



## Prevalence of smoke exposure amongst children who undergo tonsillectomy for recurrent tonsillitis



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### ABSTRACT

**Purpose:** The hypothesis tested was that smoke exposure has a detrimental effect on the developing upper respiratory tract. The purpose of this study was to determine if more children undergoing tonsillectomy for recurrent tonsillitis had smoke exposure in comparison to a control group of children undergoing hernia repair.

**Methods:** This was a retrospective case-control study. Medical records of children less than 15 years of age that underwent tonsillectomy for recurrent tonsillitis at Penn State Hershey Medical Center from July 2009 to October 2012 were retrospectively reviewed to determine exposure to smoking contacts. Records of children less than 15 years of age that underwent hernia repair surgery at this facility during the same time, were also retrospectively reviewed for smoke exposure.

**Results:** A total of 256 children who underwent tonsillectomy for recurrent tonsillitis and 241 children who underwent hernia repair surgery met the inclusion criteria. Of the children in the tonsillectomy for recurrent tonsillitis group, 121 (47.27%) had previous smoke exposure, compared to 67 (27.80%) in the hernia repair group. Further analysis of the data using logistic regression yielded an odds ratio of 2.49 ( $P = 0.004$ ), indicating that children with smoke exposure had more than twice the odds of having tonsillectomy for recurrent tonsillitis compared to those with no exposure.

**Conclusions:** Exposure to smoking contacts was more common in children who underwent tonsillectomy for recurrent tonsillitis than children who underwent hernia repair surgery. Future studies could address the relation of smoke exposure quantity to health outcomes in children.

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## 1. Introduction

A significant amount is known about the damaging effects that smoking tobacco has on the body, as smoking is associated with many diseases and reduced health, in general [1]. Not only is smoking detrimental to the smoker, but harmful effects of secondhand smoke, defined as the combination of smoke from the burning end of a cigarette and smoke exhaled by the smoker, are known to be harmful to bystanders, such as children. The Surgeon General's 2006 report on involuntary smoking concluded

that there is no “safe” level of exposure to secondhand smoke. Additionally, thirdhand smoke, the residual tobacco smoke contaminants that remain after a cigarette is extinguished, also exposes nonsmoking individuals, such as children, to toxins in workplace and home environments when others smoke there [2,3].

The effects of cigarette smoke exposure on immune system function are complex and seemingly translate to many troublesome health problems in children. For example, evidence has shown that middle ear disease, such as recurrent otitis media and otitis media with effusion, is more common in children exposed to parental smoking [4]. Children's respiratory system may also be adversely affected by passive inhalation of cigarette smoke toxins, as reactive oxygen species found in cigarette smoke have been implicated in damaging epithelial cells lining the airways via activation of intracellular signaling cascades that lead to immune cell recruitment and inflammation [5]. Additionally, studies have

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demonstrated that cigarette smoke extracts are involved in suppression of several proinflammatory cytokines normally involved in host defense against infections, such as interferon  $\gamma$  (IFN- $\gamma$ ). For example, levels of IFN- $\gamma$  were found to be reduced, with a significant inverse dose-response relationship to pack years, among children that had experienced parental smoke exposure during their first 11 years of life compared to children with nonsmoking parents [6]. Such complex effects on the immune system seem to play a role in making children more prone to breathing complications, like asthma, and recurrent respiratory infections, such as tonsillitis [2].

Throat infections, such as tonsillitis and pharyngitis, can contribute to missed days of school for children and account for over 10% of all office visits to primary care physicians as well as 50% of outpatient antibiotic use [7]. Recurrent episodes of throat infections, such as tonsillitis, may eventually warrant tonsillectomy as a treatment option, as this procedure has been shown to be effective at significantly reducing the number and severity of episodes in children who are severely affected [8]. Children are considered to be severely affected when they experience three or more episodes of recurrent infection in each of 3 years, five or more episodes in each of 2 years, or seven or more episodes in 1 year [9].

Tonsillectomy is one of the most commonly performed operations in children, it was estimated that 530,000 tonsillectomies were performed in children less than 15 years of age in the United States in 2006 [9]. Previous British and French studies attempted to determine if parental smoking is associated with increased occurrence of tonsillectomy in children, but the results were inconsistent [4]. We hypothesized that children's respiratory systems are susceptible to environmental smoke exposure and those that underwent tonsillectomy for recurrent tonsillitis will have a higher prevalence of contacts with smoke compared to a control group of children that underwent hernia repair surgery.

## 2. Methods

This was a retrospective case-control study that incorporated data contained in electronic medical records from July 2009 to October 2012, inclusive. Data used was from pediatric patients that were less than 15 years of age at the time they underwent tonsillectomy for recurrent tonsillitis or hernia repair surgery at Penn State Hershey Medical Center. This age was chosen to decrease the likelihood that patients were active smokers. Any patient noted to be an active smoker was excluded from the study. Additionally, patients with documented immunodeficiency were excluded, since such patients are more likely to develop recurrent infections, regardless of exposure to smoking contacts. To accommodate for unique living situations in which parents may not be the primary caregivers, documented smoke exposure from any household contact was included. Patient charts were reviewed for surgical indication, age, gender, and smoking exposure and data was recorded and coded using an Excel spreadsheet. Smoking exposure status was determined primarily by information from pediatric health assessment questionnaires completed by parents or caregivers. If this was not included in the patient's record or the section regarding smoke exposure was incomplete, then provider documentation or any indication of a smoking contact included in the patients' electronic medical records was used to determine exposure to smoking contacts.

A statistical analysis of the above data was performed by the Public Health Services Biostatistics Department at Penn State Hershey. The prevalence of smoking contacts amongst children who underwent tonsillectomy for recurrent tonsillitis was compared to the prevalence observed in a control group, which was comprised of children who underwent hernia repair surgery during the same time period. The control group was selected on the

premise that, like the pediatric tonsillectomy patients, they also represented a common pediatric surgical population. The hernia surgery did not involve any component of the respiratory system and was presumably not indicated due to potential effects of exposure to smoking contacts.

A logistic regression model was utilized for data analysis. The main independent variable of this model was smoke exposure and the main dependent variable was tonsillectomy for recurrent tonsillitis. Age and gender were identified as potential covariates. The association between the main dependent and independent variables was analyzed initially without any adjustment for covariates. The association between the dependent variable and each covariate was then analyzed independently. The association between the independent variable and each covariate was also analyzed independently. After demonstrating significance in the associations with each of the dependent and independent variables separately, the covariates were included for adjustment in a multivariable model used to determine the association between the dependent and main independent variables. Odds ratios were used to quantify the magnitude and direction of the associations. All analyses were carried out using SAS version 9.3 (SAS Institute, Cary, NC).

Penn State Hershey Medical Center institutional review board (IRB) approval was obtained before research commenced. The IRB approval corresponds to protocol ID: 41237, entitled "Prevalence of Smoking Parents in Children that Undergo Tonsillectomy for recurrent tonsillitis."

## 3. Results

A total of 269 children who underwent tonsillectomy for recurrent tonsillitis and 275 children who underwent hernia repair surgery during the time period were examined in this study. Of the 269 that had a tonsillectomy for recurrent tonsillitis, nine were excluded due to being outside the age criteria, one was excluded for documentation of being an active smoker, and three were excluded due to lack of documentation regarding their exposure to smoking contacts. Of the 275 that underwent hernia repair surgery, eight were excluded due to being outside the age criteria and 26 were excluded due to lack of documentation regarding their exposure to smoking contacts. No children were excluded from either group for documented immune deficiency syndrome, as no records that were reviewed indicated any child had such a condition. Therefore, a total of 256 children who underwent tonsillectomy for recurrent tonsillitis and 241 children who underwent hernia repair surgery met the inclusion criteria, had information regarding smoke exposure documented in their electronic record, and were included in the statistical analysis of the data.

Differences in average age, gender, and smoke exposure were found to exist among the tonsillectomy for recurrent tonsillitis and hernia repair surgery groups, as summarized in Table 1. The average patient age in the tonsillectomy for recurrent tonsillitis group was 8.2 years (range: 1.80–14.90 years) compared to 2.9 years (range: 0.04–14.98 years) in the hernia repair surgery

**Table 1**  
Average age, gender, and smoke exposure by group.

	Tonsillectomy for recurrent tonsillitis group	Hernia repair group
Average age (years)	8.2 (range: 1.80–14.90)	2.9 (range: 0.04–14.98)
Gender	Total males = 122 (43.75%) Total females = 144 (56.25%)	Total males = 194 (80.50%) Total females = 47 (19.50%)
Smoke exposure	Total negative = 135 (52.73%) Total positive = 121 (47.27%)	Total negative = 174 (72.20%) Total positive = 67 (27.80%)

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