

# The Effect of Secondhand Smoking on Dental Caries among Schoolchildren in Riyadh, Saudi Arabia: A Cross-sectional Study

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**ABSTRACT** **Aim:** The aim of this study was to explore the relationship between dental caries and exposure to secondhand smoking in mixed teeth among Saudi children. **Materials and Methods:** A cross-sectional study was designed to target schoolchildren aged between 6 and 13 years in their mixed dentition stage. A cluster random sample of schools teaching first to sixth grades from different regions in Riyadh city was used. Data were obtained by self-reported questionnaires and clinical dental examinations. Questionnaires comprised sections related to sociodemographic, behavioral, health characteristics, and questions related to mother and father smoking status, type, and duration of smoking, and whether parents smoked inside homes or not. The clinical dental examination was based on the basic methods of the World Health Organization criteria for decayed, missing, and filled teeth (DMFT) (1997). Statistical analyses included descriptive statistics, *t* test, and one-way analysis of variance. **Results:** Of the 302 participating schoolchildren, 56% were females, 72% were Saudi nationals, and 84% were of normal weight. Of the total 3246 teeth examined, DMFT was found in 1922 teeth (mean DMFT = 6.36). Only eight mothers (2.7%) were smokers, seven of them smoked inside their homes. Majority of fathers were smokers (110, 37%) and 82% smoked inside their houses. It had been found that 26% of schoolchildren were exposed to secondhand smoking. The mean DMF scores were higher among schoolchildren with smoking fathers and mothers, and the difference was statistically significant (*P* = 0.05). **Conclusion:** The DMFT among Saudi schoolchildren was 6.36. Children, who are exposed to secondhand smoking by their family members, are more likely to have dental caries in their mixed dentitions.

**KEYWORDS:** Children, dental caries, Saudi, secondhand, smoking

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## INTRODUCTION

The risk of developing dental caries by exposure to secondhand smoke may be explained by three major mechanisms: (1) direct exposure of the developing teeth buds to chemicals of smoke, leading to delay in the formation and impair of mineralization;<sup>[1]</sup> (2) damaging the salivary glands by chemicals of smoke, resulting in a decreased salivary flow, which affects buffering capacity and cleansing;<sup>[2]</sup> and (3) secondhand smoking impairs the immune system of children and increases

colonization of *Streptococcus mutans*, which have been attributed to the formation of dental caries.<sup>[3,4]</sup>

The factors associated with dental caries were numerous. The main causative factors were directly related to diet

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control and oral hygiene practices.<sup>[5-7]</sup> However, many other demographic and behavioral factors were also associated with dental caries.<sup>[8,9]</sup>

The association between secondhand smoking and early childhood dental caries was revealed by several epidemiological studies as reviewed by Hanioka *et al.*<sup>[10]</sup> In addition, secondhand smoking has been proven to have an adverse effect on children's decayed, missing, and filled teeth (DMFT) and gingival index scores by increase in cotinine level and bacterial colonies.<sup>[11]</sup> The effect of secondhand smoking as an indirect factor to dental caries was investigated.<sup>[2,11-14]</sup> However, the relationship between secondhand smoking and dental caries in Saudi Arabia needs to be investigated more.

Dental caries was found to be a major problem among Saudi children, with more than 90% showed dental caries.<sup>[15]</sup> We reviewed the literature addressing the relationship between secondhand smoking and dental caries among Saudi schoolchildren, and to the best of our knowledge, this is the first Saudi study to address this issue. The aim of this study was to explore the relationship between dental caries and exposure to secondhand smoking in mixed teeth among Saudi children.

## MATERIALS AND METHODS

This study comprised a cross-sectional analytical study of the relationship between secondhand smoking and dental caries among schoolchildren in mixed dentition. The target sample of this study was schoolchildren aged between 6 and 13 years, studying in primary schools that are teaching first to sixth grades from different regions in Riyadh city, Saudi Arabia. The exclusion criteria included adults, children with systemic syndromes, and children who were wearing fixed orthodontic appliances. Students were recruited via a cluster random sampling procedure by considering students' classes as separate clusters from the selected schools. The data collection was completed between September and December of 2018 by a one-time examination. The sample size was calculated based on confidence level of 95%, confidence interval of 5%, and estimated population response distribution of 50%. The sample size obtained using this calculation was 249 participants.<sup>[16]</sup>

The samples were identified with secondhand smoking by their parents' answers to our question: whether they were smoking or not. The time of exposure of children to secondhand smoking was not considered. Correlations between secondhand smoking and DMFT were noted.

The study was conducted using a questionnaire and clinical dental examination. The questionnaire

consisted of Arabic printed papers sent with children to their parents or legal guardians before the date of clinical examination. It comprised a demographic part including age, gender, family income, and educational level of each parent, a behavioral part including brushing, snacking, breastfeeding, and dental visits, and a health characteristic part including medical conditions and medications. The last part of the questionnaire included questions about mother and father smoking status, type and duration of smoking, and whether parents smoked inside homes or not.

Owing to unavailability of previously used and validated questionnaire, we had to formulate a new questionnaire. After reviewing the current literature related to smoking and dental caries, most questions were collected from previous studies and assembled together in our questionnaire. Content validation of the questionnaire was checked by spotting all the detailed elements on the questionnaire to examine whether the questionnaire addresses the topic completely. We had created a list of all elements that the questionnaire intended to measure and checked the questions on the questionnaire against this list of elements. We had ensured that every element of the list corresponded to the desired measurement. The reliability of the questionnaire was checked by Cronbach  $\alpha$  to determine the average correlation of elements in the questionnaire. Answers to questions that have two options (yes or no) and those with multiple points were only used in the average correlation tested. The questionnaire was constructed in English language and then translated to Arabic language by official Translator. Later, the Arabic version was translated back to English, and a comparison of the two English versions was made.

The examination consisted of a visual oral examination to inspect the number and condition of teeth present using a mouth mirror under artificial light wore by the head of the examiner. The oral examination included the observation of the presence of the following characteristics that have been determined by the basic methods of World Health Organization (WHO):<sup>[17]</sup> (1) missing teeth, (2) filled teeth, (3) decayed teeth, and (4) sound teeth. Clinical dental examinations were conducted by six calibrated senior dental students. Inter-examiner reliability was checked in the midway and toward the end of participants' examination using  $\kappa$  statistics for DMFT. The DMFT data were marked on a teeth form on a printed examination sheet, which was then entered into a computer-based statistical program. All questionnaire items were only quantitative data; schoolchildren were grouped into two age-groups: 6–9 and 0–13 years.

Incomplete data from questionnaires were inspected during the clinical examinations. Incomplete questions related to smoking habits of parents were labeled, and children with incomplete data were asked to return the questionnaire again to their parents or legal guardians to complete the labeled questions.

Data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) (IBM, Armonk, New York) software, version 23.0. Statistical tests included frequency distribution: mean values and standard deviations (SDs), *t* test, and one-way analysis of variance to assess the difference in mean values of DMFT among children who are exposed or not exposed to secondhand smoking.

## RESULTS

The final number of participants who agreed to participate and completed questionnaires and clinical dental examination was 302 schoolchildren. Of the 22 subjects who declined participation, 14 refused to participate and eight either preferred not to participate in the oral examination or could not complete the

examinations. The response rate was 93%. The mean age of participants was 9.16 years (SD = 1.67), ranging from 6 to 13 years.

The total number of teeth examined was 3246 teeth. Of those, 1716 were primary teeth and 1530 were permanent teeth. DMFT was recorded in 1460 primary teeth and in 462 permanent teeth. The mean number of DMFT in primary, permanent, and mixed dentitions was 4.83, 1.53, and 6.36 teeth, respectively.

Table 1 presented the demographic characteristics of participating schoolchildren. Approximately 53% of children were from the younger age-group (6–9 years) and more than 56% of participants were females, Saudi nationals comprised 72%, and 84% of participants were with normal weight. Approximately 59% of participants were of low income (monthly salary ≤ SR 12,000), 22% were rich, and the rest were in the middle category. Approximately 45% of mothers and 40% of fathers had a high school education or less. Table 1 also presented the DMFT of mixed dentition among demographic characteristics. DMF was significantly higher among the younger age-group compared to that

**Table 1: Mean numbers of decayed, missing, and filled teeth of mixed dentition among different demographic characteristics**

Variable	Category	No.	%	Mean DMFT	SD	P value
Age	6–9 years	158	52.5	6.85	4.30	0.030*
	10–13 years	143	47.5	5.84	3.68	
Gender	Male	131	43.4	6.56	4.21	0.468
	Female	171	56.6	6.22	3.90	
Nationality	Saudi	217	71.9	6.82	4.07	0.002*
	Non-Saudi	85	28.1	5.20	3.71	
BMI	Normal	109	83.8	6.41	3.75	0.016*
	Overweight and obese	21	16.2	4.29	3.14	
Family monthly income	<9000	70	40.2	6.14	4.25	0.388
	9000–12000	33	19	6.36	3.81	
	12000–15000	32	18.4	5.72	4.02	
	>15000	39	22.4	7.21	2.64	
Mother's education level	Illiterate	10	3.4	7.90	2.96	0.021*
	Elementary	11	3.7	7.18	2.23	
	Middle	25	8.4	6.68	4.51	
	High school	87	29.2	6.78	4.42	
	Diploma	12	4	4.33	3.09	
	Bachelor's	135	45.3	3.41	3.92	
Father's education level	Higher education	18	6	3.56	2.92	0.190
	Elementary	12	4.1	6.92	4.21	
	Middle	18	6.1	7.50	4.54	
	High	87	29.5	6.91	4.14	
	Diploma	36	12.2	5.69	3.88	
	Bachelor's	119	40.3	6.27	3.89	
DMF Total	Higher education	23	7.8	4.87	3.95	
				6.36	4.03	

BMI = body mass index, SD = standard deviation, DMFT = decayed, missing, and filled teeth

\*Statistically significant using *t* tests or one-way analysis of variance

among the older age-group (6.85 vs. 5.84). No gender predilection was observed in DMFT index; however, Saudi nationals scored higher DMF (6.6) compared to non-Saudi nationals (5.2), and the difference was statistically significant. Surprisingly, the DMFT index was significantly lower among overweight and obese children (4.3) compared to that among normal children (6.4). No statistically significant difference was observed in DMFT with different income categories. However, the DMF index was decreased among schoolchildren whose parents had higher education.

Table 2 presented the mean number of DMF teeth among different behavioral characteristics in mixed dentitions. The mean DMF scores were significantly lower among children who brush their teeth more frequently ( $P = 0.037$ ). However, no significant difference was observed in DMF scores among categories of snacking, breastfeeding, and dental visits.

Table 3 presented the mean number of DMF teeth among different health parameters. The mean DMF score was statistically higher among children with systemic diseases (7.8) compared to that among healthy ones (5.9). In addition, children who reported using medications on a regular basis had higher DMF (7.8) compared to those using medication occasionally (6.0). No significant relationship was observed between the DMF index and the type of disease, type of medication, or annual checkups.

Table 4 presented the mean number of DMF teeth among different smoking statuses of parents and other family members. The results of the study showed that

only eight mothers (3%) were smokers, seven of them were smoking inside their homes. Of the eight smoking mothers, six were smoking *shisha* and two smoked cigarettes. The smoking period of mothers was also compared, and the results showed that five mothers were smoking for less than 10 years, and three mothers were smoking for more than 10 years. DMFT index was significantly higher among schoolchildren who had smoking mothers (9.1) compared to that among schoolchildren who had nonsmoking mothers (6.3).

Unlike mothers, majority of fathers were smokers 110 (37%), and cigarettes were found to be commonly used by them compared to the other types of smoking. Approximately 65% were smokers for more than 10 years, and 48% reported smoking inside their homes. The DMF index of mixed dentition was higher among schoolchildren whose fathers smoke, and *shisha* smoking was highly associated with caries in these children,  $P = 0.028$ . Almost 17% of the sample had other family members (other than parents) who were smokers. Of these, 27% had two or more other family members who smoked, and 47% smoked inside the house, and cigarettes were smoked the most (81%).

Furthermore, caregivers were asked if smoking was a common habit inside the home and in front of children, almost 74% answered no and that it was not a common habit. Children who were exposed to secondhand smoking accounted for approximately 73 (24%). The frequency of secondhand smoking was assessed, and it had been found that 26% of schoolchildren were exposed to secondhand smoking. The mean DMF

**Table 2: Mean numbers of decayed, missing, and filled teeth of mixed dentition among different behavioral characteristics**

Variable	Category	No.	%	Mean DMFT	SD	P value
Brushing times	Three times	16	5.3	5.81	4.09	0.037*
	Twice	120	40.0	5.64	3.96	
	Once	134	44.7	6.92	3.94	
	Never	30	10.0	7.33	4.30	
Snacks frequency	Once	79	27.9	5.68	3.66	0.065
	Twice	116	41.0	6.41	3.80	
	+Three times	88	31.1	7.14	4.45	
Breastfeeding	Yes	106	35.5	6.30	4.16	0.407
	No	27	9.0	5.44	4.54	
	Both	166	55.5	6.56	3.90	
Breastfeeding period	<3 months	57	20.7	6.28	3.65	0.255
	3–6 months	69	25.0	7.28	4.08	
	6–12 months	85	30.8	6.09	4.04	
	12–24 months	65	23.6	6.17	4.04	
Dental visits	More than twice	73	24.3	7.19	3.81	0.183
	Twice	59	19.6	6.27	3.56	
	Once	89	29.6	5.81	4.00	
	Never	80	26.6	6.25	4.52	

\*Statistically significant  $\leq 0.05$  using one-way analysis of variance

**Table 3: Mean numbers of decayed, missing, and filled teeth of mixed dentition among different health characteristics**

Variable	Category	No.	%	Mean DMFT	SD	P value
Systemic disease	Yes	74	24.7	7.76	4.24	0.000*
	No	224	74.9	5.86	3.86	
Types of disease	Osteoporosis	1	4.8	3.00	-	0.402
	Rheumatoid arthritis	1	4.8	12.0	-	
	Asthma	9	42.9	7.67	3.97	
	Obesity	2	9.5	7.00	0.00	
	Hearing problems	2	9.5	5.50	0.71	
	glucose-6-phosphate dehydrogenase deficiency	1	4.8	12.0	-	
	Epilepsy	1	4.8	4.00	-	
	Attention deficit hyperactivity disorder	1	4.8	0.00	-	
	Allergy	3	14.3	4.67	5.69	
	Annual checkup	No	181	60.3	6.64	
Rarely		79	26.3	6.49	3.44	
Yes, every 12 months		28	9.3	4.89	4.27	
Yes, every 6 months		12	4	5.50	3.21	
Medications	Yes	67	22.3	7.79	4.40	0.001*
	No	233	77.7	5.95	3.85	
Medication type	Movicol	1	7.1	3.00	-	0.359
	Painkillers	1	7.1	12.0	-	
	Vitamins	1	7.1	7.00	-	
	Ventolin inhaler	8	57.1	7.63	4.24	
	ADHD medications	1	7.1	0.00	-	
	Epilepsy medications	1	7.1	4.00	-	
	Anti-allergy medications	1	7.1	0.00	-	

\*Statistically significant  $\leq 0.05$  using *t* tests or one-way analysis of variance

scores were higher among schoolchildren with smoking fathers and mothers, and the difference was statistically significant ( $P = 0.05$ ).

## DISCUSSION

This study found that 37% of fathers and 8% of mothers were smokers, with more than 80% of them practicing smoking inside their homes, leading to significant exposure of their children to passive smoking. The study found that the DMFT was higher among children with smoking parents compared to that among normal children, which could be attributed to secondhand smoking.

To the best of our knowledge, this is the first Saudi study to question the effect of smoking on DMFT of children. The sampling procedure and sample size calculations were carried out properly enough to provide confidence in our results. The calibration of examiners to the assessment criteria of DMFT was conducted in the dental clinics of the College of Dentistry to necessitate reproducibility with a minimum acceptable inter-examiner variation. The  $\kappa$  statistics for DMFT was 0.93 in midway and 0.95 toward the end of clinical examination. However, the study had the limitations

of any cross-sectional study in which examination of the dental caries was conducted once, and the temporal effect of smoking on caries was not clear. Therefore, caution should be taken in interpreting the results. The questionnaire was self-reported by parents, and this might be subjected to social desirability bias, especially questions that were related to the smoking status of parents. Dental caries was assessed without radiograph as this examination followed the WHO criteria of field examination.

This study attempted to explore the prevalence of dental caries in mixed dentitions in a group of Saudi schoolchildren. In addition, the study investigated the likelihood of having more caries among schoolchildren with smoking parents and/or family members. This study revealed a positive relationship of DMFT with the smoking status of parents and family members. This supports our observation that children with parents who smoke had poorer oral health. The outcome of this study might be useful in providing parental awareness against the effect of secondhand smoke on children.

Interpretation of the results of this study based on the totality of the evidence needs to be considered with caution because the international literature

**Table 4: Mean numbers of decayed, missing, and filled teeth of mixed dentition among different smoking statuses of family members**

Variable	Category	No.	%	Mean DMFT	SD	P value
Mother's smoking status	Yes	8	2.7	9.13	4.70	0.05*
	No	292	97.3	6.29	4.01	
Mother's smoking type	Cigarettes	2	25	14.0	1.41	0.88
	Shisha	6	75	7.50	4.23	
Mother's smoking period	<5 years	3	37.5	8.67	2.89	0.21
	5–10 years	2	25	14.0	1.41	
	>10 years	3	37.5	6.33	5.69	
Mother smoking frequency in pregnancy	Never	52	92.9	8.35	4.32	0.29
	Rarely	1	1.8	15.0	-	
	Regularly	3	5.4	7.00	6.56	
Mother's smoking location	Inside home	7	87.5	9.29	5.06	0.82
	Outside home	1	12.5	8.00		
Father's smoking status	Yes	110	37.3	6.95	3.95	0.05*
	No	185	62.7	6.01	4.06	
Father's smoking type	Cigarettes	78	70.9	6.68	3.99	0.03*
	Cigar	2	1.8	2.50	3.54	
	Chewable tobacco	1	0.9	0	-	
	Shisha	29	26.4	8.21	3.41	
Father's smoking period	<5 years	6	5.7	5.50	4.08	0.33
	5–10 years	31	29.2	7.81	4.00	
	>10 years	69	65.1	6.88	3.85	
Father's smoking location	Inside home	51	48.1	7.41	4.04	0.30
	Outside home	55	51.9	6.62	3.74	
Other family members' smoking status	Yes	50	17.4	6.94	4.41	0.30
	No	237	82.6	6.29	3.98	
Number of other family members who smokes	One	19	39.6	6.53	4.96	0.36
	Two	16	33.3	8.50	4.58	
	Three	4	8.3	4.50	1.73	
	More than three	9	18.8	6.67	3.67	
Other family members' smoking type	Cigarettes	38	80.9	7.32	4.52	0.66
	Cigar	1	2.1	5.00		
	Shisha	6	12.8	8.17	3.31	
	Other	2	4.3	4.00	5.66	
Other family members' smoking location	Inside home	22	46.8	7.05	4.25	0.83
	Outside home	25	53.2	7.32	4.61	
Smoking habit in the family	Yes	73	26.1	7.19	4.32	0.10
	No	207	73.9	6.28	3.93	

\*Statistically significant  $\leq 0.05$  using *t* tests or one-way analysis of variance

revealed conflicting results on the relationship between secondhand smoking and dental caries. This study found that the mean DMFT index in mixed teeth was higher among children who have smoker mothers and fathers, even though the number of smoking fathers in the study was much higher than that of smoking mothers. This explains higher DMF score in children whose fathers smoke compared to that in children whose mothers smoke. Smoking *shisha* by fathers was highly associated with caries in mixed dentition. These results were in agreement with other studies that reported a significant association between parental smoking and caries experience.<sup>[2]</sup> However, the results of this study were in contrast with the findings of the other two studies.<sup>[11,12]</sup>

However, reviewing the current literature, it was found that no Saudi study reported a relationship between secondhand smoking and dental caries among Riyadh schoolchildren. Although some studies have failed to find relationship between caries and secondhand smoking,<sup>[11]</sup> others reported significant positive associations between the two components.<sup>[1,2,12-14]</sup> It is worth noting that this study is the first in the region to address the issue of the relationship between dental caries and secondhand smoking components in Saudi Arabia. Future study with large number of participants with secondhand smoking is recommended to provide more power of the association between smoking and caries.

## CLINICAL SIGNIFICANCE

The results of this study provide an insight into the importance of prevention of dental caries by the protection of children from exposure to secondhand smoking in their homes. The dental practitioner should consider secondhand smoking as one of the factors that should be included during their education sessions with their pediatric patients.

## CONCLUSION

An increased number of smoking Saudi parents were noticed, coupled with a higher percentage of smokers inside homes among their children. The prevalence of dental caries among schoolchildren reached a high level of 6.36 teeth per subject. The distribution of dental caries according to the status of smoking parents indicated an increase in the number of dental caries among exposed children. Parents should be encouraged not to expose their children to secondhand smoke.

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## CONFLICTS OF INTEREST

There are no conflicts of interest.

## AUTHOR CONTRIBUTIONS

All authors had contributed to study conception, data collection, data acquisition and analysis, data interpretation and manuscript writing. All the authors approved the final version of the manuscript for publication.

## ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT

All the procedures have been performed as per the ethical guidelines laid down by the Declaration of Helsinki (2013). The Institutional Review Board approval was obtained from King Abdullah International Medical Research Center, Riyadh, Kingdom of Saudi Arabia (SP18/436/R).

## PATIENT DECLARATION OF CONSENT

Consent forms were distributed to participants and their legal guardians which include statements to allow participation in the study and publication of the data for research and educational purposes.

## DATA AVAILABILITY STATEMENT

The data will be added to the OneDrive on acceptance.

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