TSE	332 (87.4)	48 (12.6)	7.24***	(4.22, 12.44)
IV Fluids				
Non-TSE	1,137 (99.7)	3 (0.3)	Ref	Ref
TSE	360 (94.7)	20 (5.3)	24.49***	(6.68, 89.70)
Medications Given as a Prescription among all Patients (N=1,520)				
Oral Antibiotics				
Non-TSE	842 (73.9)	298 (26.1)	Ref	Ref
TSE	277 (72.9)	103 (27.1)	1.08	(0.81, 1.43)
Ophthalmic or Otic Antibiotics				
Non-TSE	1,112 (97.5)	28 (2.5)	Ref	Ref
TSE	367 (96.6)	13 (3.4)	1.18	(0.58, 2.40)
Steroids				
Non-TSE	1,134 (99.5)	6 (0.5)	Ref	Ref
TSE	378 (99.5)	2 (0.5)	1.01	(0.19, 5.36)
Medications Administered during the Visit among Asthmatic Patients (*n*=204)				
Steroids				
Non-TSE	135 (97.1)	4 (2.9)	Ref	Ref
TSE	40 (61.5)	25 (38.5)	27.29***	(8.06, 92.47)
Albuterol				
Non-TSE	133 (95.7)	6 (4.3)	Ref	Ref
TSE	41 (63.1)	24 (36.9)	15.59***	(5.43, 44.78)
Ipratropium				
Non-TSE	136 (97.8)	3 (2.2)	Ref	Ref
TSE	52 (80.0)	13 (20.0)	16.18***	(3.76, 69.54)
Asthma Medications[d]				
Non-TSE	131 (94.2)	8 (5.8)	Ref	Ref

	Medications Given			
	No	Yes	Regression[b]	
TSE Group	*n* (%)[a]	*n* (%)[a]	aOR	95% CI
TSE	38 (58.5)	27 (41.5)	14.37***	(5.50, 37.52)
Medications Given as a Prescription among Asthmatic Patients (*n*=204)				
Steroids				
Non-TSE	137 (98.6)	2 (1.4)	Ref	Ref
TSE	64 (98.5)	1 (1.5)	1.80	(0.14, 23.80)
Albuterol				
Non-TSE	134 (96.4)	5 (3.6)	Ref	Ref
TSE	53 (81.5)	12 (18.5)	7.00***	(2.23, 22.02)
Asthma Medications[e]				
Non-TSE	133 (95.7)	6 (4.3)	Ref	Ref
TSE	52 (80.0)	13 (20.0)	6.33***	(2.17, 18.43)

Abbreviations: TSE, tobacco smoke exposure; aOR, adjusted odds ratio; CI, confidence interval; Ref, reference group.

*** $p<0.001$;

[a] Percent refers to row percent unless noted otherwise;

[b] Regression analysis controlling for PED patient age, sex, race, ethnicity, insurance type, and any TSE-related PMH;

[c] Antipyretics includes tylonel or motrin;

[d] Asthma medications given during the PED visit includes Albuterol, Ipratropium, and steroids;

[e] Asthma medications given as a prescriptions include steroids and Albuterol.