

## Children with Special Health Care Need's Association of Passive Tobacco Smoke Exposure and Dental Caries: 2007 National Survey of Children's Health

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### Abstract

**Purpose:** The purpose of this study was to determine a relationship between passive tobacco smoke exposure (secondhand and third hand tobacco smoke exposure) and dental caries in Children with Special Health Care Needs (CSHCN) ages 0-17 years.

**Method:** This study used data from the 2007 National Survey of Children's Health involving 17,901 CSHCN. Telephone survey data were used to determine recent caries experience and passive tobacco smoke exposure (secondhand and third hand tobacco smoke exposure). Recent caries was defined as a positive response to if CSHCN had "decayed teeth or cavities within the past 6 months." Passive smoke was defined as a positive response to if someone in the household used cigarettes, cigars, or pipe tobacco.

**Results:** A statistically significant relationship was determined between passive tobacco smoke exposure and recent caries in CSHCN (adjusted odds ratio: 1.23 (95% CI: 1.02, 1.50; p-value= 0.0352).

**Conclusion:** A positive independent association of passive tobacco smoke exposure and dental caries was determined in Children with Special Health Care Needs (CSHCN).

**Keywords:** Tobacco; Abnormalities; Bacterial colonization, Allergies

### Introduction

The U.S. Maternal and Child Health Bureau's Division of Services for Children with Special Health Care Needs (CSHCN) identifies CSHCN as children having or having the risk of psychological abnormalities (developmental, behavioral or emotional) as well as children having or having the risk of chronic physical conditions/diseases beyond the typical needs of children in general [1]. There are more than 14.1 million U.S. children who are CSHCN [2], and more than 20% of U.S. families have CSHCN [3]. Identifying children as CSHCN, rather than by having specific psychological abnormalities/physical conditions, has improved health care delivery programs [3], and has resulted in a national surveillance, the National Survey of Children's Health. From the surveillance, it is known that CSHCN are at increased risk of depression, inactivity, and injury [2]. Additionally, tobacco smoke exposure is greater in CSHCN [2].

Tobacco smoke exposure may be primary or passive. Primary smoke exposure is the exposure to the person smoking tobacco. Passive smoke exposure may occur as Second Hand Smoke (SHS) (the sidestream smoke of the burning tobacco and mainstream smoke exhaled by the smoker [4]) or Third Hand Smoke (THS) (the residue, pollutant, persistent tobacco contaminant on clothes, skin, hair, furniture, carpet, etc. [5]). Myriad studies indicate tobacco is associated with poor health. However the association between passive smoke exposure and dental caries is controversial. Some studies indicate such an association exists in pre-school children [6-11], in older children [12,13], and in animal models [14]; while two reviews suggested the evidence is weak or of poor quality [15,16]; and other studies failed to find an association [17-19].

Dental caries is a complex, multi-factorial biofilm-induced disease involving the endogenous oral bacteria and the demineralization/reminerization process of an affected tooth in which the balance is shifted to greater tooth demineralization. There are several theoretical bases for considering passive smoke as a factor in the etiology of caries. Vitamin C levels were found to be decreased in children exposed to passive smoke, and low levels of Vitamin C are associated with decreased immune function and *Streptococcus Mutans* growth

[16]. Passive smoke is associated with decreased saliva and reduced buffering capacity in children exposed to passive smoke, which may reduce remineralization, allow for less bacterial clearance, and allow enhanced bacterial colonization [16]. Heavy metals, such as cadmium, in passive smoke may be independent risk factors for caries [16].

It is important to identify the role of passive smoking and dental caries. The purpose of this study is to examine the relationship of passive smoking (SHS and THS) and dental caries in CSHCN. CSHCN are a vulnerable population in which the exposure to passive smoke may be particularly detrimental. The research hypothesis is that CSHCN who are exposed to passive smoking (SHS and THS) by having a person in the household who used cigarettes, cigars, or pipe tobacco, will have greater odds of having caries within the previous 6 months than CSHCN who are not exposed to passive smoke. The results of this study will add to the literature current information about the role of tobacco smoke exposure and caries development in the vulnerable population of CSHCN, whereas previous studies have worked with children who did not have SHCN. Also, the results will add to the weight of evidence in support of or against the role of tobacco smoke and caries in the current literature.

### Methods

The data used in this study were public use, de-identified data

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resulting in non-human subject secondary data analysis research. Researchers from the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention conducted the 2007 National Survey of Children's Health, a national telephone survey of 91,642 participants (between 1725 and 1932 participants of Columbia) with in each state and the District IRB approval from the CDC [20]. Survey weights were applied to adjust for the state-specific population characteristics of the non-institutionalized children age 0-17 years [20]. Detailed methodology is available from the NSCHS website: [http://www.cdc.gov/nchs/data/series/sr\\_01/sr01\\_055.pdf](http://www.cdc.gov/nchs/data/series/sr_01/sr01_055.pdf).

### Identification of CSHCN

The NSCHS provided a yes/no variable to identify CSHCN. The variable was derived by the researchers at NSCHS using the CSHCN Screener<sup>®</sup>. In summary, for a child to be categorized as CSHCN, he or she had an ongoing behavioral, medical, or health condition which lasted or was expected to last 12 months or longer. Additionally at least one of the following on-going conditions based upon a behavioral, medical or health condition had to be met: 1) emotional, developmental, or behavioral problems in need of counseling; 2) use of more services than other children for mental health care, educational support, or medical care; 3) use of prescription medications for the behavioral, medical, or health condition; 4) use of therapies (speech therapy, occupational therapy, physical therapy, etc.) for the behavioral, medical, or health condition; or 5) limitations due to behavioral, medical, or health conditions.

### Recent caries definition

A participant was asked about his or her child's dental status with the question: "To the best of your knowledge, did [child's name] have decayed teeth or cavities within the past 6 months?" In this study, the respondents who answered affirmatively were classified as having recent caries, and the respondents who answered negatively were classified as not having recent caries.

### Passive tobacco smoke exposure definition

The participants were asked, "Does anyone living in your household use cigarettes, cigars, or pipe tobacco?" The participants who responded affirmatively were classified as having children with passive tobacco smoke exposure (SHS or THS), and the respondents who answered negatively were classified as having children with no passive smoke exposure.

### Other variables

Several other variables were considered for potential inclusion in the multivariable logistic regression, if the bivariate associations were significant. Participants provided the sex of the child (male/female), age of the child (0-5 years, 6-11 years, 12-17 years), race/ethnicity of the child (Hispanic, non-Hispanic white, non-Hispanic black, other), and allergy and asthma status of the child (yes/no). They also provided family income which was categorized into less than 100% of the Federal Poverty level (FPL), 100-199% FPL, 200-399% FPL, and 400% and above FPL. The respondent provided the child's mother's and father's educational status, categorized into highest level of education in the household (less than high school education, high school graduate, greater than high school education). Other variables with the potential to confound smoking and caries that were considered were medication use (with the potential for xerostomia), asthma, and allergies. These variables had yes/no response options for the participants.

### Statistical analyses

Statistical analyses were performed using SAS software package version 5.1 (SAS Institute, Inc., Cary, NC, USA). Data were analyzed using chi square statistics and multivariable logistic regression with a priori selection of  $p < 0.05$  as the significance level. Of the 91,642 participants, 85,913 had complete data concerning caries and household tobacco use; these participants included parents/guardians of CSHCN and children who did not have SHCN. There were 17,901 parents/guardians of CSHCN who had complete data concerning caries and household tobacco use. The analysis included both parents/guardians of CSHCN and of children who did not have SHCN to determine the odds ratio of exposure/non-exposure of tobacco smoke and caries and as a secondary aim, the differences between the overall group and the CSHCN group as a secondary focus of the study. Bivariate analyses with Chi square were conducted, and a multivariable logistic regression model was developed. Variables with bivariate relationships not reaching significance in the chi square analysis or logistic regression (if they did not impact the passive smoke odds ratio by 15% and therefore could be considered a confounder) were not to be included in the final multivariable model.

### Results

Overall, there were 48.72% females, 56.53% non-Hispanic white, 20.17% Hispanic and 14.40% non-Hispanic black. The children's age groups (0-5 years, 6-11 years, and 12-17 years) had 29.25%, 34.44% and 36.31%, respectively. The majority of families had a household member who had more than a high school education (67.77%). There were 18.28% reporting a household income of less than 100% FPL; 20.88% reporting between 100-199% FPL; 31.22% reporting between 200-399% FPL and 29.62% reporting 400% and above FPL. Tobacco use was reported by 26.12%, and caries within the previous 6 months was reported by 19.41%.

For CSHCN, there were 40.67% females, 60.86% non-Hispanic white, 15.35% Hispanic and 16.20% non-Hispanic black. The children's age groups (0-5 years, 6-11 years, and 12-17 years) had 18.65%, 38.66% and 42.69%, respectively. The majority of families had a household member who had more than a high school education (68.64%). There were 20.15% reporting a household income of less than 100% FPL; 20.78% reporting between 100-199% FPL; 30.58% reporting between 200-399% FPL and 28.49% reporting 400% and above FPL. Tobacco use was reported by 30.25%, and caries within the previous 6 months was reported by 22.79%. The sample descriptive statistics are presented in Table 1.

Table 2 describes the bivariate associations of caries and variables of interest. In addition to the key association of interest (caries and passive smoke exposure), other significant associations existed for race/ethnicity, age, highest household education, and household income for CSHCN. For children, overall, asthma had a significant association with caries, but the association was not significant for CSHCN.

Table 3 provides the logistic regression for caries and passive smoke exposure. For all children, the unadjusted odds ratio for caries related to passive smoke exposure was 1.37 (95% Confidence Interval: 1.23, 1.52;  $p$ -value < 0.0001). The unadjusted odds ratio for caries related to passive smoke exposure for CSHCN was 1.35 (95% Confidence Interval: 1.13, 1.62;  $p$ -value = 0.0011). When a model was constructed to adjust for race/ethnicity, age, and income the overall adjusted odds ratio for caries related to passive smoke was 1.27 (95% Confidence Interval: 1.14, 1.41;  $p$ -value < 0.0001). For CSHCN, the adjusted odds ratio was 1.23 (95% Confidence Interval: 1.02, 1.50;  $p$ -value 0.0352).

## Discussion

The results of this study indicate that CSHCN have an independent association of recent caries (within the previous 6 months) and passive smoke (someone in the household used cigarettes, cigars, or pipe tobacco). These results are consistent with previous studies supporting such an association in children who did not have SHCN [6-11]. For example, maternal smoking was independently associated

	Overall		CSHCN	
	N	wt%	N	wt%
	<b>85913</b>		<b>17901</b>	
<b>Sex</b>				
Female	41240	48.72	7531	40.67
Male	44568	51.28	10352	59.33
<b>Race/ethnicity</b>				
Non-Hispanic white	58179	56.53	12548	60.86
Non-Hispanic black	8419	14.4	1857	16.2
Hispanic	10680	20.17	1796	15.35
Other	7768	8.9	1546	7.6
<b>Age</b>				
0-5 years	22583	29.25	3002	18.65
6-11 years	27504	34.44	6143	38.66
12-17 years	35826	36.31	8756	42.69
<b>Household highest education</b>				
Less than high school	64567	8.94	927	8.94
High school graduate	13261	23.29	2778	22.42
More than high school	4979	67.77	13271	68.64
<b>Household income</b>				
Less than 100% FPL	10057	18.28	2398	20.15
100-199% FPL	14590	20.88	3101	20.78
200-399% FPL	29055	31.22	5820	30.58
400% and above FPL	32211	29.62	6582	28.49
<b>Medication use</b>				
Yes	1900	2.04	1441	9
No	75453	97.96	12477	91
<b>Asthma</b>				
Yes	11789	14.34	6691	38.89
No	74022	85.66	11177	61.11
<b>Allergies</b>				
Yes	16197	17.36	7112	37.7
No	69554	82.64	12828	62.3
<b>Passive Smoke Exposure</b>				
Yes	21245	26.12	5073	30.25
No	64668	73.88	12828	69.76
<b>Caries</b>				
Yes	15132	19.41	3748	22.79
No	70781	80.59	14153	77.21

Wt%-Weighted percentage: Weighted percentages were obtained to control for complex sample design, therefore division of individual cell sizes by the total sample will not reflect weighted percentages.

N-number of participants

FPL-Federal Poverty Level

Data Source: Child and Adolescent Health Measurement Initiative (CAHMI). DRC Indicator

Dataset: 2007 National Survey of Children's Health. Data Resource Center for Child and Adolescent Health, www.childhealthdata.org.

**Table 1:** Descriptive statistics 2007 National Survey of Children's Health.

	Passive Smoke Exposure		No Passive Smoke Exposure		p-value
	N	wt%	N	wt%	
<b>Sex</b>					
Overall					0.4254
Female	7196	9.59	34044	39.13	
Male	7921	9.8	36647	41.48	
<b>SHCN</b>					0.1289
Female	1601	9.86	5930	30.81	
Male	2140	12.9	8212	46.44	
<b>Race/ethnicity</b>					
Overall					<.0001
Non-Hispanic White	9326	9.17	48853	47.36	
Non-Hispanic Black	1671	2.92	6748	11.49	
Hispanic	2494	5.66	8186	14.51	
Other	1509	1.69	6259	7.21	
<b>CSHCN</b>					<.0001
Non-Hispanic White	2387	11.93	10161	48.92	
Non-Hispanic Black	458	3.75	1399	12.44	
Hispanic	498	5.32	1298	10.03	
Other	381	1.85	1165	5.75	
<b>Age</b>					
Overall					<.0001
0-5 years	2223	3.47	20360	25.78	
6-11 years	6533	8.93	20971	25.51	
12-17 years	6376	7.01	29450	29.3	
<b>CSHCN</b>					<.0001
0-5 years	369	2.61	2633	16.04	
6-11 years	1560	10.52	4583	28.14	
12-17 years	1819	9.66	6937	33.03	
<b>Household highest education</b>					
Overall					<.0001
Less than high school	1380	2.62	3599	6.32	
High school graduate	2858	5.76	19403	17.53	
More than high school	10187	10.87	54380	56.89	
<b>CSHCN</b>					<.0001
Less than high school	283	2.94	644	6	
High school graduate	746	6.29	2032	16.13	
More than high school	2459	13.37	10812	55.27	
<b>Household income</b>					
Overall					<.0001
Less than 100% FPL	2600	5.04	7457	13.23	
100-199% FPL	3046	4.84	11544	16.04	
200-399% FPL	5063	5.41	23992	25.81	
400% and above FPL	4423	4.11	27788	25.51	
<b>CSHCN</b>					<.0001
Less than 100% FPL	743	6.77	1655	13.39	
100-199% FPL	839	5.49	2262	15.29	
200-399% FPL	1126	5.96	4694	24.62	
400% and above FPL	1040	4.57	5542	23.92	
<b>Medication use</b>					
Overall					0.5208
Yes	423	0.44	1477	1.6	
No	13757	19.92	61696	78.04	

CSHCN					0.7307
Yes	333	1.98	1108	7.03	
No	2540	20.72	9937	70.28	
<b>Asthma</b>					
Overall					<.0001
Yes	2440	3.38	9349	10.96	
No	12666	16	61356	69.66	
CSHCN					0.5383
Yes	1424	9.12	5267	29.77	
No	2320	13.69	8857	47.41	
<b>Allergies</b>					
Overall					0.1843
Yes	3070	3.55	13127	13.81	
No	12026	15.87	57528	66.77	
CSHCN					0.672
Yes	1482	8.78	5630	28.92	
No	2257	14.06	8483	48.24	
<b>Passive Smoke exposure</b>					
Overall					<.0001
Yes	4635	6.07	16610	20.05	
No	10497	13.34	54171	60.54	
CSHCN					<.0001
Yes	1322	8.05	3751	22.2	
No	2426	14.74	10402	55.01	

Wt%: Weighted percentage. Weighted percentages were obtained to control for complex sample design, therefore division of individual cell sizes by the total sample will not reflect weighted percentages.

Significant group differences were tested by Chi-square statistics (Rao-Scott Chi-Square p-values)

Data Source: Child and Adolescent Health Measurement Initiative (CAHMI). DRC Indicator

Dataset: 2007 National Survey of Children's Health. Data Resource Center for Child and Adolescent Health, www.childhealthdata.org.

**Table 2:** Chi square analyses for caries versus variables of interest 2007 National Survey of Children's Health.

with caries in pre-school children in an adjusted analysis including socioeconomic status, diet/nutritional status, and confectionery spending [21]. Additionally, in a study of young children, the decayed, missing, and filled teeth indices were higher with children having a higher salivary cotinine level (the biomarker for passive tobacco smoke exposure) than young children who did not have a high salivary cotinine level [9].

The results of the adjusted model indicate that the relationship is attenuated, but remains significant with an adjusted odds ratio of 1.23 (95% Confidence Interval 1.02, 1.50; p=0.0352). Although not the primary focus of this study, the relationship between passive smoke and all children also showed an independent association in both the unadjusted and adjusted models. CSHCN were more likely, in general, to have a higher odds of caries than children overall, with an adjusted odds ratio of 1.22 (95% Confidence Interval 1.09, 1.36; p=0.0003).

Other researchers have suggested potential mechanisms by which tobacco exposure may be related to caries. These include predisposition of children to infection through changes to the immune system, nicotine inhibition of phagocytic activity in neutrophils and monocytes, and lowered amount and buffering capacity of saliva [13] Cigarette smoke condensates from sidestream smoke (passive exposure) were found to suppress macrophage responsiveness to interferon, although the potential effects on the host's defenses systemically and orally were undetermined [22]. As noted previously, decreased Vitamin C levels in children exposed to passive smoke were associated with decreased immune function and *Streptococcus Mutans* growth [16]. Additionally, passive smoke exposure (as measured by salivary cotinine levels) has been associated with decreased secretory IgA--the concentration of secretory IgA is lower in infection-prone children, and secretory IgA is involved in a complex relationship with the aggregation of bacteria and dental caries [23].

	All children		CSHCN	
	Odds (95% CI) Ratios	p-value	Odds (95%CI) Ratios	p-value
<b>Unadjusted</b>				
Passive smoke exposure	1.37 (1.23, 1.52)	<.0001	1.35 (1.13, 1.62)	0.0011
<b>Adjusted</b>				
Passive Smoke exposure	1.27 (1.14, 1.41)	<.0001	1.23 (1.02, 1.50)	0.0352
<b>Race/ethnicity</b>				
Non-Hispanic White	1.00 (reference)		1.00 (reference)	
Non-Hispanic Black	1.08 (0.96, 1.22)	0.0085	1.00 (0.78, 1.27)	0.0214
Hispanic	1.75 (1.05, 1.32)	<.0001	1.90 (1.38, 2.60)	0.004
Other	1.20 (1.02, 1.41)	0.6967	1.27 (0.94, 1.71)	0.8734
<b>Age</b>				
0-5	1.00 (reference)		1.00 (reference)	
6-11	2.66 (2.32, 3.05)	<.0001	2.40 (1.77, 3.24)	<.0001
12-17	1.86 (1.62, 2.14)	0.0095	1.97 (1.46, 2.65)	0.0198
<b>Household income</b>				
Less than 100%FPL	1.91 (1.64, 2.22)	<.0001	2.27 (1.69, 3.05)	<.0001
100-199%FPL	1.65 (1.44, 1.90)	0.0002	1.75 (1.33, 2.31)	0.0294
200-399%FPL	1.22 (1.09, 1.38)	0.0002	1/18 (0.90, 1.54)	0.0058
<b>CSHCN</b>	1.22 (1.09, 1.36)	0.0003		

Data Source: Child and Adolescent Health Measurement Initiative (CAHMI). DRC Indicator

Dataset: 2007 National Survey of Children's Health. Data Resource Center for Child and Adolescent Health, www.childhealthdata.org.

**Table 3:** Logistic regression odds ratios and adjusted odds ratios for caries and passive smoke exposure: 2007 National Survey of Children's Health.



## Study Limitations

However, it should also be noted that this study's results are associations and do not necessarily assume a causal relationship. There could be confounding due to diet, and oral hygiene which were not measured in this study. It is possible that smoking during pregnancy increased the potential for childhood illness, immune system compromise, and enamel hypoplasia, and ultimately caries rather than current exposure to passive smoke [24]. However, in this study, the increase in odds of recent caries and passive smoke were determined not only in pre-school children, but also in school aged children and teenagers who would have mixed dentitions and permanent dentitions as the sample included children ages 0-17. Distinctions were not made between secondhand and third hand smoke exposure nor the number of cigarettes to which a child was exposed or length of time of such exposure in this study. However the study did involve current exposure and current report of caries. There may have been misclassification of tobacco use and presence of caries due to social desirability bias of the telephone respondents. Such biases would potentially have resulted in more responses of no use of tobacco than actually occurred, and fewer reports of caries than actually occurred. Such biases would have attenuated the results or biased the results to the null. Caries experience within the previous 6 months may also have been subject to recall bias. Such a bias would be expected to be non-differential.

## Study Strengths

This was a study based on data from the large, Nation Survey of Children's Health which has been sponsored by the Maternal and Child Health Bureau of the Department of Health and Human Services. The survey was supervised for data integrity by the National Center for Health Statistics in the Centers for Disease Control and Prevention. Data analysis accounted for weighting which improved result precision. The results are consistent with other research. There is theoretical biologic plausibility of the hypothesis.

## Conclusion

The results of this cross-sectional study indicate an association of recent caries and passive tobacco smoke in CSHCN ages 0-17 years. Additional research is needed in a cohort study to determine a true causal association.

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