Influences of diet on caries activities and caries-risk grouping in children, and changes in parenting behavior

Michiko Nishimura1,*, Omar M.M. Rodis2, Seishi Matsumura2 and Michiyo Matsumoto-Nakano2

1 Pediatric Dentistry, Okayama University Hospital of Medicine and Dentistry
2-5-1 Shikata-cho, Kita-ku, Okayama 700-8525, JAPAN
2 Department of Pediatric Dentistry,
Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences
2-5-1 Shikata-cho, Kita-ku, Okayama 700-8525, JAPAN

Abstract
BACKGROUND: Dental caries incidence in early childhood is known to be influenced by the behavior of parent with their children, and clinicians and dental staff are advised to provide parents with effective oral health instructions. The objectives of this study were to identify the influence of diet of 18- and 24-month-old children on caries activities and investigate changes related to the behavior of their parents after receiving health instructions regarding caries risk for 2-year-old children. METHODS: The subjects were 1,206 child-parent pairs. The children participated in 18-, 24-, and 42-month-old health examinations at Kurashiki City Public Health Center in Kurashiki City, Japan. Cariostat, a caries activity test (Dentsply-Sankin Co., Tokyo), was conducted and the children were then classified into 6 caries-risk groups based on the 42-month-old predictive cutoff points. Their parents were given oral health instructions on caries prevention by dental hygienists of the Kurashiki City Public Health Center. In addition, a questionnaire regarding diet was given to identify its influence on caries activities in 18- and 24-month-old children, as well as the influence of changes in parenting behavior. RESULTS: A significant number of children in the high-risk group received breast feeding or bottle-feeding with liquids other than water at 18 months of age. Also total time for sucrose-containing food intake was significantly associated with increased caries activity at 18 months of age. After giving oral health instructions to parents of the 18-month-old children dietary habits significantly correlated with the high-risk group at 24 months of age were breast feeding or bottle-feeding with liquid other than water, total intake time of sucrose-containing food, and frequency of sucrose-containing foods intake. Furthermore, parents whose children were in the higher caries-risk group at 18 months of age showed a lower level of change in parenting behavior as compared to those with children in the lower caries-risk group. CONCLUSION: It is important to assess problematic dietary habits in accordance with caries-risk in young children and change parent behavior through effective oral health instructions. CLINICAL IMPLICATION: Clinicians can identify problematic dietary habits in children based on caries-risk and provide effective oral health instructions to parents, which may influence early prediction of caries-risk have been discussed without giving too scientific or practical details2,3). The American Academy of Pediatric Dentistry (AAPD) reported that caries-risk assessment is an essential element of contemporary clinical care for infants and children4). Furthermore, strategies for managing dental caries have increasingly emphasized

Key words
Caries activity,
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Introduction
Koch1) emphasized the importance of early prediction and determination of caries-risk and the problems of

*Correspondence to: Michiko Nishimura
E-mail: naruto10@md.okayama-u.ac.jp
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the concept of risk assessment\(^5\). In our previous study\(^6\), we performed caries-risk assessment for very young children using Cariostat, a caries activity test (Dentsply-Sankin Co., Tokyo) and established 6 caries-risk groups. We speculated the parent’s compliance with oral health instructions was associated with caries-risk grouping of their children. Dental caries is a multifactorial, chronic, and lifestyle-related disease. Hunter\(^7\) considered diet, such as sucrose intake, frequency of sucrose-containing foods intake and total exposed time to such foods, oral hygiene, and micro flora, to be as lifestyle related factors while Reich et al.\(^8\) added child behavior to that list. However, the lifestyles and habits of children are primarily controlled by their parents. Therefore, parent education, understanding of nutrition, socioeconomic status and behavior are all related to prevention of dental caries in their children\(^9\)–\(^11\).

The objectives of this longitudinal study were to identify the influence of diet on 18- and 24-month-old children in regard to caries activities, and investigate the effects of dietary changes following oral health instructions to their parents according to caries-risk grouping.

**Subjects and Methods**

**Subjects**
The initial group of subjects was composed of 1,208 children born between Oct. 2000 and Sep. 2001, who received the 18-, 24-, and 42-month-old health examinations at Kurashiki City Public Health Center in Japan. The subjects exclusion criteria were as follow, 1) Any medication taken during either of 2 Cariostat sampling periods. 2) No Cariostat test undertaken at 18 months of age. As result, 1,206 subjects were enlisted as participants in this study.

This study was performed through Kurashiki City Public Health Center ethical committee’s approval and local city health officers completely sealed each subjects’ private information and released the data to us in coded form.

**Methods**

**Oral Examination System of Kurashiki City**
Oral examinations of 18- and 42-month-old children are routinely performed in Japan as part of government sanctioned national dental check-up activities. In addition, a 24-month-old oral examination is conducted by Kurashiki City’s part of the community general health program. Monthly programs for those ages began in 1975, 1961, and 1980, respectively. In the present study, 2 pediatric dentists of Okayama University performed Cariostat testing of 18 and 24 months of age, while dentists of Kurashiki City Dental Society performed oral examinations during the 18 and 42 months of age. Oral examinations of subjects at 24 months of age were performed by the same pediatric dentists of Okayama University. Caries-risk assessment was done based on Cariostat test results in using cross-sectional and longitudinal analysis. Calibration of the examinations was not possible because of the different programs. However, these have been performed regularly by the same dentists including one of the authors (M.N.) and were done in accordance with the criteria of the Health Policy Bureau, Ministry of Labor and Welfare, of Japan\(^12\). Figure 1 shows the time schedule of this study.
Local city health officers completely sealed subjects' private information and released the data to us in coded form.

**Six caries-risk groups**

The 42-month-old predicted cutoff points based on the 18- and 24-month-old Cariostat test results were 1.5 and 2.0, respectively. The 6 caries-risk groups used in the present study were as follows: (1) Low risk (LR): children who had a Cariostat score at or lower than the 18-month-old cutoff point, and a score lower than the 24-month-old cutoff point. (2) Moderate risk (MR): children who had a Cariostat score higher than the 18-month-old cutoff point but had scores lower than the 24-month-old cutoff point. (3) Progressive border (PB): children who had a Cariostat score at or lower than the 18-month-old cutoff point but reaching the 24-month-old cutoff point. (4) Improved border (IB): children who had a Cariostat score higher than the 18-month-old cutoff point and reaching the 24-month-old cutoff point. (5) Moderately high (MHR): children who had a Cariostat score at or lower than the 18-month-old cutoff point but higher than the 24-month-old cutoff point. (6) High (HR): children who had a higher Cariostat score than the cutoff points for both ages (Fig. 2).

**Questionnaire**

A questionnaire was given to the parents, which evaluated which dietary factors were associated with high caries-risk in their children and the data were released by the Kurashiki City Public Health Center. The questions were as follows: 1) Do you check and brush your child’s teeth? 2) How many times a day does your child ingest sucrose-containing foods? 3) Do you determine the total time of your child’s sucrose-containing foods intake? 4) Does your child continue to breast feed or drink a liquids other than water through a bottle? These questionnaires were sent to individual subjects by mail along with a notification of their examination date. The parents completed and brought it to Kurashiki City Public Health Center on the day of their child’s scheduled examination.

**Oral health instructions**

The same Kurashi City public dental hygienists provided the parents with instructions for caries prevention. The results of the oral examinations and the Cariostat tests as well as completed questionnaires were computerized and provided to us as coded data. These results identified whether or not the patient was at high-risk for caries prevalence. Oral hygiene instructions were tailored to the risk level of each parent. Oral hygiene instructions for caries prevention included the following: 1) cessation of bottle feeding before 18 months of age, 2) parent-assisted daily tooth brushing, and 3) instructions to decrease the frequency of consuming sucrose-containing foods during the day.

**Statistical methods**

The authors analyzed the coded data released by the Kurashiki City Public Health Center using SPSS Ver.12.5. A Chi-square test was used to assess the significant differences in the distribution of answers between the 2 groups. A Mann-Whitney U test was
used to investigate changes in behavior from 18 to 24 months of age. A $P$-value of 0.05 was considered to be significant.

**Results**

**Dietary factors found to influence caries-risk**

Table 1 shows the influence of diet on Cariostat test results of the 18-month-old children. Sugar-intake total time was related to the 24-month-old cutoff point, as children belonging to the MR, PB, and IB groups had caries activities below the 42-month-old predictive cutoff point based on the 18-month-old cutoff point (Cariostat test result of 1.5). Breastfeeding or liquid intake other than water significantly increased the risk for caries at 18 months old.
Table 2 shows the influence of lifestyle on Cariostat test results of the 24-month-old children. Again breast-feeding or liquid intake other than water had a significant relationship with increased risk for caries, at 24 months old.

Changes in parent behavior from 18- to 24-month examination
1) Do you check and brush your child’s teeth? There were no data released from the Kurashiki City Public Health Center.
2) How many times a day does your child ingest sucrose-containing foods? Changes in the behavior of children in the HR group were significantly worse as compared to those in the LR, MR, PB, and IB groups from 18 to 24 months old (Fig. 3).
3) Do you determine the total time of your child’s sucrose-containing foods intake? Changes in the behavior of children in IB group were significantly worse as compared to LR and PB groups from 18 to 24 months old. Changes in children’s behavior belonging to moderate caries-risk group were significantly worse than children belonging to low-caries-risk group (Fig. 5).
4) Does your child continue to breast feed or drink liquids other than water through a bottle? Changes in the behavior of children in HR group were significantly worse as compared to those in LR, MR, and PB groups from 18 to 24 months old. Changes in behavior of children belonging to the IB and MR groups were significantly worse as compared to LR group from 18 to 24 months old. Changes in children’s behavior belonging to moderate caries-risk group were significantly worse than children belonging to low-caries-risk group (Fig. 5).

Discussion
Caries is a multi-factorial disease and the most important dietary component contributing to caries-risk without any doubt is ingestion of fermentable carbohydrates, particularly sugar. The frequency of sucrose-containing food intake per day and total time of sucrose-containing foods intake have been shown to be related to susceptibility to caries in children. Prolonged breast-feeding and liquid intake other than water through a bottle in early childhood is a factor related to increased caries-risk. Some researchers reported that when sucrose-containing food was eaten frequently, newly erupted teeth are at risk at a time when the immune response of
children is still immature\textsuperscript{7,17,18}. Furthermore, the mother’s parenting behavior toward the child influenced the child’s caries status\textsuperscript{19–21}. In our previous study\textsuperscript{13}, we reported that the 18-month-old caries activity influenced the child’s future oral conditions compared to caries activity at more than 24 months of age. This result supported Newbrun’s conclusion\textsuperscript{17}.

Newbrun concluded as follows “In the clinical situation, the accurate prediction of caries is not as important as the assessment of the individual caries risk and risk factors. Even with routinely available clinical and sociodemographic information at clinical examination, a dentist can identify high caries risk subjects with good accuracy”.

In the present study, Cariostat test results of children belonging to the LR and PB groups were at or the cutoff levels for 18- and 24-month-old children. Thus it is reasonable that were no significant differences in the lifestyles of the children in those groups, as shown in Figs. 2 and 3. The reason for the increased risk of caries in 18-month-old children is due to increased total time of sucrose-containing food intake. Thus, the lifestyle factor of 18-month-old children that had the greatest effect to make them susceptible to caries was feeding method. There were no data released by the Public Health Center of Kurashiki City regarding parent-assisted brushing with their 24-month-old children.

In contrast, there were no significant differences in dietary habits among the LR, MR, PB, and HR groups, which showed the importance of dietary habits in 18-month-old children to prevent caries initiation. Children in the HR group did not significantly change their dietary habits after the parent received oral care instructions, such as the frequency of sucrose-containing food intake. On the other hand, there were significant differences for the total time of sucrose-containing food intake among children belonging to LR, MR, PB, and IB groups whose Cariostat scores were below or at the predicted cutoff point at age of 24 months. Furthermore, there were significant differences for change in dietary habits between the LR and IB groups, the MR and PB groups, and the PB and IB groups. Those results indicated that children belonging to these 4 caries-risk groups and whose Cariostat scores were above the predicted cutoff point at 18 months old, did not significantly change their diet. Children whose Cariostat scores became worse from 18 to 24 months did not significantly change their behavior regarding feeding method. An understanding of the most problematic dietary factors is a prerequisite before effective instructions for prevention of caries initiation can be given. We consider that appropriate oral

Q.4 Does your child continue to breast feed or drink liquids other than water through a bottle? (No or Yes)

\begin{figure}[h]
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\includegraphics[width=\textwidth]{fig5.png}
\caption{Changes in patient behavior from 18 to 24 months old}
\end{figure}
health instructions for parent, especially those with very young children, are effective tools for caries prevention. However, compliance by the parents to oral health instructions varies, so it is also useful to understand the rate of compliance in accordance to caries-risk grouping of their children in order to provide effective instructions. The limitation of the study was that we did not have full access of the data and that what we analyzed was just the data released by Kurashiki City. As a result, we could not analyze the data associated with the effects on mothers regarding brushing their children’s teeth. Therefore, we instructed the parents to regularly check their children’s oral health to assess intake of foods and drinks containing sucrose and at the same time to brush their children’s teeth before sleeping at the night. Furthermore, we researched mother’s parenting stress in each caries-risk group. The mother having a high-risk child significantly felt less anxiety than mothers having other caries-risks children (data not shown). The mothers’ character might be strongly associated with the effectiveness of oral care instruction.

We began research regarding caries-risk assessment in 2001, with sampling for Cariostat tests, calculation of current and predicted screening indexes, determination of cutoff points, caries-risk assessment, and analyses of changes in child behaviors from 18 to 24 months performed until 2005. When the children, born in 2000, became 42 months old, their caries prevalence was 32.4% from 2003 to 2004. After completing caries-risk assessment in 2005, we managed and instructed parents with children in the low and moderate caries-risk groups, as shown in our previous study. As a result, caries prevalence in our subjects at 42 months old (2007) was 24.7%. The children in these studies were very young and could not determine their own dietary habit.

Based on our findings, we consider that parents of children with a higher risk of caries are more likely to neglect oral health instructions.

**Conclusion**

Appropriate assessment of problematic lifestyle habits in children is very important to understand their relationship with caries-risk. Furthermore, identification of parenting behaviors is important for providing effective caries prevention instructions.

**References**
