

Antenatal Health Care and Postnatal Dental Check-Ups Prevent Early Childhood Caries

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The first stage of early childhood caries (ECC) is infection by mutans streptococci, of which the primary infection source is the child's mother. Early intervention programs including antenatal and postnatal phases are effective for reducing ECC. This study was conducted to assess the respective effects of antenatal health care and postnatal care such as regular dental check-ups on reducing ECC among 3-year-old Japanese children. This nested case-control study of 155 three-year-old children (49.0% boys) was conducted at a dental clinic that provides collaborative health services with the Obstetrics and Gynecology Clinic, Okayama. Child characteristics and the mothers' antenatal data were collected retrospectively from the dental charts. They were divided into two groups: caries-free children ($n = 77$) and children without ECC ($n = 78$). Most of the children (81.9%) received regular check-ups with topical fluoride application. Most of the mothers reported morning sickness during pregnancy (81.3%), normal delivery (72.9%), and used antenatal health care (80.6%). Over half (55.5%) were primigravida. Adjusted odds ratio (AOR) and 95% confidential interval (95% CI) were computed to assess the strength of association using logistic regression analysis. Receiving antenatal health care (AOR, 3.27; 95% CI, 1.30-8.24) and child's having regular check-ups (AOR, 3.42; 95% CI, 1.35-8.69) were significantly associated with caries-free status among three-year old children. For ECC prevention, antenatal health care is as effective as regular check-ups up to three years of age. The results of this retrospective study demonstrate that maternal health education during pregnancy is effective for ECC prevention.

Keywords: caries prevention; mother-child transmission; nested case-control study; pregnancy; prenatal care
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Introduction

The first stage of early childhood caries (ECC) is infection by mutans streptococci (MS), of which the primary infection source is the child's mother. Several reports have described that the earlier the colonization occurs in a child, the greater the degree of decay in later years (Köhler et al. 1988; Straetemans et al. 1998; Isokangas et al. 2000). Intervention to safeguard the oral health of pregnant women and new mothers with infants can produce benefits for both the mother and child. Various interventions using professional prophylaxis (Köhler and Andréen 1994), chlorhexidine and fluoride rinse (Brambilla et al. 1998), and xylitol chewing gum (Söderling et al. 2000; Thorild et al. 2003; Nakai et al. 2010) have been demonstrated as effective for preventing or delaying mother-child transmission of MS. Motivational discussions with mothers also lowered the severity of caries in their children (Weinstein et al. 2006; Harrison et al. 2012). Therefore, early oral health care was emphasized to include dental preventive measures, ideally

antenatal and postnatal, for the mother and child until the age of 3 (Meyer et al. 2014). Such early intervention programs that include both antenatal and postnatal phases are effective to reduce ECC (Günay et al. 1998; Gomez and Weber 2001) and to produce sustained improvement of oral health until young adulthood (Meyer et al. 2014).

Nevertheless, throughout Japan, antenatal interventions to reduce ECC have remained insufficient. More than 60% of respondents to a national survey conducted in 2011 (Japanese Ministry of Health, Labour, and Welfare 2011) reported having experienced topical fluoride application, which indicates that predominant interventions to prevent ECC are still aimed specifically at the postnatal phase. Unlike antenatal care, because topical fluoride application has long been promoted as an effective strategy to control ECC, preventive dental check-ups have become increasingly common among 3-year-old children on public health and private practice bases in Japan (Okazaki et al. 1999, 2000, 2001).

Antenatal health care is an ideal entry opportunity to

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provide knowledge, behavior modification, and multiple health interventions to promote maternal and child well-being. It is also regarded as an efficient means of ECC prevention. No report of the relevant literature describes studies in Japan of antenatal health care for the prevention of ECC in one's own children. No report has described the respective effects of antenatal and postnatal preventive measures on ECC reduction. Better knowledge of the relative efficacy of antenatal health care compared with regular dental check-ups would be helpful to improve overall dental care for children.

This study was conducted to assess whether antenatal health care and regular check-ups contribute to ECC prevention in 3-year-old Japanese children, or not. This study examined the hypotheses that children whose mothers with antenatal health care and those with the regular dental check-ups show significantly better oral health than children of mothers receiving no care, and that both measures are equally effective.

Methods

Study design

This nested case-control study was conducted at Hello Dental Clinic, which is part of the medical corporation of the Miyake Obstetrics and Gynecology (OB-GYN) Clinic, the largest in central Okayama city, Japan. The dental charts of children, who were three years old when they visited the dental clinic between September 2011 and November 2012, were selected and considered for inclusion in the retrospective chart review. The pediatric dental visits generally include prevention-oriented purposes such as seeking anticipatory guidance, caries-risk assessment, tooth cleaning, dietary consultation, and topical fluoride, as well as treatment-oriented purposes for specific problems such as cavity, gingivitis, orofacial infections, malocclusion, dental trauma, and dental anomalies. Some subjects had multiple dental visits. Therefore, the first record during the study period was regarded as representing enrollment. Inclusion criteria were age of three years with full primary dentition, and with a lack of systemic disorder or use of antimicrobials. Power analysis determined that at least 49 children were required per group, with $\alpha = 0.05$ type I for 80% power to detect a two-tailed difference in the proportion of caries-free children between the groups with and without regular dental check-ups (Gomez and Weber 2001). Three-year-old caries-free children were selected as cases, whereas those with ECC at three years of age were selected as controls. Of the 155 children included in this study, 77 were frequency-matched 1:1 to 78 controls. Matching was based on the gender and age in years. The ethics committee of Miyake Obstetrics and Gynecology Clinic Medical Corp., to which the Dental Clinic belongs, approved the study protocol. This study used routinely collected clinical data in an anonymous form retrospectively. Individual consent was not required.

Clinical data

We retrospectively reviewed dental charts and obtained data related to maternal data (gravida status, morning sickness during pregnancy, mode of delivery, place of delivery, use of antenatal health care, use of postpartum dental examination) and each child's data (sex, chronological age at first dental visit and survey enrollment, caries status at first dental visit and survey enrollment, number of

erupted teeth at first visit, use of regular check-up with fluoride application). Maternal data were given by the child's mother as necessary information in the chart at the child's first dental visit. Intra-oral examinations of the children were conducted by one of two pediatric dental specialists. The examinations elicited information related to which teeth were erupted. Dental caries were found using a sharp explorer and a mouth mirror under good illumination in a fully equipped dental chair, or using the knee-to-knee position in cases of uncooperative children. According to World Health Organization criteria (World Health Organization 2013), caries were charted when a lesion had a detectable cavity and undermined enamel in a pit or fissure, or a smooth surface. We calculated the number of decayed (cavitated), missing (because of caries), and restored teeth (dmft) to record the dental caries experience of primary teeth. Radiographic examinations were applied on an individual basis when appropriate, but not for study purposes.

Statistical analysis

Distributions of the data used for this study were examined to assess the degree of missing data. No data were missing. Data were entered into the computer and were checked for accuracy. Data management and analyses were conducted using software (SPSS ver. 19; IBM SPSS Inc.), with statistical significance inferred for $p < 0.05$. The sample power was calculated using software (SPSS Sample Power 3; IBM SPSS Inc.). Descriptive analysis (frequencies, means, and standard deviation: SD) was applied along with Fisher exact, chi-square, and *t*-tests (Welch or Student). Odds ratios (OR) and 95% confidence intervals (CI) were calculated to ascertain the factors associated with caries status. Spearman's correlation coefficient (r_s) was used to assess the possibility of interaction between the use of antenatal health care during pregnancy and regular dental check-ups. The outcome variable was caries-free status (dmft > 0 coded as 0, dmft = 0 coded as 1). Bivariate analyses were performed individually with each explanatory variable: sex (girl coded as 0, boy coded as 1), gravida status (multigravida = 0, primigravida = 1), morning sickness during pregnancy (yes = 0, no = 1), mode of delivery (Caesarean etc. = 0, normal = 1), place of delivery (other = 0, Miyake OB-GYN Clinic = 1), antenatal health care (no = 0, yes = 1), postpartum dental examination (no = 0, yes = 1), and regular check-up with fluoride application (no = 0, yes = 1). All explanatory variables were combined into a logistic regression model after controlling simultaneously for potential confounders.

This study was reported according to the STROBE statement (Vandenbroucke et al. 2007).

Results

Child and maternal characteristics and comparison between ECC and Caries-free groups

This study enrolled 77 caries-free children and 78 children with ECC. Characteristics of the subjects and their mothers are presented in Table 1. The mean age of all subjects was 3.7 ± 0.1 years (range 3.5-3.9) at survey enrollment and 2.1 ± 0.8 years (range 1.0-3.8) at the first dental visit. Nearly half (49.0%) of them were boys. Groups were well matched for age and sex: no significant difference was found between groups ($p = 0.83$ and $p = 0.34$, respectively). Most of the children (81.9%) received regular check-ups with topical fluoride application. Most of the mothers

Table 1. Characteristics of enrolled child subjects and their mothers.

Variable	All subjects (n = 155)	ECC (n = 78)	Caries-free (n = 77)	P
<u>Child characteristics</u>				
Sex				
Boy	76 (49.0)	35 (44.9)	41 (53.2)	0.34 ^a
Girl	79 (51.0)	43 (55.1)	36 (46.8)	
Age at survey enrollment, year (mean±SD)	3.7 ± 0.1	3.7 ± 0.1	3.7 ± 0.1	0.83 ^c
Age at first dental visit, year (mean±SD)	2.1 ± 0.8	2.1 ± 0.8	2.0 ± 0.7	0.64 ^d
Number of teeth at first visit (mean±SD)	15.8 ± 3.9	15.8 ± 4.1	15.7 ± 3.7	0.93 ^c
Regular check-ups with fluoride application*				
Yes	127(81.9)	58 (74.4)	69 (89.6)	0.02 ^a
No	28 (18.1)	20 (25.6)	8 (10.4)	
<u>Maternal characteristics</u>				
First child (primigravida)				
Yes	86 (55.5)	39 (50.0)	47 (61.0)	0.20 ^a
No	69 (44.5)	39 (50.0)	30 (39.0)	
Morning sickness during pregnancy				
Yes	126 (81.3)	60 (76.9)	66 (85.7)	0.22 ^a
No	29 (18.7)	18 (23.1)	11 (14.3)	
Mode of delivery				
Normal	113 (72.9)	57 (73.1)	56 (72.7)	1.00 ^a
Others (Caesarean etc.)	42 (27.1)	21 (26.9)	21 (27.3)	
Place of delivery				
Miyake OB-GYN Clinic	91 (58.7)	50 (64.1)	41 (53.2)	0.19 ^a
Other	64 (41.3)	28 (35.9)	36 (46.8)	
Antenatal health care*				
Yes	125 (80.6)	57 (73.1)	68 (88.3)	0.02 ^a
No	30 (19.4)	21 (26.9)	9 (11.7)	
Postpartum dental examination				
Yes	77 (49.7)	41 (52.6)	36 (46.8)	0.52 ^a
No	78 (50.3)	37 (47.4)	41 (53.2)	

n (%). P values were determined by comparison between ECC and Caries-free groups.

^aFisher exact test, ^bChi-square test, ^cStudent t-test, ^dWelch t-test, *Statistically significant.

reported morning sickness during pregnancy (81.3%) and normal delivery (72.9%). Over half (55.5%) were primigravida. Most mothers (80.6%) reportedly used antenatal health care, but less than half (49.7%) underwent a postpartum dental examination. Over half (58.7%) of mothers had delivered their child at the OB-GYN Clinic affiliated with the dental clinic. No significant difference was found between groups for any variable except for children's regular check-ups and antenatal health care usage. Caries-free children were significantly more likely to have regular check-ups than children with ECC (89.6% vs. 74.4%; $p = 0.02$). Mothers of caries-free children were significantly more likely to use antenatal health care than mothers of ECC children (88.3% vs. 73.1%; $p = 0.02$). No significant correlation was found between mothers' use of regular check-ups and antenatal health care usage for children ($r_s =$

-0.06 , $p = 0.46$).

Association between independent variables and caries-free status at three years of age

Both bivariate and multivariate regression analyses revealed that antenatal health care usage by mothers and regular check-ups for children were associated significantly and independently with caries-free status for 3-year-old children (Table 2). Children of mothers who had used antenatal health care were significantly more likely, in fact more than three times more likely, to be caries-free at three years of age (Adjusted OR, 3.27; 95% CI, 1.30-8.24; $p = 0.01$). Children who had regular dental check-ups with topical fluoride application were also significantly more likely, actually more than three times more likely (Adjusted OR, 3.42; 95% CI, 1.35-8.69; $p = 0.01$), to be caries-free than children

Table 2. Bivariate and multivariate analyses of variables contributing to caries-free status at three years of age.

Variable	Crude OR	95% CI	<i>p</i>	Adjusted OR	95% CI	<i>p</i>
Sex						
Girl	1.00	reference				
Boy	1.40	0.74–2.63	0.30	1.28	0.63–2.60	0.50
First child (primigravida)						
No	1.00	reference				
Yes	1.57	0.83–3.00	0.17	1.43	0.69–2.99	0.34
Morning sickness during pregnancy						
Yes	1.00	reference				
No	0.56	0.24–1.27	0.16	0.54	0.22–1.31	0.17
Mode of delivery						
Others (Caesarean etc.)	1.00	reference				
Normal	0.98	0.48–2.00	0.96	1.09	0.50–2.36	0.84
Place of delivery						
Other	1.00	reference				
Miyake OB-GYN Clinic	0.64	0.34–1.21	0.17	0.45	0.14–1.42	0.17
Antenatal health care*						
No	1.00	reference				
Yes	2.78	1.18–6.56	0.02	3.27	1.30–8.24	0.01
Postpartum dental examination						
No	1.00	reference				
Yes	0.79	0.42–1.49	0.47	1.31	0.42–4.07	0.65
Regular check-ups with fluoride application*						
No	1.00	reference				
Yes	2.97	1.22–7.25	0.02	3.42	1.35–8.69	0.01

OR, odds ratio; CI, confidence interval; *Statistically significant.

who did not have such care.

Discussion

This retrospective study demonstrates the ECC prevention efficacy of maternal health education during pregnancy, a health care strategy requiring neither pharmacological intervention nor professional prophylaxis. This minimal intervention is particularly effective from a public health perspective. This report is the first to describe that antenatal health care and regular dental check-ups contribute equally to reducing ECC up to three years of age. The respective effects of the behaviors for ECC prevention were more than three times stronger than the alternative. This result supports the hypotheses examined in this study. Moreover, those behaviors did not mutually confound, as demonstrated by their lack of mutual correlation in this population. This study did not compare socioeconomic conditions of the enrolled mothers between groups, but the effects of their financial situation on those behaviors are expected to be negligible because no individual payment is necessary for their own antenatal health care and dental check-ups of their children. In Okayama city, no individual payment of medical expenses is necessary under health insurance for children until they enter school.

No significant association was found between ECC

and other independent variables. Li et al. (2005) reported that children of Caesarean delivery acquired MS significantly earlier than those of vaginal delivery. In this study, however, the mode of delivery did not affect caries occurrence. Maternal gravida status and morning sickness during pregnancy were assumed as possible factors predisposing a child to having caries, but they did not affect ECC in this study. Postpartum dental examinations for mothers (Yamamoto et al. 2001), which have been rarely implemented throughout Japan, are expected to remind mothers of their oral condition and facilitate their dental visits for reducing ECC. However, this study did not elucidate the mechanisms of the effects.

Another report of the literature (Ishihara-Shinga et al. 2007) has described that more than half of pregnant women (56.3%) showed high salivary MS levels, which represents a high risk of infecting their child with MS. Those results accord with results of a Swedish study which revealed that nearly 50% of mothers exhibited high levels of salivary MS (Thorild et al. 2002). Recently, long-term benefits of prevention or delaying mother-child transmission of MS were reported to affect caries occurrence at 10 and 15 years of age (Köhler and Andréen 2010; Laitala et al. 2012). Milgrom et al. introduced a community-based intervention to provide dental services for low-income pregnant women

in Oregon, USA. They presented a successful and sustainable model of extended care (Milgrom et al. 2008, 2010). However, Japanese women rarely use preventive dental care (2.2%) during pregnancy (Ishihara-Shinga et al. 2007). That fact contrasts with survey results showing that 22.7-34.7% of women in the US used dental care during pregnancy (Gaffield et al. 2001). Although the barriers hindering their use of dental care access were unclear, few pregnant women in Japan are able to receive benefits. Medical doctors and other medical staff in the OB-GYN constitute the front line of antenatal health care. They should be involved more closely to promote oral health education for pregnant women and to encourage dental visits to improve ECC prevention. A preventive paradigm or dental visit concept must support both public health and private practice bases.

This study has some limitations. First, the caries assessments were performed by two dentists who were not calibrated for inter-rater reliability. However, their diagnostic disagreement might be minimal because both were experienced pediatric dental specialists. These data were used for actual dental treatments. They were re-checked for accuracy by the other pediatric dentist. Second, the findings might not be generalizable to other populations because this sample might be extremely homogeneous. Third, this study population might have missed the inclusion of subjects with extremely high caries risk such as those who had ECC but who were not symptomatic. The possibility exists that mothers did not visit a dentist with their children until they became symptomatic. Despite these limitations, this study might be accomplished only at a dental clinic similar to ours because collaboration with an OB-GYN clinic to provide oral health education during pregnancy supports this case-control study well. Such collaboration is not common in public health or private practice in Japan (Yamamoto et al. 1998). This uncommon set of circumstances is an important strength of this study.

In conclusion, results show that ECC preventive dental care should be started at pregnancy. Improved knowledge alone cannot always produce behavioral changes sufficiently to improve oral health, especially for high risk populations. Therefore, subsequent effective intervention should also be arranged for mothers and their young children. Additional studies must be conducted to identify barriers that prevent women from taking action to access dental care, and to increase awareness about antenatal oral health care. Education that produces better understanding and the spread of knowledge is also necessary for medical professionals to support their collaboration in informing pregnant women. Medical professionals can provide important information to enhance oral health programs during pregnancy.

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Conflict of Interest

The authors declare no conflict of interest.

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