A longitudinal study of early childhood caries risk, dental caries, and life style

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Abstract The objectives of this longitudinal study were to assess children's caries risk and mean number of decayed teeth and determine their life style factors that influence their caries activity. A total of 283 children were selected based on the following criteria: they had 1.5, 2.5, and 3.5-year-old oral examinations, participated in Cariostat microbial sampling and the mother of a child filled out the questionnaires. Caries experiences of children were 2.1% for the 1.5-year-old, 8.1% for the 2.5-year-old, and 14.8% for 3.5-year-old period, respectively. Caries risk at the 1.5-year-old period showed significant differences \((P<0.001)\) for mean number of decayed teeth when children were at the 2.5-, and 3.5-year-old period. A significant difference \((P<0.01)\) was also seen for caries risk at the 2.5-year-old period. Regarding children's lifestyle factors at the 1.5-year-old period, pre-chewing food and breastfeeding produced significant caries susceptibility in both 2.5- and 3.5-year-old period. Additionally, children's life styles were analyzed to have an impact on caries only at the 2.5-year-old period. For children's lifestyle at the 2.5-year-old period, increased frequency of snack, irregular snack time, and brushing without assistance by the mother put 3.5-year-old children at high risk of developing caries. A caries activity test could predict 2.5-, and 3.5-year-old children's caries risk based on the 1.5-year-old test result. Some children's life styles at an early age showed a higher risk of developing caries at a later age.

Key words Caries activity, Cariostat, Dental caries, Life style

Introduction

Children are important target group for dental health education because during this period, the primary teeth erupt, children are at a higher risk for early cariogenic bacteria colonization, and children begin to form their lifelong dental behaviors\(^1,2\)\). Additionally, during this time, children undergo the dietary transition of breast/bottle feeding to their solid food and developing their childhood tastes for food. Thus, it is thought that there may be unique risk factors for caries in infants and young children\(^3\).

A child’s mother plays a vital role in raising, and transferring health-related habits to her children\(^4,5\). Behavior which is learnt during the child’s first year become deeply ingrained and resistant to change. Dental health education that is provided to mothers, and aimed at children is more concerned with forming habits, than at trying to change established routines. Intervention that requires behavioral changes at a later stage is more difficult to implement, and the chances of it benefiting dental health are lower. If positive dental health routines are taught in early childhood, later health education intervention can be of a reinforcing nature\(^6\).

Caries is preventable through caries risk reduction\(^7,9\). Health of the primary teeth affects the health of the succeeding permanent teeth. A child with dental caries in the primary dentition is at much...
higher risk of developing decay in the permanent dentition\textsuperscript{6,8,10}. Therefore, a continual accurate assessment of the risk of caries should include monitoring and documenting changes in oral findings and risk factors, as these provide an estimate of future caries activity\textsuperscript{11).

To identify an individual’s caries susceptibility, many bacteriological caries activity tests have been developed. So far, there are two methods for obtaining a bacterial sample; it can be taken from the patient’s saliva\textsuperscript{12–15} or from their dental plaque\textsuperscript{2,4,14–16}. However, theoretically, dental plaque seems to be a particularly appropriate method because the tooth surface constitutes the natural habitat of \textit{Streptococcus mutans}\textsuperscript{13,14,17}. The biofilm in the dental plaque produces acid, which when challenged with sucrose, allows for the carious process to progress\textsuperscript{7,18}. In contrast, salivary test seems unsuitable in a public health program as it is difficult to collect saliva from young children\textsuperscript{19}.

The Cariostat test (Dentsply Sankin Co., Japan), is a caries risk assessment tool developed by Shimono in 1974\textsuperscript{9,15}. It has been widely used in many clinical, epidemiological, and fieldwork-related studies in Japan. The Cariostat test has reliably predicted caries experience in the short time in toddler and in the long term by sampling as early as age 3 and predicting df outcomes as long-term as age 10\textsuperscript{20}. Recently, Nishimura \textit{et al.} reported the ability of this method to predict caries in 3.5-year-old children based on the caries risk results when they were at the 1.5- and 2.5-year-old period\textsuperscript{9}.

Factors that may be implicated in giving rise to caries in young children have been described in a number of studies\textsuperscript{1,3,4,8}. However, many of these studies have not used the optimum study design, which is a longitudinal study. A longitudinal study is more appropriate for following the changes of dental caries progression, oral hygiene habits of children, and looking for predictors of caries\textsuperscript{3,21–24}. This involves clearly understanding the rate of caries progression and the probability of transitional oral hygiene habit changes over time in order to find an appropriate access time for dental caries prevention. Hence, the objectives of the present study were to assess mean number of decayed teeth at the 2.5- and 3.5-year-old period based on 1.5-year-old children’s caries activity and to determine children’s life style factors at the 1.5-year-old period that influence caries activity when they were at the 2.5-, and 3.5-year-old period.

### Materials and Methods

#### Study sample

The population of this study was recruited through an annual report of children who underwent dental examination from 2004 to 2006 at the Municipal Health Center in Katano City, Osaka, Japan: 1.5-year-old period (n = 666), 2.5-year-old period (n = 607), and 3.5-year-old period (n = 592). A total of 283 children were selected based on the following criteria: they had the three oral examinations, had filled the questionnaires by their mother, and had participated in Cariostat microbial sampling at every times examinations. Prior to the oral examination, the mothers of the children took part in lectures and discussions. The lectures were given by a pediatric dentist using documents and visual aids to describe the criteria and illustrate caries progress and tooth brushing methods, as well as interpretation of the Cariostat test results. These oral examinations were held at the Municipal Health Center in Katano City. Next, the every collected data were computerized by the public dental staff and then released unconnected coded data to us.

#### Examination procedure

The children were postured in the ‘knee-to-knee’ position; the child’s legs placed around the parent’s waist, and the child’s head placed in a cradle formed by the dentist’s lap. The examinations were carried out by the same dentist with a dental mirror and explorer under natural light. The caries status of each child was recorded using the criterion of the Ministry of Health, Labour and Welfare, Japan.

After the oral examination, the same dentist also collected plaque samples from maxillary buccocervical surfaces using sterile cotton-tipped applicators. The swabbing was done for a minimum of three strokes before they were put into the Cariostat medium (Sankin, Co., Japan). Dental hygienists then incubated the Cariostat medium at 37°C for 48 hours. The Cariostat scores were assigned by the same dental hygienists based on a reference chart in the Cariostat kit. In the present study, the Cariostat results were grouped according to low risk group (Cariostat score; 0, 0.5, 1.0 and 1.5) and high risk group (Cariostat score; 2.0, 2.5, and 3.0).

#### Questionnaires

To evaluate which factors regarding the children’s life style made them susceptible to caries, original
questionnaires were completed by the mothers of the children at each screening period. After the questionnaire was completed, the data were checked by a hygienist through personal interviews.

Data analysis
The coded data of the subjects were transferred to SPSS 16.0 software for analysis. The chi-square test was used to analyze significant ranking of children’s lifestyles associated with caries risk. Student t-test was used to analyze how children’s lifestyles and caries risk at the 1.5-year-old period would influence children’s average caries at the 2.5- and 3.5-year-old periods.

Results
Oral examination
Out of 666 children, a total of 283 children continually adhered to the selection criteria. A caries ratio was calculated, expressing the proportion of children with caries versus the total sample size. Caries experiences of selected children were 2.1%, 8.1%, and 14.8% in the 1.5-, 2.5- and 3.5-year-old period, respectively.

Table 1 shows the mean numbers of mean decayed teeth of the 1.5-, 2.5-, and 3.5-year-old children based on the 1.5-year-old caries activity test results. There were highly significant differences (P<0.001) for mean numbers of decayed teeth at the 2.5-, and 3.5-year-old period based on 1.5-year-old children’s caries activity. Table 2 shows the significant difference of mean (P<0.01) decay teeth at the 3.5-year-old period was recorded based on caries risk when they were at the 2.5-year-old period. The 1.5-year-old caries activity results predicted 2.5- and 3.5-year-old caries incidence higher than 2.5-year-old caries activity results predicted the 3.5-year-old caries incidence.

Table 2 Children’s mean number of carious teeth at 3.5-year-old based on caries risk at 2.5 years of age

<table>
<thead>
<tr>
<th>Caries risk</th>
<th>3.5-year-old</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk ≤ 1.5</td>
<td>0.63 **</td>
<td></td>
</tr>
<tr>
<td>High risk ≥ 2.0</td>
<td>1.43 **</td>
<td></td>
</tr>
</tbody>
</table>

**: P<0.01

Questionnaires
Table 3 shows the ranking of significant children’s lifestyle associated with caries risk. For the 1.5-year-old period, a number of the mothers of children who practiced pre-chewing was significant with the increase in the mean numbers of decayed teeth of the children (OR = 1.8, CI = 1.1–3.0). The effect of daytime care giving (OR = 0.1, CI = 0.0–0.5) and breastfeeding (OR = 4.7, CI = 0.9–24) were also shown to have a remarkable impact on the occurrence of caries.

Table 4 shows the responses of children’s lifestyle that would put them at risk of developing caries. We observed that pre-chewing at the 1.5-year-old period had a strong influence (significant difference P<0.001) to mean number of decayed teeth when they were at the 2.5- and 3.5-year-old period. Regarding daytime care giver, a significant difference of mean number of carious teeth (P<0.01) was found between children in nursery school and parent/grandparents when children were at the 2.5-year-old period while no significant difference was seen when children were at the 3.5-year-old period. Regarding breastfeeding, significant differences (P<0.05) were found between children who were regularly breastfed and those who were only breast fed when a wake/before sleeping when they were at the 2.5- and 3.5-year-old period.

For the 2.5-year-old period, it was determined
that children who had snacks three times or more per day were more likely to have dental caries than those who snacked two times or less per day (OR = 3.9, CI = 1.6–9.4). Also, for “children not receiving brushing assistance from their mother” (OR = 2.2, CI = 0.8–5.6), and “children snacking at irregular times” (OR = 2.1, CI = 0.9–4.4) were the next most important factors with respect to a child’s risk for caries.

Table 5 presents children’s life style and mean decay when they were at the 3.5-year-old period.
who had three times or more per day. A significant difference of mean number of decayed teeth ($P<0.01$) was found between children who had regular snacking and those who had irregular snacking. Brushing assistance factor had an influence on the children’s mean decay teeth when they were at the 3.5-year-old period. A significant difference ($P<0.05$) was seen between children who received brushing assistance from their mothers everyday and those who received assistance sometimes/never.

**Discussion**

The basic goal in dentistry and medicine is to prevent the initiation of disease as well as its further development ($P<0.05$). Knowledge regarding caries risk factors in children are useful for determining the optimal period for prevention and interceptive treatment ($P<0.05$). This study could show the caries risk children’s life styles, and mean decay teeth based on Cariostat score longitudinally.

The results of the present study are similar to several previous studies that caries experience and caries activity in children tend to increase as their age increases ($P<0.05$). In this study, caries experience at the 3.5-year-old period was lower than those reported in a Japanese prefecture, which varied between 24% and 53% in 2001 ($P<0.05$). In comparison, according the annual report in 2006, caries prevalence in 1.5-, 2.5-, and 3.5-year-old were 3.5%, 9.7% and 27.7%, respectively. The fact that the children routinely underwent dental examination starting at an early age may be an explanation of this finding.

The significant differences between the mean numbers of decayed teeth in low and high risk groups, Cariostat was useful in assessing and predicting caries susceptibility. Therefore, before a carious lesion is actually manifested, caries risk assessment is recommended ($P<0.05$).

For life style at the 1.5-year-old period, a strong difference of the mean number of carious teeth was found between children with and without pre chewing habit. This negative parental behavior plays a role in early vertical transmission by salivary contact ($P<0.05$). The effect of breastfeeding to children’s caries occurrence is still controversial ($P<0.05$). A few specific case studies have linked prolonged ad libitum and nocturnal breastfeeding to early childhood

<table>
<thead>
<tr>
<th>Life style</th>
<th>2.5-year-old</th>
<th>3.5-year-old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast feeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>0.31</td>
<td>0.82</td>
</tr>
<tr>
<td>Wake up/before sleep</td>
<td>0.61</td>
<td>1.55</td>
</tr>
<tr>
<td>Care giver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursery school</td>
<td>0.68</td>
<td>1.1</td>
</tr>
<tr>
<td>Parent/grand parent</td>
<td>0.3</td>
<td>0.89</td>
</tr>
<tr>
<td>Pre chewing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.73</td>
<td>1.63</td>
</tr>
<tr>
<td>No</td>
<td>0.18</td>
<td>0.61</td>
</tr>
</tbody>
</table>

$*: P<0.05$, $**: P<0.01$, $***: P<0.001$, ns = not significant
alone does not cause caries\textsuperscript{30}. However, in the present study, extended breastfeeding had a potential contribution to children’s decay rate. Further, investigation concerning breastfeeding needs to be done in detail.

Care giving factor was also determined have a correlated to the decay rate when parent/grandparents acted as day time caregivers. We assume that probably the parent/grandparents of those children may over indulge their child’s liking for snacks if they feel it makes them happy. To gain control over the children’s behaviors, further investigation to identify how and why sweet snacks are given to children is needed.

For life style at the 2.5-year-old period, children who took more three times foods containing sugar were clearly associated with an increase in caries at the 3.5-year-old period than the children who took less than two times foods. Children with irregular snacking had a significant influence on children’s decay rate. Intake of fermentable carbohydrates, particularly sucrose, is well-known as a caries risk factor. Furthermore, children who brushed their own teeth without help have been shown to be more likely to develop caries than those who sometimes or always had their teeth brushed by their mothers. As young children lack the ability to effectively clean their own teeth, parents are therefore advised to assist their children at least until school age\textsuperscript{4}.

**Conclusion**

Cariostat score at the 1.5-year-old period not only showed the present oral condition but also succeeded in predicting oral condition at the 2.5- and 3.5-year-old. Cariostat score at the 2.5-year-old period also showed the same result.

Children’s life style changes according to their age and can also potentially affect caries risk status.

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**References**


