RESEARCH ARTICLE

# Association between environmental tobacco smoke and dental caries amongst 5-14 years old children in Karachi, Pakistan

Anna Ali Nayani,[1] Romaina Iqbal,[2] Syed Iqbal Azam,[3] Farhan Raza Khan,[4] Aysha Habib Khan,[5] Naveed Janjua,[6] Azmina Hussain[7]

## Abstract

**Objective:** To determine the association between environmental tobacco smoke and dental caries.

**Methods:** This cross-sectional study was conducted in peri-urban and urban areas of Karachi, from February to August 2014, and comprised children aged 5-14 years. A pre-coded questionnaire for environmental tobacco smoke and food frequency questionnaire for dietary habits were used. Dental examination of children was done to detect caries. Cox-proportional hazard algorithm was used to measure the association of environmental tobacco smoke with dental caries at multivariable level. STATA version 12.0 was used for statistical analysis.

**Results:** Of the 500 children, 250(50%) each were from peri-urban and urban localities. The prevalence of dental caries was 336(67.2%).Family members of 154(30.8%) participants reported smoking. After adjusting for junk food intake, in-between meals, age, plaque index, dental visits and socio-economic status, the association between environmental tobacco smoke and dental caries remained statistically significant ($p<0.05$). Compared to non-exposed children, the adjusted prevalence ratio was 1.25 (95% confidence interval: 1.08-1.46) and 1.36 (95% confidence interval: 1.09-1.70) for children with < 30 minutes and >30 minutes of environmental tobacco smoke exposure, respectively.

**Conclusion:** Environmental tobacco smoke was found to be associated with dental caries.

**Keywords:** Dental caries, Tobacco smoke pollutions, Children. (JPMA 68: 203; 2018)

## Introduction

Dental caries is a preventable disease. The known risk factors for caries include intraoral high count of acidogenic and cariogenic bacteria, poor quantity and quality of saliva, susceptible tooth surface, presence of faulty dental restorations, inadequate brushing habits, high sugar intake and poor knowledge and attitude towards oral hygiene, etc. Emerging evidence indicates an association between environmental tobacco smoke (ETS) and dental caries.[1] However, the results on this association are conflicting and warrant further exploration.[2]

ETS can directly and indirectly cause dental caries. The direct exposure of environmental tobacco can affect tooth surface, whereas indirect affect may cause enamel hypoplasia of a developing tooth or caries resulting from salivary gland impairment caused by ETS can be a plausible pathway.[3] Connection of oral diseases with systematic health opens a window for public health professionals to come up with solutions that improve the well-being of the populations at risk. The evolving relationship between ETS and dental caries demands attention of experts in dentistry, epidemiology, public health and particularly dental public health.[3] They should explore this ETS and dental caries association further and suggest cost-effective interventions in communities where it exists.[4]

Recently, studies have shown that ETS can affect the tooth at the time of tooth development, at the time of eruption and even after the eruption.[5] Studies have demonstrated an association of ETS with caries in primary dentition,[2,6-9] whereas the association of ETS and caries in permanent dentition has yet to be established.[10] In 2010, the Ryukyus Child Health Study reported an association of ETS with dental caries in both the permanent and the primary dentition.[11] However, a Japanese study involving 1-14 years' old children failed to establish such an association.[12]

Studies in Pakistan have reported a high prevalence of ETS and dental caries. A survey conducted in 2004-05 showed that in Pakistan, smoking inside the house was permitted in 91% households. Moreover, around 50% of pregnant women were exposed to second-hand tobacco smoke indoors and nearly 51% young children

[1]Graduate Student, [2]Departments of Community Health Sciences and Medicine, [3]Department of Community Health Sciences, [4]Section of Dentistry, Department of Surgery, [5]Department of Pathology and Laboratory Medicine, Aga Khan University, Karachi, Pakistan, [6]School of Population and Public Health, University of British Columbia, Canada and Senior Scientist, British Columbia Centre for Disease Control, Canada, [7]Oral Pathology, Dow University of Health Sciences, Karachi, Pakistan.

**Correspondence:** Farhan Raza Khan. Email: farhan.raza@aku.edu

were found to be exposed to ETS in house.[13] The prevalence of dental caries among 3- to 14-year-old Pakistani children ranges between 45-75%.[14-16] However, the association of ETS with dental caries, especially in the age group of 5-14 years, has not been studied in Pakistan. Infact, there is no data on ETS and caries in the South Asian population. Literature from other parts of world also shows inconsistent results. Smoking and exposure to ETS are on the rise in Pakistan. The prevalence of dental caries among children is also high and treatment for dental caries is quite expensive. Therefore, it is imperative to identify whether ETS and dental caries are related in children, so that preventive strategies can be designed.

The present study was planned to determine the association between ETS and dental caries in children living in urban and peri-urban areas.

## Subjects and Methods

This cross-sectional study was conducted from February to August 2014 among 5- to 14-year-old children living in urban and peri-urban areas of Karachi. Gadap Town (a peri-urban site) is inhabited by diverse ethnic groups and a majority of the residents belong to Balochi and Jhokio castes. The residents of the town have relatively low socio-economic status (SES) with poor access to dental health services. The urban sites refer to the Ismaili neighbourhoods of Karachi. These neighbourhoods are located in Garden, Hyderi and Federal B. Area.

The sample size was adjusted according to the population size of communities within urban and peri-urban areas.

Any refusal from the participants was replaced by some other child from the same community. Ten children from Radho Jhokio were using smokeless tobacco in the form of gutka. Such children were replaced with other siblings of that household. Five refusals from the urban sites were replaced by other children from the same locality.

Epi Info was used for sample size calculation. A minimum sample of 492 children was required to achieve 80% power with the anticipated prevalence of environmental tobacco smoke ranging from 10% to 75%. A prevalence ratio of 2.0 and a level of significance of 5% were anticipated. Non-probability convenience sampling technique was employed to recruit the subjects. We excluded children who were active smokers and had the habit of taking smokeless tobacco. Only one child from each household was inducted.

Three dentists were hired for intraoral examination of the subjects. Dental examination was done indoor by using small wooden spatula and a common hand torch light. Wooden spatula was used to retract the tongue and cheeks. An excellent agreement on the assessment of caries was observed among dentists (Kappa = 0.92; $p<0.001$).

For the purpose of the study, "a tooth with a definite cavity and undermined enamel was designated as decayed. A tooth with a temporary filling, and teeth that were sealed but decayed, were also termed decayed."[17] The white spot lesions were ignored and hidden caries could not be explored as no radiographs were logistically practical in the communities. However, oral hygiene was recorded using dental plaque index.[18]

Involuntary inhalation of smoke from cigarettes smoked by any family member in the house near children's eating, playing, TV watching or sleeping area was considered as ETS exposure. True induction period necessary for ETS to cause dental caries could not be found in literature. Thus, we took a minimum of 6 months. Smoking status was assessed by using World Health Organisation's (WHO) smoking surveillance questionnaire[19] which was modified to record number of members who smoke, frequency, duration and type of smoking from each and every member of the household. Information on other co-variates such as socio-demographics, parental and children education, height, weight, food intake, etc. was also obtained. Ethical approval was taken from the ethics and review committee of the Aga Khan University, Karachi, before the study.

STATA version 12.0 was used for statistical analysis. The presence of atleast one visibly diseased tooth (Decayed, Filled and Missing) of a child was classified as carious and any child with non-diseased teeth was classified as non-carious. Prevalence of dental caries along with 95% confidence interval (CI) was computed prevalence by co-variate stratified by urban and peri-urban areas. Cox proportional hazard algorithm was applied to determine the association of dental caries with ETS and other predicting factors such as age, gender, weight, SES, family size and other demographics indicators. Also, predictors like junk food intake, carbohydrate intake, dental visit, plaque and others were also included in the analysis while accounting for cluster at communities using r robust standard error estimation. P?0.05 was taken as statistically significant.

## Results

Of the 500 participants, 250(50%) were from urban and 250(50%) from peri-urban sites. The overall mean age of

**Table-1:** Distribution and prevalence of dental caries by participant's characteristics.

| Variable | Categories | All | | Peri-urban | | Urban | |
|---|---|---|---|---|---|---|---|
| | | Total | Prevalence of caries (%) | n | Prevalence of caries (%) | n | Prevalence of caries (%) |
| Age | 5-9 years | 328(65.6) | 229(69.8) | 154(61.6) | 109(70.8) | 174(69.6) | 120(69.0) |
| | 10-14 years | 172(34.4) | 107(62.2) | 96(38.4) | 65(67.7) | 76(30.4) | 42(55.3) |
| Child's education | Not enrolled | 82(16.4) | 59(72.0) | 82(32.8) | 59(72.0) | 0 | 0 |
| | Public school | 166(33.2) | 116(69.9) | 161(64.4) | 112(69.6) | 5(2.0) | 4(80.0) |
| | Private school | 252(50.4) | 161(63.9) | 7(2.8) | 3(42.9) | 245(98.0) | 158(64.5) |
| BMI | Normal | 80(16.0) | 50(62.5) | 28(11.2) | 20(71.4) | 52(20.8) | 30(57.7) |
| | Underweight | 344(68.8) | 236(68.8) | 194(77.6) | 137(70.6) | 150(60.0) | 99(66.0) |
| | Over weight | 76(15.2) | 50(65.8) | 28(11.2) | 17(60.7) | 48(19.2) | 33(68.8) |
| SES | Low | 159(31.8) | 116(73.0) | 131(52.4) | 95(72.5) | 28(11.2) | 21(75.0) |
| | Middle | 171(34.2) | 111(64.9) | 98(39.2) | 65(66.3) | 73(29.2) | 46(63.0) |
| | High | 170(34.0) | 109(64.1) | 21(8.4) | 14(66.7) | 149(59.6) | 95(63.8) |
| Mother's education | Illiterate | 196(39.2) | 144(73.5) | 192(76.8) | 141(73.4) | 4(1.6) | 3(75.0) |
| | Primary | 22(4.4) | 13(59.1) | 18(7.2) | 10(55.6) | 4(1.6) | 3(77.6) |
| | Secondary | 76(15.2) | 53(69.7) | 27(10.8) | 15(55.6) | 49(19.6) | 38(64.1) |
| | Intermediate | 76(15.2) | 48(63.2) | 12(4.8) | 7(58.3) | 64(25.6) | 41(59.7) |
| | Graduate | 130(26.0) | 78(60.0) | 1(0.4) | 1(100.0) | 129(51.6) | 77(64.8) |
| Father education | Illiterate | 119(23.8) | 87(73.1) | 115(46.0) | 83(72.2) | 4(1.6) | 4(100.0) |
| | Primary | 48(9.6) | 33(68.8) | 43(17.2) | 28(65.1) | 5(2.0) | 5(100.0) |
| | Secondary | 92(18.4) | 71(77.2) | 50(20.0) | 38(76.0) | 42(16.8) | 33(78.6) |
| | Intermediate | 70(14.0) | 43(61.4) | 18(7.2) | 11(61.1) | 52(20.8) | 32(61.5) |
| | Graduate | 171(34.2) | 102(59.6) | 24(9.6) | 14(58.3) | 147(58.8) | 88(59.9) |

BMI: Body mass index

SES: Socioeconomic status.

**Table-2:** Distribution and prevalence of dental caries by participant's dietary and oral hygiene characteristics and area of residence.

| | All | | Peri-urban | | Urban | |
|---|---|---|---|---|---|---|
| | n | Prevalence of caries (%) | n | Prevalence of caries (%) | n | Prevalence of caries (%) |
| **Dietary habits** | | | | | | |
| Biscuits | 454(90.8) | 311(68.5) | 233(93.2) | 164(70.4) | 221(88.4) | 147(66.5) |
| Candies | 449(89.8) | 290(64.6) | 204(81.6) | 133(65.2) | 245(98.0) | 157(64.1) |
| Chips | 444(88.8) | 302(68.0) | 216(86.4) | 154(71.3) | 228(91.2) | 148(64.9) |
| Bunties | 179(35.9) | 142(79.3) | 104(41.8) | 77(74.0) | 75(30.0) | 65(86.7) |
| Soft drinks | 182(36.4) | 137(75.3) | 90(36.0) | 68(75.6) | 92(36.8) | 69(75.0) |
| Betel nuts | 146(29.2) | 107(73.3) | 137(54.8) | 99(72.3) | 9(3.6) | 8(88.9) |
| **Brushing/day** | | | | | | |
| 1 time | 350(78.0) | 229(65.4) | 185(90.7) | 117(63.2) | 16567.3) | 112(67.9) |
| 2 or more | 99(22.0) | 61(61.6) | 19(9.3) | 16(84.2) | 80(32.7) | 45(56.3) |
| No brushing | 51(10.2) | 46(90.2) | 46(18.4) | 41(89.1) | 5(2.0) | 5(100) |
| **Brushing tool** | | | | | | |
| Miswak* | 69(15.4) | 45(62.5) | 69(33.8) | 45(65.2) | 0 | 0 |
| Dandasa** | 15(3.3) | 10(66.7) | 14(6.9) | 9(64.3) | 1(0.4) | 1(100) |
| Toothpaste & brush | 365(81.3) | 235(64.4) | 12159.3) | 79(65.3) | 244(99.6) | 156(63.0) |
| **Type of dentition** | | | | | | |
| Permanent | 99(19.8) | 63(63.6) | 65(26.0) | 45(69.2) | 34(13.6) | 18(52.9) |
| Mixed | 326(65.2) | 224(68.7) | 148(59.2) | 105(70.9) | 178(71.2) | 119(66.9) |
| Primary | 75(15.0) | 49(65.3) | 37(14.8) | 24(64.9) | 38(15.2) | 25(65.8) |

*traditional method of tooth cleaning using wood stick

**tree bark used for dental cleaning.

**Table-3:** Distribution of ETS by socio-demographic characteristics.

| Socio-demographic characteristics | Non-exposed (%) | Exposed for ≤ 30 mins (%) (Low) | Exposed for > 30 mins (%) (High) |
|---|---|---|---|
| **Site** | | | |
| Peri-urban | 153(61.2) | 54(21.6) | 43(17.2) |
| Urban | 221(88.4) | 27(10.8) | 2(0.8) |
| **SES** | | | |
| Low | 106(66.7) | 31(19.5) | 22(13.8) |
| Middle | 123(71.9) | 30(17.5) | 18(10.5) |
| High | 145(85.3) | 20(11.8) | 5(2.9) |
| **Family monthly incomeRs** | | | |
| < 10000 | 101(58.0) | 44(25.3) | 29(16.7) |
| 10000-19999 | 68(70.8) | 16(16.7) | 12(12.5) |
| 20000-29999 | 57(89.1) | 5(7.8) | 2(3.1) |
| 30000-39999 | 38(90.5) | 4(9.5) | 0 |
| 40000-49999 | 34(87.2) | 4(10.3) | 1(2.6) |
| 50000 and above | 76(89.4) | 8(9.4) | 1(1.2) |
| **No. of rooms in house** | | | |
| >2 rooms | 169(83.7) | 26(12.9) | 7(3.5) |
| 2 or <2 | 205(68.8) | 55(18.5) | 38(12.8) |

ETS: Environmental tobacco smoke
SES: Socio-economic status.

**Table-4:** Multivariable model with dental caries as outcome.

| | Variables (adjusted for SES) | Adjusted Prevalence Ratio (95% CI) Pseudo-log-likelihood -2079.96 | Variables (adjusted for site) | Adjusted Prevalence Ratio (95% CI) Pseudo-log-likelihood -2080.25 |
|---|---|---|---|---|
| ETS | Exposed ≤30mins | 1.25(1.08-1.46) | Exposed ≤30mins | 1.25(1.07-1.45) |
| | Exposed >30mins | 1.36(1.09-1.70) | Exposed > 30mins | 1.34(1.05-1.72) |
| | Not exposed | 1 | Not exposed | 1 |
| Age | 5-9 years | 1.19(1.04-1.35) | 5-9 years | 1.19(1.04-1.35) |
| | 10-14 year | 1 | 10-14 year | 1 |
| Junk food intake between meals | Yes | 1.33(1.03-1.70) | Yes | 1.33(1.04-1.71) |
| | No | 1 | No | 1 |
| Dental visit | Yes | 1.24(1.06-1.45) | Yes | 1.27(1.05-1.53) |
| | No | 1 | No | 1 |
| Plaque | Mild | 1.12(1.03-1.22) | Mild | 1.10(1.01-1.21) |
| | Moderate | 1.27(1.13-1.43) | Moderate | 1.27(1.15-1.39) |
| | Normal | 1 | Normal | 1 |
| SES | Low | 1.13(0.98-1.30) | | |
| | Middle | 1.01(0.81-1.26) | | |
| | High | 1 | | |
| Site | | | Urban | 0.91(0.76-1.09) |
| | | | Peri-Urban | 1 |

ETS: Environmental tobacco smoke
SES: Socio-economic status
CI: Confidence interval.

the children was 8.71±2.91 years. There were 256(51.2%) girls and 244(48.8%) boys. Besides,344(68.8%)participants were underweight; of them, 194(56.4%) were from the peri-urban area. The prevalence of dental caries was 336(67.2%). The overall prevalence of caries was higher among children in the peri-urban (91.6%) compared to urban sites 107(42.8%). Moreover, 174(67.9%) girls had dental caries compared to 162(66.4%) boys. The prevalence of dental caries was higher in children from low SES and more so among those whose parents were illiterate (Table-1).

Of the 51(10.2%) children who didn't brush, 46(90.2%) had dental caries. Data on dietary habits of children

revealed that all children ate junk food, but those who had the habit of eating junk food between meals had a higher prevalence of dental caries (Table-2).

The number of children exposed to ETS was 97(38.8%) and 29(11.6%) in peri-urban and urban sites, respectively. Of the total, 154(30.8%) subjects' family members reported smoking. The prevalence of dental caries among children exposed to ETS was 74(76.3%) and 22(75.9%) in peri-urban and urban sites, respectively. There was a directly proportional relationship of caries with ETS exposure: 237(63.4%) among non-exposed children; 60(75%) among those exposed for ≤30 minutes and 39(84.8%) for those exposed to >30 minutes (Table-3).

When the clustering effect of communities were controlled, the following variables were found to be associated with dental caries at uni-variate level: age, site, family size, the number of younger and elder siblings, dental visits, parents education, family income, candies and carbohydrate intake, ETS, betel nut intake, child's education and junk food intake between meals ($p<0.05$ each). In the multivariable model, the following factors were significantly associated with dental caries: ETS, age <9 years, junk food intake between meals, dental visit, and dental plaque ($p<0.05$ each). As site and SES were correlated, we adjusted our final model accordingly (Table-4).

After adjusting for junk food intake, in-between meals, age, plaque index, dental visit and SES, the association between ETS and dental caries remained statistically significant ($p<0.05$). Adjusted prevalence ratio was 1.25 for children exposed to ≤30 minutes of ETS (95% CI: 1.08-1.46) in comparison to non-exposed children. Adjusted prevalence ratio was 1.36 for children exposed for >30 minutes of ETS [95% CI: 1.09-1.70] compared to non-exposed children.

## Discussion

The present study showed that the prevalence of dental caries among children of age 5-14 years in urban and peri-urban areas was nearly 67.2%. It further confirmed the association of ETS with dental caries. To the best of our knowledge, this was the first study done in Pakistan that assessed this relationship among children of this age group.

Our results highlighted that children living in peri-urban site, with uneducated parents (with low socio-economic status) had a higher exposure to ETS and a higher prevalence of dental caries. One probable explanation for this association could be that children who were exposed to ETS had higher exposure of nicotine that probably suppressed the immune system and predisposed them to various infections. Although we did not have any biological evidence to conclude our findings, but literature shows that nicotine (or cotinine) decreases the phagocytic activity of monocytes and neutrophils[20] and dental caries results from chronic bacterial infection by acidogenic bacteria. This pathway potentially relates the ETS with dental caries. This is further supported by the evidence that demonstrates a relationship between prenatal maternal smoking and higher incidence of caries in primary dentition.[6-8]

ETS may also act as a marker of unhealthy choices in diet and oral hygiene practices, but after adjusting for junk food intake between meals and socio-economic disparities, our association remains significant. However, we cannot demonstrate conclusively that ETS is causally linked to the dental caries. This is due to the inherent limitation of a cross-sectional study design. However, our results are consistent with studies done in other parts of the world.[2,10,11]

In comparison to global studies, the prevalence of dental caries in our population was higher which could be due to socio-economic disparities and lifestyle differences between our study participants and those living in Japan, South Africa and the United States.[2,7,8] Also, our study population does not have the facility of annual dental check-ups, topical fluoride application or even water fluoridation. Our results related to oral hygiene showed that less than 30% children had started brushing habit at age 3-5 years and >75% children had never visited a dentist. These results highlighted disparities of knowledge and poor oral hygiene practices in the population.

One of the strengths of the present study is that we calculated the ETS exposure time for every child. This was a better approach than other studies[6,10] that had classified the exposure as 'yes' or 'no' by taking into account if family members smoked at the place where child was raised.[6] Earlier studies did not elaborate on the ETS exposure status[1,2,6-12] that whether family members were smoking inside the house in the presence or absence of children and what was the duration of exposure. Whereas in the present study, the time of in-house smoking (or using hookah) and smoking in front of the children have also been taken into account.

Literature suggests that one session of hookah can last 15-90 minutes with an uptake of amount of tobacco equivalent to 2-12 cigarettes per day.[21] A study done in

the United States also suggests that one hookah session lasts 60 minutes and cigarette lasts 5 minutes. Compared to cigarette smoking, hookah exhales larger amount of nicotine, carbon monoxide and other toxic compound.[22] In our data, females of peri-urban area were found to be using hookah in-house in small intervals.

The present study showed that dental healthcare facilities were not frequently used by people residing in these communities. The prevalence of dental caries was 64.8%, but only 44% subjects ever visited the dental healthcare facilities. Thus, the lack of knowledge regarding oral health remains a huge problem in the community.

There were certain limitations of the present study. Because of the cross-sectional study design, the temporal nature of the association between ETS and dental caries could not be examined. Furthermore, ETS smoke was assessed by questionnaire reports and was not validated by biomarkers, such as salivary, serum or urine cotinine levels. This may have resulted in misclassification bias along with recall and response bias. We could not use any objective tool as these procedures were difficult and expensive. However, exposure classification and assessment were the same for all the participants, thus reducing the possibility of differential misclassification.

Food frequency questionnaire was used to assess the intake of the junk food which is based on recall of daily intake of food items. Children and mothers might have exaggerated the response of their junk food intake. To decrease the bias created with food frequency questionnaire, we validated child's response with parents reporting about their junk food intake.

Assessment of dental caries was done with visual exam without using any intraoral mirror and explorer. Thus, we might have missed proximal surface caries resulting in an under reporting. This can potentially weaken the ETS-dental caries association. Moreover, very few children had filled teeth which we were not able to study separately. We classified children having atleast one decayed tooth as diseased. As most of the children had one and two decayed teeth and very few children had 3 and 4 decayed teeth, thus we haven't analysed them separately. Similarly, we did not analyse data on the basis of permanent and primary dentitions.

Future research is needed to establish the association of ETS via using some objective measures. A more robust study design is needed to study biological effects of ETS and pollutant related to oral health. If causal association between ETS and dental caries is substantiated, then health intervention for dental caries should aim at reducing the ETS exposure.

## Conclusion

ETS was associated with dental caries. The prevalence of dental caries among 5-14 years' old children in urban and peri-urban areas of Karachi was 67%. Reduction of second-hand smoking is imperative for not only improving the oral health of children but for the prevention of other chronic illnesses as well.

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