Effects of Secondhand Smoke Exposure on Childhood Caries

Cindy Lee DMD [1], Marie Beverly Dizon MS DDS [2], Wai-Yin Chan, MS DMD MPH [2], Mark Macaoay DDS MBA MAS [3], Jacy Stauffer DMD [4]
NYU Langone Dental Medicine-Advanced Education in Pediatric Dentistry, San Diego, CA
San Ysidro Health, San Diego, CA

NYU Langone Dental Postdoctoral Residency Programs

INTRODUCTION

- Dental caries, the most common chronic childhood disease,[1] is an infectious disease caused primarily by the colonization of *Streptococcus mutans (S. mutans)*.[2] In addition to nutrition, various elements contribute to the multifactorial nature of dental caries, such as genetics, behaviors, and environmental factors.[3]
- Secondhand Smoke (SHS) originates from the burning of tobacco products such as cigarettes, cigars, hookahs, or pipes, and comprises both exhaled mainstream smoke from a smoker and sidestream smoke emitted from the burning end of a cigarette.[4,5]
- Nicotine is the main addictive substance in tobacco[6] and cotinine is the major metabolite of nicotine.[7] Nicotine stimulates the proliferation of *S. mutans*, exacerbating the onset of cavities among smokers.[8]
- The developmental stage of infants and young children makes them particularly susceptible to the health ramifications of SHS exposure.[9] SHS has been linked to negative impacts on children's health, such as premature birth, restricted fetal growth, higher rates of perinatal death, exacerbated and more frequent asthma episodes, respiratory symptoms, inhibited lung growth, behavioral issues, and reduced academic performance.[6,9,10,11]
- From the oral health perspective, tobacco use can result in oral cancer, periodontitis, compromised wound healing, melanosis, leukoplakia, and loss of periodontal support.[12] Therefore, it is biologically reasonable that SHS exposure could potentially increase the risk of caries, especially in early childhood.

PURPOSE

- The purpose of this retrospective chart review is to determine whether Early Childhood Caries (ECC) or Severe Early Childhood Caries (S-ECC) are associated with SHS exposure in the household.
- It is hypothesized that children with SHS exposure in the household are at greater risk of having ECC or S-ECC compared to children with no SHS exposure.

METHOD

- **Participants**
  - Inclusion criteria were as follows: patients 13 years of age and younger seen for an examination between January 1, 2018 and January 1, 2022 with American Society of Anesthesiologists (ASA) classification status I or II; and examined under the care of a pediatric dental resident and an attending.
- **Procedure**
  - A retrospective chart review was completed using American Dental Association (ADA) procedure codes from the ADA Code on Dental Procedures and Nomenclature (CDT) for comprehensive exam (D0150), periodic exam (D0120), and an exam for patients younger than three years of age (D0145).
  - From the electronic health record (EHR) software, Dentrix Enterprise, which was available to study personnel using a password-protected login.
  - A quota sampling method was used to obtain at least 150 subjects in each exposure group (SHS exposed or unexposed). Demographic and study data was recorded using REDCap. The sum of the number of decayed, missing due to caries, and filled teeth due to caries (dmft score) was calculated to quantify dental health status.
- **Statistical Analysis**
  - Descriptive statistics included mean and standard deviation (SD) for continuous variables.
  - Bivariate tests included t-tests for continuous variables and chi-square tests for categorical variables.
  - Associations of SHS exposure with dmft scores were assessed by multiple linear regression with adjustments for other demographic and clinical variables.
  - Additionally, odds ratios were calculated using logistic regression to examine the association between SHS exposure and caries experience.
  - The threshold of significance was set at <0.05.

TABLE 1. Demographic characteristics according to SHS* status (n=310)

Variables	Total n=310 (%)	No SHS n=160 (%)	SHS n=150 (%)	p-value†
Age				**<0.001‡**
0-3 years	58 (18.7)	14 (9.4)	43 (28.7)	
4-5 years	72 (23.2)	34 (21.1)	38 (25.3)	
6-9 years	146 (47.1)	86 (53.8)	60 (40.0)	
10-13 years	34 (11.0)	25 (15.6)	9 (6.0)	
Gender				0.219
Female	161 (51.9)	89 (55.6)	72 (48.0)	
Male	149 (48.1)	71 (44.4)	78 (52.0)	
ASA				0.942
1	111 (35.8)	56 (35.0)	55 (36.7)	
2	199 (64.2)	104 (65.0)	95 (63.3)	
Race				**<0.001‡**
African American	6 (1.9)	2 (1.2)	4 (2.7)	
Asian	8 (2.6)	2 (1.2)	6 (4.0)	
Hispanic	245 (79.0)	143 (89.4)	102 (68.0)	
Mediterranean	13 (4.2)	2 (1.2)	11 (7.3)	
White	38 (12.3)	11 (6.9)	27 (18.0)	
Caries				**<0.001‡**
Yes	277 (89.4)	132 (82.5)	145 (96.7)	
No	33 (10.6)	28 (17.5)	5 (3.3)	
ECC*				0.476
Yes	50 (16.1)	23 (14.4)	27 (18.0)	
No	260 (83.9)	137 (85.6)	123 (82.0)	
S-ECC*				**<0.001‡**
Yes	96 (31.0)	24 (15.0)	72 (48.0)	
No	214 (69.0)	136 (85.0)	78 (52.0)	

FIGURE 1. SHS* status across caries subcategories

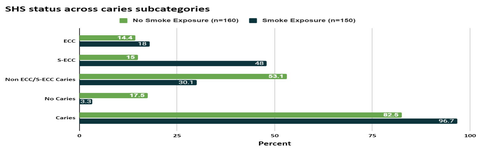

TABLE 2. Logistic Regression Results for S-ECC* associated with SHS

Effect	Odds ratio with SHS	95% Wald Confidence Limits		p-value†
SHS Yes vs No	4.598	2.614	8.086	**<0.0001‡**

TABLE 3. Mean dmft* score and mean number of decayed, missing, and filled teeth according to Secondhand Smoke Exposure

Variables	Overall Score (n=310)	No Smoke Exposure (n=160)	Smoke Exposure (n=150)	p-value†
Mean dmft score ± (SD)	7.54 (5.17)	6.05 (4.95)	9.13 (4.93)	**<0.001‡**
Mean decayed Teeth ± (SD)	3.27 (3.33)	2.72 (3.14)	3.84 (3.43)	**0.003‡**
Mean missing Teeth ± (SD)	1.10 (2.19)	0.49 (1.11)	1.75 (2.79)	**<0.001‡**
Mean filled Teeth ± (SD)	3.28 (3.38)	2.87 (2.89)	3.72 (3.80)	**0.027‡**

TABLE 4. Regression test results in determining the effects of different variables in relation to dmft* score

	Term	Estimate	Std error	statistic	p-value†
(Intercept)		0.13828	0.45508	2.763	0.30
SHS	No	*Ref*	*Ref*	*Ref*	*Ref*
	Yes	0.30394	0.13435	2.262§	**0.02‡**
Race	African American	*Ref*	*Ref*	*Ref*	*Ref*
	Asian	-0.2942	0.56124	-0.524	0.60
	Hispanic	-0.19562	0.43163	-0.453	0.65
	Mediterranean	-0.14511	0.51477	-0.282	0.78
	White	-0.06976	0.45766	-0.152	0.88
Gender	Female	*Ref*	*Ref*	*Ref*	*Ref*
	Male	-0.13915	0.11854	-1.174	0.24

*** Abbreviations:** SHS=secondhand smoke; ECC=early childhood caries; S-ECC=severe early childhood caries; ASA=American Society of Anesthesiologists classification status; dmft=decayed, missing, and filled primary teeth; SD=standard deviation.
† Chi-squared analysis (Table 1); Logistic regressions analysis (Table 2); T-test (Table 3); Multivariable regression analysis (Table 4).
‡ Statistically significant.
§ 2.262 unit increase in dmft score in secondhand exposure.

ACKNOWLEDGEMENT

This research was approved by the NYU Langone IRB and the San Ysidro Health Research Review Committee in San Diego, California. Data interpretation was conducted by Alberta Twi-Yeboah, MS, Assistant Research Scientist at NYU Langone Dental.

RESULTS

- Out of 1,400 charts reviewed, a total of 310 patients qualified for the study and were included in the analysis.
  - 1,090 charts were omitted because they lacked documentation of social history or failed to meet the inclusion criteria.
  - The mean age was 6.11 ± 2.78 (SD) years (ranging from 1 to 13 years old).
- A significant difference in S-ECC was observed between SHS exposed and unexposed groups (48.0% and 15.0%, respectively; *P*< 0.001) (Table 1; Figure 1).
  - No significant difference in ECC prevalence was observed between the SHS and no SHS exposure groups (p = 0.476).
  - A total of 72 (48.0%) children experienced S-ECC with SHS while a total of 24 (15.0%) exhibited S-ECC without SHS.
- Children with SHS exposure were more likely to have S-ECC (odds ratio [OR], 4.598; 95% CI, 2.514-8.086) (Table 2).
- A *t*-test analysis revealed that patients who had SHS exposure had significantly higher mean dmft scores than patients who reported no SHS exposure (9.13 ± 4.93 versus 6.05 ± 4.95; *P*<0.001) and also at every individual level of the dmft metric (decayed, missing, filled) (p= 0.003, *P*< 0.001 and p= 0.027, respectively) (Table 3).
- Those exposed to SHS had a significantly higher estimate of dmft score compared to those not exposed (estimate= 0.30394, std. error= 0.13435, statistic= 2.262, p-value = 0.02) (Table 4).

LIMITATIONS AND STRENGTHS

- **Strengths**
  - Utilized a metric of dmft scores, which is a validated and precise tool to quantify caries status[13] compared to other studies.[14]
  - Focused on patients aged 13 years and younger, specifically examining S-ECC and ECC and its association with SHS
  - Studied multiple variables.
- **Limitations**
  - Information on SHS was obtained by participants' narrative social history and is likely an underestimation of SHS exposure in subjects
    - SHS exposure omission by the charting clinician due to charting error or not inquiring about exposures
    - Recall bias and social desirability bias in subjects discussing their personal health choices with a clinician
  - Quota sampling can lack random or systematic selection.
  - Those exposed to third hand smoke or residual contamination from tobacco smoke that remains on a variety of indoor surfaces is a possibility that was not accounted for due to the limitations of the standard clinical documentation in the chart.
  - The duration of SHS exposure and variations in the types of tobacco products were not considered.
  - Other confounding variables which can influence caries risks and dmft
    - Oral hygiene, exposure to fluoride, diet, habits and fetal exposure to maternal smoking.
  - The nature of this retrospective study did not allow for use of a biological marker.

CONCLUSIONS

- Patients who had SHS exposure had significantly higher dmft scores and a higher prevalence of S-ECC than patients who reported no SHS exposure.
- Pediatric dentists should utilize a holistic approach to caries risk reduction and prevention counseling that includes inquiring about SHS exposure.

REFERENCES

1. National Center for Chronic Disease Prevention and Health Promotion (U.S.). Division of Oral Health. Oral Health: Preventing Cavities, Gum Disease, Tooth Loss, and Oral Cancers: At a Glance 2011, 2011.
2. Forssten SD, Björklund M, Ouwehand AC. Streptococcus mutans, caries and simulation models. *Nutrients*. 2010;2(3):290-298.
3. Peršić Bukmir R, Paljević E, Peraj-Ribarić S, Brekalo Pršo I. Association of the self-reported socioeconomic and health status with untreated dental caries and the oral hygiene level in adult patients. *Dent Med Probl*. 2022;59(4):539-545.
4. Saho H, Taniguchi-Tabata A, Ekuni D, et al. Association between Household Exposure to Secondhand Smoke and Dental Caries among Japanese Young Adults: A Cross-Sectional Study. *Int J Environ Res Public Health*. 2020;17(22):8523.
5. Florescu A, Ferrence R, Einarson T, Selby P, Soldin O, Koren G. Methods for quantification of exposure to cigarette smoking and environmental tobacco smoke: focus on developmental toxicology. Ther Drug Monit 2009;31:1430.
6. Hwang SH, Hwang JH, Moon JS, Lee DH. Environmental tobacco smoke and children's health. *Korean J Pediatr*. 2012;55(2):35-41.
7. Benowitz NL. Biomarkers of environmental tobacco smoke exposure. Environ Health Perspect 1999;107 Suppl 2:349S5.
8. Liu S, Qiu W, Zhang K, et al. Nicotine Enhances Interspecies Relationship between Streptococcus mutans and Candida albicans [published correction appears in Biomed Res Int. 2017;2017:5803246]. *Biomed Res Int*. 2017; 7953920.
9. Mannino, D M et al. "Health effects related to environmental tobacco smoke exposure in children in the United States: data from the Third National Health and Nutrition Examination Survey." *Archives of pediatrics & adolescent medicine* vol. 155,1 (2001): 36-41.
10. National Report on Human Exposure to Environmental Chemicals. Atlanta, GA: Centers for Disease Control and Prevention; 2001.
11. Cheraghi M, Salvi S. Environmental tobacco smoke (ETS) and respiratory health in children. *Eur J Pediatr* 2009;168:897905.
12. Muthukrishnan A, Warnakulasuriya S. Oral health consequences of smokeless tobacco use. *Indian J Med Res*. 2018;148(1):35-40.
13. World Health Organization. Indicator Metadata Registry. Mean number of Decayed, Missing, and Filled Permanent Teeth (mean DMFT) among the 12-year-old age group. Accessed March 20, 2024. Available from: https://www.who.int/data/gho/indicator-metadata-registry/imr-details/3812.
14. Tanaka S, Shinzawa M, Tokumasu H, et al. Secondhand smoke and incidence of dental caries in deciduous teeth among children in Japan: population-based retrospective cohort study. *BMJ*. 2015;351:h5397.