

# Evaluation of Possible Associated Factors for Early Childhood Caries and Severe Early Childhood Caries: A Multicenter Cross-Sectional Survey

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**Objectives:** The present study evaluated associated factors for developing early childhood caries (ECC) and Severe-ECC (S-ECC) in a group of children aged 24-71 months. Potential positive effects of early dental visit on formation of ECC is investigated as well. **Study Design:** This was a multicenter, cross-sectional study conducted at three governmental and university pediatric dentistry clinics in 408 preschool children who were randomly selected from a total of 4116 children. The questionnaires administered to the mothers by interview and intraoral examination performed by calibrated pediatric dentists. The children were evaluated in three groups according to their caries experience as who had caries free, ECC and S-ECC.

**Results:** The following factors were significantly associated with caries formation: 1. Prolonged (i.e., >18 months) breastfeeding in preterm babies (OR=2.4) 2. Prolonged breastfeeding in children who started tooth brushing after 1.5 years of age (OR=3.7), 3. Sugar ( $p<0.001$ ) and fruit-juice consumption ( $p<0.0001$ ), and 4. Lack of periodic dental examination ( $p<0.05$ ). Parental smoking habit does not significantly affect ECC development. Nocturnal bottle feeding and nocturnal feeding also affected S-ECC formation significantly ( $p=0.043$  and  $p=0.005$ , respectively). **Conclusions:** There is a significant difference between the children with caries and caries-free associated with the brushing initiation age started before or after 18 months. If a child is under the risk of multiple caries factors, it is very difficult to evaluate which habits affect the caries formation or increase the severity of the caries lesions.

## INTRODUCTION

Early childhood caries (ECC) is recognized as a serious public health problem due to its high prevalence, impact on quality of life, potential for increasing risk of caries in the permanent dentition and its role in general health<sup>1-3</sup>. ECC is defined as the presence of one or more decayed (non cavitated or cavitated lesions), extracted, or filled (dmft) primary tooth in a child 71 months of age or younger<sup>4-5</sup>. In children younger than 3 years-old, any sign of smooth surface caries indicates severe early childhood caries (S-ECC)<sup>2</sup>. The 'Significant Caries Index' (SiC Index) is focusing attention on those individuals with the highest caries scores in each population. One third of the population with the highest caries score is selected and the mean DMFT/dmft for this subgroup is calculated. This value constitutes the SiC Index<sup>6</sup>.

Dental caries is a transmissible infectious disease controlled by both cariogenic microorganisms, behavioral, and sociological factors<sup>5</sup>. Microbial risk markers for ECC include early colonization and increased colony forming units (CFU) of *Streptococcus* and *Lactobacillus* species<sup>7</sup>. Other risk factors are the frequent consumption of fermentable carbohydrates, particularly bottle-feeding with sugar-containing liquids, breast-feeding on demand, falling asleep while breast-feeding, and nursing beyond the recommended weaning age<sup>8</sup>. Genetic predisposition, environmental, and

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socioeconomic factors, parental education and awareness, ethnicity, marital status, and family size also affect formation of caries<sup>9-10</sup>. The best practices for preventing ECC include parental education, avoiding MS transmission, and supervised brushing twice-daily with a fluoridated toothpaste designed for children<sup>4,11</sup>. Ideally, ECC prevention should begin during the prenatal and perinatal periods by informing the mother and primary caregiver<sup>12</sup>. Recent evidence highlights that preventive interventions such as dental counseling and initiation oral hygiene habits before 1 year of age are critically important due to the aggressive and virulent nature of ECC<sup>13</sup>.

Based on these observations, the present study aimed to investigate possible associated factors for ECC and S-ECC formation and potential positive effects of early dental visits in a group of children aged 24–71 months. Two null hypotheses were tested: (i) dental visits at a young age helps to prevent development of ECC; and (ii) some associated factors contribute to the increase in the severity of dental caries once the demineralization process is initiated.

## MATERIALS AND METHOD

This multicenter, cross-sectional study was conducted between the years 2010 and 2013 at one government-based clinic and two university-based pediatric dentistry departments. The study population consisted of 408 preschool children which were randomly selected from a total of 4116 children between 24-71 months of age. The sample size calculation was 217 subjects at 5% of type 1 error<sup>14</sup>. 140 children were selected for each center but 12 children refused to open their mouth and they were excluded. The children were divided into 4 groups (24-35 months, 36-47 months, 48-59 months and 60-71 months) according to their age. The study protocol was approved by the Institutional Review Board and informed consent was obtained. A questionnaire was used to assess the child's dietary and oral hygiene habits, ferritin and fluoride intake, socioeconomic status, family educational level, and the age at the first dental visit. The questionnaire was administered to the mothers during dental examination. In each center, one pediatric dentist performed both the intraoral examination and the interview. Calibrations were performed with the examiners and the consistency of their evaluations was confirmed using a Kappa statistic. Kappa for inter and intra-examiner reliability was 0.84 and 0.91 respectively. Intraoral examinations were performed at the dental chair using a dental mirror and probe or in a knee-to-knee approach for the infants. Decayed, missing, and filled primary teeth (dmft) were recorded based on the dental caries diagnostic criteria of the World Health Organization (WHO, 1997) but the authors followed the criteria of Drury et al.<sup>15</sup> for the assessment of non-cavitated lesions. The dmfi index is usually used to assess caries experience in primary dentition based on the WHO criteria that only consider caries present on the dentine level (true cavitation). Secondary caries was considered decayed, and children suffering dental trauma or enamel hypoplasia were excluded. The children were further evaluated in three groups according to their caries experience as who were caries free or had ECC and S-ECC.

Based on the questionnaire, risk factors were grouped into 6 categories:

1. *Parental factors*: Socioeconomic status, education, and smoking status

2. *Dental visit*: Initial complaint, age of first dental visit, dental visit frequency
3. *Oral hygiene practices*: Tooth brushing frequency, degree of supervision, age of brushing initiation
4. *Feeding practices*: Bottle use, breast-feeding on demand, prolonged nocturnal feeding (>18 months), prolonged breast-feeding (>18 months), water consumption following breast- or bottle-feeding, weaning age, snack consumption frequency ( $\leq 1$  snack/day,  $\geq 2$  snacks/day), sugar consumption (low/moderate/high), fruit juice consumption ( $\leq 1$  day,  $\geq 2$  day)
5. *Fluoride and ferritin intake*: Use of fluoride tablets or multivitamins containing fluoride and ferritin syrup.
6. *Birth*: Preterm (before 37 completed weeks of gestation) or term birth.

## Statistical Analysis

The data were collected and analyzed with SPSS 21.0 software (SPSS Inc, Chicago, IL) using t-test, analysis of variance (ANOVA), chi-square at  $p=0.05$ . A logistic regression model was utilized for the multivariable assessment of factors related to ECC. The corresponding odds ratios (OR) and their 95% confidence intervals (95% CI) were determined. Scheffe's test was used to investigate differences between the dmft values, while Tukey's multiple comparison was used to assess the relationship between dmft values and maternal education. Finally, a sensitivity analysis using dental caries at 18 months of age was also utilized as the outcome variable.

## RESULTS

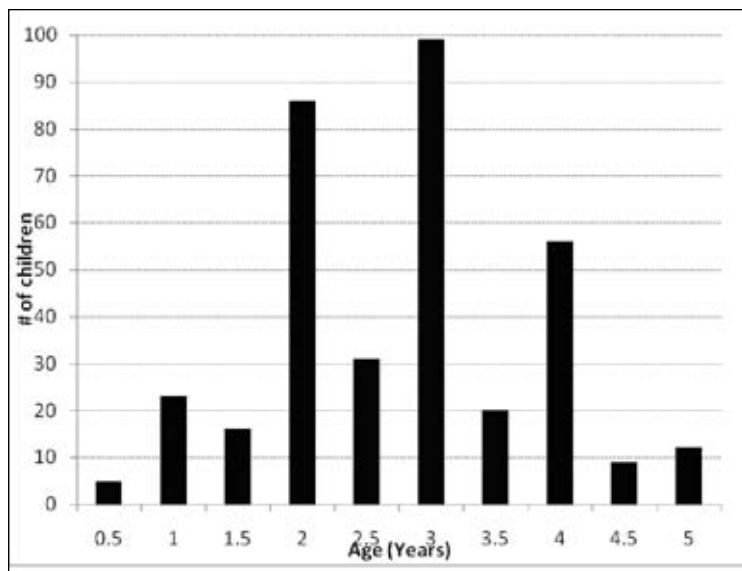
Of the 408 children included, the gender distribution was 192 (47.1%) girls and 216 (52.9%) boys. The mean dmft of the children included was  $8.0 \pm 5.1$  and there was a significant difference between different age groups with respect to mean dmft values (Table 1, Scheffe's test,  $p < 0.05$ ). Only 8.1% ( $n=33$ ) of the children were caries free. From the ECC group ( $n=375$ ), 61% of children ( $n=229$ ) had S-ECC. The SiC index was 14.

Evaluation of parental factors, feeding habits, and oral hygiene practices are presented in Table 1. Analysis of parental factors showed that neither family income, nor parental smoking significantly affected the child's oral health status ( $p > 0.05$ ). A low maternal education, with primary school being the highest educational level, was significantly associated with early childhood caries (Tukey's test,  $p=0.007$ ). As expected, the dmft values significantly decreased with the increase in level of maternal education (Tukey's multiple comparison test,  $p=0.007$ ).

In total, 43.9% of children were examined based on initial complaint of pain, followed by caries (37.3%), and routine control (12%), except for the 24–35 month age group. In this group, 48% of children were examined based on initial observation of caries by the parents.

Analyses of dental visits and oral hygiene practices showed that the age of initiating tooth brushing (Figure 1), was associated with dental caries development. There was a significant difference between the dmft of children who started brushing before and after 18 months of age (t-test,  $p=0.000$ ). As for evaluation of the initial complaint, this was the first dental visit for 252 (61.8%) of 408

Fig 1. Age of the children when toothbrushing was started.



children (mean age 3.9± 0.9 years), and the age of first dental visit was not associated with caries occurrence (p>0.05), while regular examinations significantly reduced the risk of caries formation (p<0.05). In the first time dental visit (n=252) group, with no history of dental examination, 91.3% of these children had dental caries. For the group of children (n=156) who visited a dentist before, 80.8% of them had caries (p<0.05). Children performing unsupervised brushing had a higher risk of developing caries compared to those receiving parental supervision, but this difference was not significant (OR=1.2). Finally, the dmft values of children that brushed their teeth either regularly or irregularly were significantly lower than those who never brushed (independent t-test; p=0.000).

Analysis of preterm birth, fluoride intake and ferritin syrup intake had no significant effect on initiation of ECC and S-ECC. Children who did not use fluoride tablets, had 1.4-fold higher risk (OR=1.413) of developing caries compared to those who used tablets (p=0.438).

Breast-feeding on demand with a high frequency (when it was performed more than 8 times a day) was associated with ECC (R<sup>2</sup>=0.775). Prolonged breast-feeding (>18 months) was correlated with ECC development only in preterm babies (OR=2.4), and this correlation was not observed in term babies but prolonged breast-feeding was also a risk factor for children who started tooth brushing after 1.5 years of age (OR=3.7). Overall, children weaned before 18 months had a 2.6-fold lower risk of developing caries compared to children breast-fed beyond 18 months.

Nocturnal bottle use and feeding during sleep did not significantly affect caries formation (p=0.488 and 0.287, respectively) if these habits were discontinued before 18 months of age. However, caries was significantly higher among children with nocturnal feeding up to 18 months of age and over (p<0.05). In addition, water consumption following bottle-feeding reduced caries formation risk (OR=3.45).

Besides, moderate and high sugar consumption were related to caries formation (ANOVA; p<0.001) (Table 2). The dmft values were significantly higher (Scheffe test; p<0.001) in children who consume moderate to high sugar than low consumers. The snacks

Table 1: Age, gender, parental factors, feeding habits, and oral hygiene practices

	n (%)	p-value
<b>Gender</b>		
Boys	216 (52.9%)	
Girls	192 (47.1%)	
Total	408	
<b>Age</b>		
24-45 m	5.7 ±4.4 <sup>a</sup>	50 (12.2%)
36-47 m	7.6 ±5.5 <sup>a,b</sup>	84 (20.6)
48-59 m	8.5± 5.3 <sup>b,c</sup>	117 (28.7%)
69-71 m	8.5± 4.8 <sup>b,c</sup>	157 (38.5%)
Total	8.0± 5.1	408
<b>dmft</b>		
24-45 m	5.7 ±4.4 <sup>a</sup>	50 (12.2%)
36-47 m	7.6 ±5.5 <sup>a,b</sup>	84 (20.6)
48-59 m	8.5± 5.3 <sup>b,c</sup>	117 (28.7%)
69-71 m	8.5± 4.8 <sup>b,c</sup>	157 (38.5%)
Total	8.0± 5.1	408
<b>Education level of mother</b>		
Primary School	29 (31.6%)*	p=0.007
Middle School	52 (12.8%)	
High School	142 (34.8%)	
University	85 (20.8%)	
<b>Duration of breastfeeding</b>		
<12 months	167 (40.9%)	p=0.011
12-17 months	98 (24.0%)	
>18 months	43 (35.1%)*	
<b>The existence of nighttime bottle feeding</b>		
No:	175 (42.9%)	p=0.048
Yes:	233 (57.1%)	
<b>Snack intake</b>		
≤1 /day	212 (52%)	p<0.05
≥2 /day	196 (48%)*	
<b>Sugar intake (Intake of sugar containing foods or drinks)</b>		
Low (≤1 /day)	148 (36.3%)	p<0.05
Moderate (=2 /day)	109 (26.7%)*	
High (≥3 /day)	151 (37%)*	
<b>Juice consumption</b>		
≤1 /day	289 (70.8%)	p<0.05
≥2 /day	119 (29.2%)*	
<b>Toothbrushing (times per day)</b>		
Once a day	198 (48.5%)	p<0.05
More than once a day	101 (24.8%)	
Not regularly	58 (14.2%)*	
Never brushed before	51 (12.5%)*	
<b>Parental assistance for children who brush their teeth</b>		
Yes	234 (65.5%)	not significant (OR=1.232)
No	123 (34.5%)	

The dmft column values with same letters indicate no significant differences (p>0.05) between groups. Each row indicates significant parameters.

≥ 2/day was also significantly associated with caries formation (p<0.0001). Among the children who had EEC and S-ECC, fruit juice consumption more than once daily affected S-ECC development (independent sample t-test; p <0.0001). Also, in this group nocturnal bottle-feeding (p =0.043) and nocturnal feeding (p =0.005) significantly affected S-ECC formation (Table 2).

**DISCUSSION**

The possible associated factors with ECC were evaluated in this multicentered study with interview and intraoral examination using both WHO criteria and Durry’s criteria. WHO criteria only consider caries present on the dentine level (true cavitation). Actually, this is a known limitation of the index and leads to underestimation of the caries experience. Therefore, both criteria were used to ensure accuracy as much as possible in order to fulfill the objectives of the research<sup>16</sup>.

In children, a tailored preventive strategy can be ideally developed through determination of possible factors associated with ECC. A recent study confirmed that caries occurrence at age 3 is indicative of vulnerability for further caries development<sup>17</sup>. Thus, early initiation of oral hygiene practices is of utmost importance in maintaining a caries-free dentition in both childhood and adulthood. This finding is underlined by the present multicenter, cross-sectional study and may be best implemented with the help of medical providers trained to counsel caregivers and to refer young children to specialists or dental facilities where available<sup>18</sup>. According to the present results, tooth brushing before 18 months had a significant effect on ECC prevention. Also, prolonged breast-feeding may be a risk factor, especially in preterm babies and children commencing oral hygiene practices after 1.5 years of age.

Further, it was observed that children who brushed their teeth either regularly or irregularly are less likely to develop caries compared to those who never brush their teeth. Early dental examinations could provide dentists an opportunity to inform parents about optimum oral health care and encourage parents to seek

regular dental care. Also, delayed first visits were associated with increased risk of dental problems<sup>19</sup>. By contrast, the present results indicated that the age at which the child is referred for the first dental examination did not affect the initiation of ECC. This could be explained by one of the limitations of the present study, which was the mean age of the first dental visit, being 3.9 years. This age makes it difficult to demonstrate the true effect of dental examination on caries prevention based on the present data.

The present study is consistent with others<sup>20-22</sup> that demonstrated a relationship between parental education level and caries formation in children. The data show that *as the maternal education level increased*, the dmft value decreased significantly<sup>20-22</sup>. Higher caries experience was observed in children who had parents with lower levels of education. These parents showed a weaker intention to control their children’s intake of cariogenic snacks compared to more highly educated parents<sup>23</sup>.

In the present study, parental smoking was not significantly correlated with ECC development. A recent systematic review revealed a strong relationship between second hand smoking and ECC, whereas the association was generally weak with regard to caries development in permanent teeth<sup>24</sup>. This finding may signal that in the present study population a single parameter, such as parental smoking, may not be able to impact mean severe ECC dmft values if other key etiologies are also present.

The present results do not establish an association between bottle use and nocturnal bottle-feeding and ECC occurrence before 18 months of age, although an effect was seen on the development of S-ECC. Nocturnal feeding was correlated with the occurrence of ECC. Thus, nocturnal feeding or bottle-feeding itself is not responsible for ECC formation, but may play an important role for S-ECC. These observations suggest that other factors may play a role in ECC susceptibility<sup>25</sup>. Our results also showed that administering a water-filled bottle following nocturnal bottle-feeding had a positive effect on caries prevention. If the child is exposed to different caries risk factors, the clinician may not be able to directly

**Table 2: Associated factors with Caries Free, ECC and S-ECC**

Risk Factors	Caries Free	ECC	S-ECC	p-value
Prolonged breast feeding (for preterm birth)	√	√		p<0.01
Nocturnal bottle feeding if this habit was discontinued before 18 months	x	x		p=0.488
Nocturnal feeding if this habit was discontinued before 18 months	x	x		p=0.287
Nocturnal bottle feeding over 18 months	√	√		p<0.05
Nocturnal feeding over 18 months	√	√		p<0.05
Nocturnal bottle feeding (without time consideration)		√	√	p<0.05
Nocturnal feeding (without time consideration)		√	√	p<0.01
Moderate or high sugar consumption	√	√		p<0.001
Fruit juice cons. more than once daily		√	√	p<0.0001
Snacks ≥2/day	√	√		p<0.0001

√: significant difference  
X: no significant difference

isolate the important causative factors. In this present study, both mean dmft values and SiC Index were very high, so apparently these children were exposed to many carries risk factors. This study could not observe significant differences in carries development between the different feeding habits groups which were indicated by other studies. Schroth *et al*<sup>26</sup> pointed that breastfed children were less likely to have S-ECC. Some studies<sup>27,28</sup> have also reported that breastfeeding is not associated with the risk for caries, while others suggested that breastfeeding was a risk factor for ECC and/or S-ECC<sup>3</sup>. Also, in this study, frequent breast-feeding on demand was correlated with ECC.

Hallett and O'Rourke<sup>20</sup> declared that there was a significant increase in ECC prevalence and severity associated with the habit of giving a bottle to sleep at night. They<sup>20</sup> also notified that children that commenced tooth brushing earlier (age 12 months) had significantly lower ECC experience compared to children that commenced tooth brushing later (age 13 months). The results of the present study confirmed these results that there was a significant difference between ECC and S-ECC groups who were affected from nocturnal bottle feeding. Also, there was a significant difference between the caries free and the ECC group that prolonged breastfeeding (>18 months) for children who started tooth brushing after 1.5 years of age.

Children consuming sweets, juice and fast food daily are more likely to have S-ECC<sup>21</sup>. In this study, moderate to high sugar consumption and snacks ( $\geq 2$ /day) were related to caries formation and fruit juice consumption at a frequency of more-than-once a day was affected S-ECC. Another study confirmed that common, highly cariogenic snack foods like cookies or cakes were consumed more by children with white spot lesions and enamel cavitation<sup>29</sup>.

The present study has a few limitations. First, the primary care givers' and siblings oral health and caries status were not evaluated. Second, in the present study the dietary habits examined which are known as dietary components for their cariogenic effects but other foods should have been investigated for their anticariogenic role, such as milk, cheese, unrefined plant foods and wholegrain foods.<sup>16</sup> Another limitation of this study is the inclusion of patients, most of them attended the clinics because of pain and/or the observation of caries by parents (43.9% and 37.3% respectively, totally 81.2%). This might be the reason why the mean dmft and SiC index were higher than other studies.<sup>3,30</sup> An interesting finding was that, 61.8% of these children did not visit a dentist before and that most of the children (81.2%) had faced some kind of severe sign of ECC such as caries and pain. It is clear that the main challenge to combat childhood caries is to gain the attention of mothers and children before problems arise.<sup>31</sup>

Cross-sectional studies are carried out at one time point, mostly in the form of a survey and with descriptive purposes. These studies are relatively quick and easy to perform with some major shortcomings. It is possible to record exposure to many risk factors and to assess more than one outcome in a cross sectional design. On the other hand, data on each participant are recorded only once, which makes it difficult to judge the temporal association between a risk factor and an outcome. Therefore, not a causation but only an association can be interpreted from a cross sectional study. In addition, associations identified may be difficult to interpret as herein<sup>32</sup>.

## CONCLUSION

As caries is a multifactorial disease, no single effect can be identified in children with ECC. Some risk factors like nocturnal bottle use and feeding may not be related to caries formation directly. However, these habits contribute to the increase in severity of dental caries. Accordingly, all key factors should be examined carefully. With adequate knowledge about the etiology of caries and a proper caries risk evaluation, health care providers can play an important role in caries eradication by guiding both parental and children behavior to provide optimum oral health.

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