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Association of prenatal exposure to maternal smoking and postnatal exposure to household smoking with dental caries in 3-year-old Japanese children

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ARTICLE INFO

Article history:

Received 17 July 2015

Received in revised form

5 October 2015

Accepted 5 October 2015

Available online 19 October 2015

Keywords:

Cross-sectional studies

Child

Dental caries

Japan

Secondhand smoke

ABSTRACT

Background: Epidemiological studies of the association between smoking exposure and dental caries are limited.

Objective: The purpose of this cross-sectional study was to examine the association between prenatal and postnatal secondhand smoke (SHS) exposure and the prevalence of dental caries in primary dentition in young Japanese children.

Methods: Study subjects were 6412 children aged 3 years. Information on exposure to maternal smoking during pregnancy and postnatal SHS exposure at home was collected via parent questionnaire. Children were classified as having dental caries if one or more primary teeth had decayed or had been filled.

Results: Compared with never smoking during pregnancy, maternal smoking in the first trimester of pregnancy was significantly associated with an increased prevalence of dental caries in children (adjusted odds ratio=1.37, 95% confidence interval: 1.03–1.80). Postnatal SHS exposure was also positively associated with dental caries, with a significant positive exposure–response relationship. Compared with children not exposed to prenatal maternal smoking or postnatal SHS at home, those exposed to both prenatal and postnatal smoking had higher odds of dental caries (adjusted odds ratio=1.62, 95% confidence interval: 1.23–2.11).

Conclusion: Our findings suggest that maternal smoking during pregnancy and postnatal SHS exposure may be associated with an increased prevalence of dental caries in primary dentition.

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1. Introduction

Although a substantial decline in the prevalence of dental caries has been documented over recent decades, dental caries remains one of the most common chronic diseases and is of medical, social and economic importance (Marthaler, 2004; Rugg-Gunn, 2013). Dental caries has adverse effects on children's health, such as pain, restricted dietary intake, impaired growth and decreased quality of life (Sheiham, 2006). Caries development is related to physical, biological, environmental, and lifestyle-related

Abbreviations: CI, confidence interval; KOCHS, Kyushu Okinawa Child Health Study; OR, odds ratio; SHS, secondhand smoke

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<http://dx.doi.org/10.1016/j.envres.2015.10.004>

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factors (Selwitz et al., 2007).

Recently, a growing body of evidence has indicated that secondhand smoke (SHS) exposure may play a role in the development of dental caries in children (Williams et al., 2000; Aligne et al., 2003; Shenkin et al., 2004; Tanaka et al., 2006; Leroy et al., 2008; Hanioka et al., 2008; Tanaka et al., 2010; Christensen et al., 2010; Al-Mendalawi and Karam, 2014; Watanabe et al., 2014; Nakayama and Mori, 2015). The Iowa Fluoride study showed that residing with a regular smoker at home was positively associated with the prevalence of dental caries in children aged 4 to 7 years (Shenkin et al., 2004). In a Japanese cross-sectional study, a positive association between maternal smoking, but not paternal smoking, and dental caries was observed in children aged 3 years (Nakayama and Mori, 2015). On the other hand, a case-control study of Iraqi preschool children showed no association between parental smoking and caries (Al-Mendalawi and Karam, 2014). Thus, no clear conclusion about the association between SHS

exposure and caries has been reached. Worldwide, about 40% of children are exposed to SHS (Oberg et al., 2011). It is important to clarify the effect of SHS exposure on dental caries.

Compared with evidence on the association between postnatal SHS exposure and caries in children, evidence on the relationship between maternal smoking during pregnancy and dental caries in children is scarce (Shulman, 2005; Iida et al., 2007; Tanaka et al., 2009; Schroth et al., 2013; Majorana et al., 2014). The previous studies that are available (Shulman, 2005; Iida et al., 2007; Tanaka et al., 2009; Schroth et al., 2013; Majorana et al., 2014) do not take into account the stages of pregnancy during which the mothers smoked. Furthermore, little is known about the independent effects of prenatal smoking exposure and postnatal SHS exposure and the additive effect of prenatal and postnatal smoking exposure on dental caries. In the present study, we assessed the associations between maternal smoking during pregnancy and postnatal exposure to SHS at home on dental caries in young children, using data from the Kyushu Okinawa Child Health Study (KOCHS).

2. Methods

2.1. Study subjects

In Japan, as a provision of the Maternal and Child Health Law, when a child is between 36 and 47 months of age, the municipality of the domicile performs a physical examination, which includes an oral examination, anthropometric measurements of height and weight, and an interview with parents or guardians about the child's health condition. Eligible subjects for the KOCHS were children aged 3 years who were receiving a physical examination that was offered at any of the public health centers in one of 45 municipalities in seven prefectures on Kyushu Island in southern Japan or Okinawa Prefecture, an island chain in the southwest of Japan. The majority of municipalities, including Fukuoka City, conducted the physical examination at around 37 months of age, and other municipalities, including municipalities in Okinawa Prefecture, conducted it at around 42 months of age. Between May 2012 and March 2014, we were granted special permission by the 45 municipal governments to provide our questionnaires directly to parents or guardians of the children receiving the physical examination at public health centers. Of the 68,527 eligible subjects, we provided 62,449 parents or guardians of those children with a structured self-administered questionnaire, a food frequency questionnaire, and a postage-paid, addressed return envelope. Ultimately, a total of 6576 parents or guardians of the children gave their informed consent in writing and answered the questionnaires and mailed these materials to the data management center (participation rate=9.6%). Our research technicians completed missing answers and/or illogical data by telephone interview with individual parents or guardians of the children. A total of 164 children with incomplete data on the variables under study were excluded from the current study, leaving data on 6412 available for analysis (9.4% of the 68,527 eligible children). The ethics committees of the Faculty of Medicine, Fukuoka University and Ehime University Graduate School of Medicine approved the KOCHS.

2.2. Outcome variable

At the time of the physical examination, dentists belonging to each municipal Dental Association carried out the dental examinations for all erupted teeth. The presence of dental caries, such as decayed (cavitated) and/or filled teeth, was assessed by a visual examination under artificial light with a dental mirror. Radiographs were not taken. The examiners were given detailed

criteria for performing the examinations, but they received no specific training aimed at standardizing the procedure. Therefore, it is unknown whether intraexaminer and interexaminer consistency was established. Data on the dental examination by a dentist were recorded at the tooth level in each child's maternal and child health handbook, which had been provided by the municipality during the pregnancy and which included information on prenatal checkups as well as postnatal health conditions of both the mother and baby and the growth of the child. In this study, parents or guardians of the children were required to transcribe the data on the dental examination from the maternal and child health handbook to our self-administered questionnaire. The reasons for missing primary teeth were not identified in the present study. Therefore, we classified children as having dental caries if one or more primary teeth had decayed (cavitated) or had been filled.

2.3. Exposure variables and covariates

Information on maternal smoking during pregnancy and postnatal SHS exposure at home was obtained from a structured self-administered questionnaire. For SHS exposure at home, pack-months of exposure (number of packs per day multiplied by months of SHS) were calculated. The questionnaire also included questions about sex, breastfeeding duration, between-meal snack frequency, dental health behavior (such as toothbrushing frequency, use of fluoride, and pattern of dental care), and paternal and maternal educational levels. Use of fluoride was defined as positive if children were reported to use fluoride toothpaste at home or to receive the application of topical fluoride products at a dental clinic or a public health center.

Data from the food frequency questionnaire were not used in the current study.

2.4. Statistical analysis

Maternal smoking during pregnancy was classified into four categories (never smoked during pregnancy, smoked only in the first trimester, smoked in the second and/or third trimesters but not throughout the pregnancy, and smoked throughout the pregnancy); SHS exposure at home into two (never and ever); and pack-months of SHS exposure at home into three (none, 0.1–18.9, ≥ 19.0). The following variables were controlled for in the multivariate model: sex, age, region of residence (Fukuoka City, cities on Kyushu Island other than Fukuoka City, and cities in Okinawa prefecture), breastfeeding duration (< 12 and ≥ 12 months), between-meal snack frequency (< 1, 1, and ≥ 2 times/day), toothbrushing frequency (< 1, 1, and ≥ 2 times/day), use of fluoride (yes and no), regular dental check-ups (yes and no), paternal and maternal educational level (< 13, 13–14, ≥ 15 years), and household income (< 4,000,000, 4,000,000–5,999,999, and $\geq 6,000,000$ yen/year).

Logistic regression analysis was performed to estimate crude odds ratios (ORs) and their 95% confidence intervals (CIs) for dental caries according to categories of prenatal and postnatal exposure to smoking. Additionally, multiple logistic regression analysis was conducted to control for potential confounders. To examine whether prevalence of dental caries increased with pack-months of SHS exposure at home, trends of association were assessed using a logistic regression model assigning consecutive integers to the levels of the independent variable. Two-sided *P* values less than 0.05 were considered statistically significant. All statistical analyses were performed using the SAS software package version 9.4 (SAS Institute, Inc., Cary, NC, USA).

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