

ENVIRONMENTAL TOBACCO SMOKE AND DENTAL CARIES IN CHILDREN

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ABSTRACT

Passive smoking is the inhalation of smoke, called Second-hand smoking (SHSe), or Environmental tobacco smoking (ETS), by the person other than the intended “active” smoker. It occurs when tobacco smoke permeates any environment, causing its inhalation by people within that environment. Active smokers not only run personal risk of serious health hazard, they may also expose their nonsmoking spouse and children to ETS. ETS is perhaps one of the most important toxic exposure in childhood. The social environment and parental smoking influences child development, including the risk for developing dental caries. Different forms of tobacco usage have direct relationship with the prevalence of dental caries. Smoking along with co-existing factors like bad oral hygiene habits, food habits, limited preventive dental visits and overall health standards, can be associated with high caries incidence. However, a direct etiological relationship is lacking. Environmental tobacco smoke (ETS) causes dental caries in children but no studies have been reported in adults. Existing findings are not sufficient and conclusive enough to confirm that ETS causes dental caries. Unfortunately, published studies are not converging towards one single factor through which tobacco usage can have direct relationship to dental caries.

KEYWORDS: dental caries, tobacco smoking, environmental tobacco smoking

INTRODUCTION

Dental caries is a multifactorial disease and is affected by physical, biological, environmental, and lifestyle- related factors, such as a high number of cariogenic bacteria, inadequate salivary flow, insufficient fluoride exposure, and poor oral hygiene.^{1,2} The interaction of a susceptible tooth surface, fermentable carbohydrates and acid- producing bacteria leads to dental caries after tooth eruption. Specific bacteria, in particular, Mutans streptococcus (MS), convert carbohydrates into acids. Prolonged lowering of the pH in dental plaque induces demineralization of the tooth surface, resulting in the destruction of the hard structure of the tooth; thus, the etiology of dental caries is chronic. Various factors may influence the disease process. Behavioral factors such as poor oral hygiene and the consumption of sugar-containing snacks are significant factors for both MS infection and caries lesion initiation.³ Among the environmental factors the mother and the family who are the part of child’s environment, influence child’s development and establishment of oral health behaviors.⁴ It is well known that social determinants play an important role in the risk assessment of many chronic disorders among individuals, including dental caries. Concerning exposure to passive smoking or secondhand smoking, several studies have suggested a connection with dental caries. Children who are raised in families and subsequently exposed to parental Environmental tobacco smoke (ETS) are reported to have an increased relative risk for caries prevalence/caries experience in primary teeth; but conflicting results are reported for

permanent teeth.⁵ The social environment influences child development including the development of dental caries. Parental educational level and non-western background are well established as indicators associated with caries in children. Low family income and father's occupational status may sometimes result in Environmental tobacco smoke (ETS). Mother-child interaction in some studies reveals association of maternal smoking with dental caries. Change in family status from a traditional two parent family to single parent families may influence the parent's ability to give the child appropriate oral care. Children living in families with complicated relationships have been reported to have higher risk of passive smoking which is associated with caries experience.

PARENTAL ORAL HEALTH BEHAVIOURS

Parental attitudes towards oral health related behaviors may influence whether the behaviors will occur in children. In some studies, parental beliefs and attitudes towards oral health have been associated with caries development in children. Several conditions such as knowledge in the field of interest and social and cultural background can influence the establishment and maintenance of beliefs and attitudes. Beliefs and attitudes are modifiable and differ between individuals with the same background.⁴ As described by several authors in recent reports no association was seen between reported tobacco consumption of the parents and the oral health condition of their child. About 10% of fathers were reported to be smokers but none of the mothers. This clear difference can easily be explained by the socio-cultural situation in different societies where smoking is tolerated in men but considered as delinquent and frivolous behavior for women. This can be from the fact that in developing countries, where life styles differ from those in westernized countries, dietary habits seem to impact considerably on oral health.⁶ Mother's dental anxiety and dental attendance pattern have been proposed as predictors of dental health in preschool children and whether she takes the child to the dentist. When preschool children do not show up for scheduled dental appointments, it is usually due to the parents not bringing the children to the dental service. This behavior may reflect parents' negative beliefs and attitudes toward dental care. It may also be due to lack of knowledge of the dental care system for children or to a parent's fear of consequences when missing work.⁴

TOBACCO SMOKING

Tobacco, in general, is used as tobacco smoking and smokeless tobacco. Tobacco smoking usually

is used in the form of cigarettes, cigars and pipe tobacco.^{7,8} Cigarettes form the core of mass production of tobacco product that is smoked globally.⁹ Exposure to tobacco smoke, which contains numerous chemical toxins, might predispose children to infection through suppression or modulation of the immune system.¹⁰ Numabe *et al.* showed that the phagocytic activity of salivary polymorphonuclear leukocytes intensifies after cigarette smoking and Secondhand smoking (SHSe).¹¹ An *in vitro* study demonstrated that nicotine inhibited phagocytic activity of neutrophils and monocytes.¹² As dental caries result from chronic bacterial infection in the oral cavity, a potential pathway linking SHSe and caries might be attributed to alterations in host responses.¹ There is strong evidence that tobacco use has numerous negative effects on oral health, for example, staining of teeth and dental restorations, reduction of the ability to smell and taste, development of oral diseases such as smokers palate, smokers melanosis, coated tongue, and possibly, oral pre-cancer, oral cancer, oral candidiasis, periodontal disease, implant failure and dental caries.¹³

SMOKING AND DENTAL CARIES

From early reports in literature and a common belief was that smoking actually helps to reduce dental caries.^{14,15,16} Schmidt, in 1951, supported this belief when he reported that increase in tobacco smoking was followed by a decrease in caries rate.¹⁷ The concentration of thiocyanate, a constituent of tobacco smoke and normal saliva with possible caries-inhibiting effect, was found to be higher in smoker's saliva.¹⁸ So, one might predict less dental caries in smokers. On the other hand, the decreased buffering effect and possible lower pH of smoker's saliva and the higher number of *Lactobacilli* and *Streptococcus mutans* may indicate an increased susceptibility to caries.¹⁹ In 1990, Zetterberg confirmed association between smoking and the prevalence of dental caries in adult males. Smokers had significantly higher DMFT (Decayed, Missing, and Filled Teeth) score, untreated decayed surfaces, and missing surfaces. He further correlated that more cigarettes consumed per day resulted in more missing tooth surfaces in a smoker's mouth.¹⁶ A Swedish study carried out in 1991 shows that smoking, as a habit and an increased number of cigarettes smoked per day, are positively correlated with increased in number of decayed, missing and filled teeth.²⁰ Even though a recent study done on American female population in 2006 did not establish a causative relationship, cigarette smoking was shown to be associated with the prevalence of caries.²¹ Studies in this regard have considered multiple variable factors

which can contribute directly or indirectly to the increase in the incidence of dental caries in smokers such as age, tobacco habits other than smoking, oral hygiene habits, eating habits, drinking habits, preventive visits to dentist (dental recalls) and overall health standards. Studies indicate that smokers not only had bad oral hygiene and less primitive outlook on health, but also had different eating habits, presumably consuming high amount of sugar containing products like soft drinks and snacks.²² Daily smoking was associated with increased use of sugar in tea or coffee, and with more frequent alcohol consumption.²³ It is also seen that smokers have ineffective brushing habits than non-smokers. The distribution of brushing strokes around the mouth was more uniform in the non-smokers than in the smokers, which may indicate a tendency towards less favorable tooth brushing performance in smokers.²⁴ In natural tobacco, sugar can be present in a level up to 20%wt. In addition, various sugars and sweeteners are added intentionally during tobacco manufacturing process up to 4%wt or can be up to 13%wt of sugars. Sugars used as cigarette additive include glucose, fructose, invert sugar (glucose/fructose mixture) and sucrose. In addition, many tobacco additives contain high amount of sugars. For example, fruit juices, honey, molasses extracts, cones and maple syrup and caramel. The added sugars are usually reported to serve as flavour/casing and humectants. However, sugars also promote tobacco smoking, because they generate acids that neutralize the harsh taste and throat impact of tobacco smoke. Moreover, the sweet taste and the pleasant smell of caramelized sugar flavors are appreciated in particular by starting adolescent smokers. All the above findings can contribute to an increased prevalence of dental caries among smokers. However, a direct etiological relation between smoking and dental caries is still missing. The above-mentioned studies and findings point to the assumption that smoking has some influence on high caries incidence.²⁵

PARENTAL SMOKING AND DENTAL CARIES

Several studies have suggested a connection between dental caries in children and parental smoking; especially with maternal smoking.²⁶ Maternal smoking during pregnancy has for instance been associated with increased risk of miscarriage, lower birth weight, perinatal mortality, poor infant growth, and increased use and costs of health services. When parents do not quit smoking after delivery, their offspring are more vulnerable to sudden infant death syndrome,

respiratory illnesses, school absence, behavioral problems, and neurocognitive deficits.²⁷ Maternal smoking was associated with dental caries in children aged 5 to 12 years in eight countries of European Union, and with those of children aged 3-4.5 years using analyses of the UK National Diet and Nutrition Survey. Children aged 4-7 years residing with a smoker displayed a higher prevalence of dental caries in the Iowa Fluoride Study.²⁶ Early childhood caries (ECC) is defined as the presence of tooth decay involving any primary tooth in a child younger than six years of age. The term 'ECC' more effectively reflects the complexity of the disease process, which involves transmission of infectious bacteria, dietary habits and oral hygiene. ECC is an infectious disease, with *Streptococcus mutans* being the most dominant causative organism. ECC has been termed the most prevalent pediatric infectious disease and the most common chronic disease of children. The effects of ECC go beyond the oral cavity and influence overall childhood health and well-being. Early tooth loss as a result of ECC may result in speech difficulties and associated self-esteem issues because of altered appearance. Children with ECC are known to be at increased risk of decay in both primary and permanent dentition, and may also experience malalignment and crowding of permanent teeth, resulting in poor bite. Dental caries has also been associated with obesity in children from families of low socioeconomic status.²⁸ The possible association of early childhood caries (ECC) with parental smoking may be explained via two pathways. ETS has effects on the infectious process of *Streptococcus mutans*, as the role of ETS in causing infections is apparent in children, and salivary nicotine due to ETS exposure enhances the growth of *Streptococcus mutans*. Alternatively, smoking parents may exhibit poorer oral health behavior themselves than non smoking parents, and have more dental caries where *Streptococcus mutans* is harboured, indicating an increase in the chance of *Streptococcus mutans* infection. Such behavior of smoking parents may also account for poorer behavior in terms of the dental care of their children. Both pathways may increase the susceptibility of children to dental caries. Children infected earlier with *Streptococcus mutans* would be more likely to experience dental caries, as primary teeth are particularly susceptible to dental caries immediately after eruption because of immature crystal enamel.³

EXPOSURE OF CHILDREN TO ENVIRONMENTAL TOBACCO SMOKE (ETS)

Exposure to ETS in young children is mainly determined by parental smoking. Active smokers

not only run personal risk of serious health hazards, they may also expose their nonsmoking spouse and children to ETS. Exposure of children to ETS is a major concern because of its long-term consequences in terms of increased disease risk and morbidity during childhood.²⁷ ETS is a common cause of pediatric morbidity and mortality, disproportionately affects children in low socioeconomic status environments. Furthermore, it may be a risk factor for cavities. Research indicates that the bacteria responsible for caries formation are acquired in infancy from the saliva of mothers (via kissing, etc). Elsewhere, nicotine has been shown to promote the growth of cariogenic *Streptococcus mutans* bacteria *in vitro* thus, mother who smoke may be more likely than non-smokers to transmit these germs to children. ETS smoke has immunosuppressive properties and is a known risk factor for infections of the cranial organs (e.g. otitis media); thus it is not surprising that it might be risk factor for caries development as well.²⁹ Vitamin C is an important plasma antioxidant; it scavenges free radicals efficiently. It has been well established that cigarette use compromises vitamin C status in active smokers. Recently, it was reported that ETS can also reduce concentrations of ascorbate in children, even when the amount of exposure to ETS is minimal. Even though it is to our knowledge not known whether oxidant damage has a causative role in the increased caries susceptibility in children exposed to ETS, it is important to note that decrease vitamin C levels have been associated with growth of cariogenic bacteria.²⁷ ETS is known to increase inflammation of respiratory tract, producing symptoms of various clinical conditions including allergic rhinitis, which frequently cause mouth breathing and thus result in dry mouth (i.e. an effective decrease in saliva). Thus, ETS could promote dental caries both through a direct effect of nicotine on caries-causing bacterial agents, as well as via other systemic physiological changes in host. Other reason given to that ETS cause caries in children is that colonization with the cariogenic *Streptococcus mutans* is thought to occur during a window of vulnerability around 1 year of age, and primary teeth are particularly susceptible to caries formation soon after their eruption. Furthermore, in early childhood, when immune system is generally less mature, the saliva is known to be different from that of adult with respect to IgA concentrations. In addition, salivary flow rate in children is lower. Young children may thus be particularly vulnerable to harmful effect of ETS on immune system and saliva flow. Hence, it is biologically plausible that passive smoking could cause caries, particularly in early childhood. Unfortunately, a recent study in 2006

failed to demonstrate a positive association between passive smoking and caries experience in Japanese children. And is also somewhat puzzling that no effect on permanent teeth was observed, as it would be expected that any effect of ETS on the developing dentition would affect both deciduous and permanent teeth in the same way. Similarly, if the main effect of ETS is more related to posterruptive force, then a similar pattern of caries susceptibility in the permanent dentition should be observed. One possible explanation suggests that ETS exposure is more likely to cause dental caries in deciduous teeth rather than permanent teeth is because enamel of deciduous teeth is much thinner compared to permanent teeth, and that enamel defect are associated with caries.²⁹

FORMS OF TOBACCO USE	BIOLOGICAL EFFECTS
Tobacco smoking	<ul style="list-style-type: none"> • Concentration of thiocyanate found to be higher in smoker's saliva may have possible caries inhibiting effect. • Decreased buffering effect and possible lower pH of saliva in smokers may indicate increased susceptibility to caries. • Higher number of <i>lactobacilli</i> and <i>Streptococcus mutans</i> in smokers may indicate caries susceptibility.
Environmental tobacco smoke (ETS)	<ul style="list-style-type: none"> • Biological plausibility of causal role of ETS in caries formation in children. • Immunosuppressive properties of ETS might be a risk factor for dental caries development. • ETS may decrease serum vitamin C level, which may be associated with growth of cariogenic bacteria in children. • ETS may reduce the protective properties of saliva that can operate against caries.

CONCLUSION

Many studies have revealed that Environmental tobacco smoking (ETS) is independently

associated with dental caries. Although the biological and behavioral plausibility for an etiological relationship between ETS and dental caries is likely to be high, epidemiological evidence is still insufficient. The addition of objective markers of ETS may help to clarify its role in dental caries. Passive smoking, according to the recent first global assessment to the burden of environment tobacco smoke, is still one of the most important threats to public health. Creating smoke free public places will reduce exposure to ETS and help to “denormalise” of smoking in public places.

BIBLIOGRAPHY

1. Tanaka *et al.*, Household smoking and dental caries in schoolchildren: the Ryukyus Child Health Study *BMC Public Health* 2010, 10:335.
2. Selwitz RH, Ismail AL, Pitts NB. Dental Caries. *Lancet* 2007, 369:51-59.
3. Hanioka T, Nakamura E, Ojima M, Tanaka K, Aoyama H. Dental caries in 3-year-old children and smoking status of parents. *Paediatr Perinat Epidemiol*, 2008 Nov; 22(6):546-50.
4. Wigen TI, Wang NJ. Parental influence on dental caries development in preschool children. An overview with emphasis on recent Norwegian research. *Norsk Epidemiologi* 2012; 22(1): 13-19.
5. Julihn A, Ekbohm A, Modeer T. Maternal overweight and smoking: prenatal risk factors for caries development in offspring during the teenage period. *Eur J Epidemiol* 2009, 24; 753-762.
6. BF Songo , D Declerck, F Vinckier, MD Mbuyi3, CM Pilipili, KPKayembe. Caries experience and related factors in 4-6 year-olds attending dental clinics in Kinshasa, DR of Congo. *Community Dental Health* 2013; 30, 257–262.
7. Vellappally S, Fialal Z, Šmejkalová1 J, Jacob1 V, Shriharsha P. Influence of tobacco use in dental caries development. *Cent Eur J Public Health* 2007; 15 (3): 116–121.
8. Winn DM. Tobacco use and oral disease. *J Dent Educ.* 2001 Apr; 65(4):306-312.
9. Prokhorov AV et al. Tobacco Consortium, American Academy of Pediatrics Center for Child Health Research. Youth tobacco use: a global perspective for child health care clinicians. *Pediatrics.* 2006 Sep; 118(3):e890-903.
10. Kum-Nji P, Meloy L, Herrod HG: Environmental tobacco smoke exposure: prevalence and mechanisms of causation of infections in children. *Pediatrics* 2006, 117:1745-1754.
11. Numabe Y, Ogawa T, Kamoi H, Kiyonobu K, Sato S, Kamoi K, Deguchi S: Phagocytic function of salivary PMN after smoking or secondary smoking. *Ann Periodontol* 1998, 3:102-107.
12. Pabst MJ, Pabst KM, Collier JA, Coleman TC, Lemons-Prince ML, Godat MS, Waring MB, Babu JP: Inhibition of neutrophil and monocyte defensive functions by nicotine. *J Periodontol* 1995, 66:1047-1055.
13. Reibel J. Tobacco and oral diseases. Update on the evidence, with recommendations. *Med Princ Pract.* 2003;12 Suppl 1:22-32.
14. Hart AC. Prevention of decay of the teeth. *Dent Items Interest.* 1899; 21(3):153-63.
15. Gibbs MD. Tobacco and dental caries. *J Am Coll Dent.* 1952;19:365-7.
16. Zitterbart PA, Matranga LF, Christen AG, Park KK, Potter RH. Association between cigarette smoking and the prevalence of dental caries in adult males. *Gen Dent.* 1990 Nov-Dec;38(6):426-31.
17. Schmidt HJ. Tobacco smoke and the teeth. *Stoma (Heidelb).* 1951 May; 4(2):111 25. (In German.)
18. Johnson NW, Bain CA. Tobacco and oral disease. EU-Working Group on Tobacco and Oral Health. *Br Dent J.* 2000 Aug 26; 189(4):200-6.
19. Kassirer B. Smoking as a risk factor for gingival problems, periodontal problems and caries. *Univ Tor Dent J.* 1994; 7(1):6-10.
20. Hirsch JM, Livian G, Edward S, Noren JG. Tobacco habits among teenagers in the city of Goteborg, Sweden, and possible association with dental caries. *Swed Dent J.*

- 1991; 15(3):117-123.
21. Heng CK, Badner VM, Freeman KD. Relationship of cigarette smoking to dental caries in a population of female inmates. *J Correct health care.* 2006; 12(3):164-174.
 22. Axelsson P, Paulander J, Lindhe J. Relationship between smoking and dental status in 35-, 50-, 65-, and 75-year-old individuals. *J Clin Periodontol.* 1998 Apr; 25(4):297-305.
 23. Telivuo M, Kallio P, Berg MA, Korhonen HJ, Murtomaa H. Smoking and oral health: a population survey in Finland. *J Public Health Dent.* 1995; 55(3):133-8.
 24. Macgregor ID, Rugg-Gunn AJ. Uninstructed toothbrushing behaviour in young adults in relation to cigarette smoking in Newcastle. *Community Dent Oral Epidemiol.* 1984 Dec; 12(6):358-360.
 25. Talhout R, Opperhuizen A, van Amsterdam JG. Sugars as tobacco ingredient: effects on mainstream smoke composition. *Food Chem Toxicol.* 2006 Nov; 44(11):1789-98.
 26. Hanioka T, Nakamura E, Ojima M, Tanaka K, Aoyama H. Dental caries in 3-year old children and smoking status of parents. *Paediatric and Perinatal Epidemiology.* 2008; 22, 546-550.
 27. Leroy R, Hoppenbrouwers K, Jara A, Declerck D. Parental smoking behavior and caries experience in preschool children. *Community Dent Oral Epidemiol* 2008; 36: 249-257.
 28. Irvine JD, Holve S, Krol D, Schroth R. Early childhood caries in Indigenous communities. A joint statement with the American Academy of Pediatrics. *Paediatr Child Health* 2011; 16(6):351-357.
 29. Aligne CA, Moss ME, Auinger P, Weitzman M. Association of pediatric dental caries with passive smoking. *JAMA.* 2003 Mar 12; 289(10):1258-1264.

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