

Prolonged pacifier-sucking and use of a nursing bottle at night: possible risk factors for dental caries in children

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At the baseline of this cohort study we determined risk factors for colonization of oral lactobacilli and candida in a group of children ($n = 166$) whose mean age was 2.5 years. The results showed that pacifier-sucking and the use of a nursing bottle at night increase the occurrence of both salivary lactobacilli and candida. In the present study these children were followed for 2 years, and the progression of caries was recorded with particular reference to the etiologic factors measured before. The results of the logistic regression analysis showed prolonged pacifier-sucking (≥ 24 months) to be a significant risk factor for caries development in children, with a rather high relative risk (RR) of 3.5 (95% confidence interval (CI), 1.5–8.2; $P = 0.003$). Prolonged use of a nursing bottle at night (≥ 24 months) was also a risk factor, but less significant than pacifier-sucking (RR, 2.6; CI, 1.1–6.4; $P = 0.03$). On the grounds of this study we conclude that prolonged pacifier-sucking (≥ 2 years) and use of a nursing bottle at night are risk factors for dental caries in children. □ *Caries activity; caries development; feeding habit; sucking habit*

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In spite of a general decline in caries prevalence in preschool children, there are some children with significant caries development during their first years of life (1–3). Identifying these children before the disease is established requires information concerning all of the possible caries-related factors during these years.

Two distinguished longitudinal studies of the prediction and development of caries in preschool children have been carried out in Sweden in the 1990s (4, 5). Grindefjord showed in her study (4) that the most important risk factors for caries development in children from 1 to 3.5 years of age were immigrant background, mother's education, frequent consumption of sugar-containing beverages, occurrence of mutans streptococci, and frequent consumption of candy. Also, Wendt (5) reported that certain risk factors could be detected at an early age. At 1 and 2 years of age, differences already existed concerning dietary habits and oral hygiene between children who had developed caries at 3 years of age and those who had not.

Although the prevalence of the pacifier-sucking habit has been reported to be very high in small children (6), the relation of that common habit to caries development has not interested the researchers of pediatric dentistry. However, there have been suggestions in a few studies (7, 8) that pacifiers may have some effect on caries activity.

In our earlier study we showed that the use of a pacifier and a nursing bottle at night increased the occurrence of salivary caries-associated microorganisms, lactobacilli, and candida (9). We therefore hypothesized that those habits may be risk factors for the development of dental caries in children. To test this hypothesis we followed the original study population for 2 years and recorded the progression

of caries, with particular reference to the etiologic factors measured at the baseline of the study.

Subjects and methods

The present study was part of a large infection survey that investigated the connection of pacifier-sucking to susceptibility to otitis media infections. The size of the study population was determined according to prevalence of otitis media infections. One hundred and eighty-three children aged 1 to 4 years were entered in the baseline study, which was conducted at 11 day-care centers in the city of Oulu, Finland. These day-care centers were chosen on the basis of their willingness to participate in the survey and the number of children attending them. Seventeen of the children were subsequently excluded, either because their families neglected to return the questionnaire or because it proved impossible to obtain a proper saliva sample. The final analysis at the baseline was therefore performed on 166 children (88 boys and 78 girls).

At the baseline of the study in 1992 we determined the occurrence of salivary lactobacilli and candida in those 166 children, whose mean age was 2.5 years (range, 0.7–4.3 years). The saliva samples were collected at day-care centers, and the parents filled in a questionnaire that included questions about possible risk factors influencing the colonization of those caries-related microorganisms (9). After 2 years of follow-up the caries progression was recorded from the children's dental health records in dental health care centers. Information about the cariologic status at the baseline in 1992 and at the

follow-up in 1994 was available for 152 (80 boys and 72 girls) of the original 166 children. The dental health records were incomplete in 11 cases, and the records were totally missing in 3 cases because the families had moved from the area.

Registration of caries development

Twelve dental health care clinics in Oulu were involved in this study. The personnel of the clinics were not aware that the follow-up study was in progress. Dental examinations were carried out annually by the local health center dentists (87% of the examinations) or dental hygienists (13% of the examinations) according to normal routines, and their findings were recorded on standard national oral health patient documents. Roentgenograms were not taken. The criteria used for caries diagnosis were those given by the National Board of Health in Finland (10). According to those instructions caries was recorded as initial when it was restricted to enamel and could probably be stopped with preventive dental care. Manifest caries lesions were defined as those that had extended to dentin and needed restorative dental care. For this survey the progression of both initial and manifest caries during the follow-up time was recorded, and the child was defined as caries-free only when initial lesions were also missing. The mean follow-up time per child was 2.1 years (range, 1.5–2.6 years).

Background information

The information on the possible risk factors was collected from the questionnaires filled in by the parents at the baseline of the study. The questionnaire included questions about pacifier- and thumb-sucking, breast-feeding, and bottle-feeding at night. The questions concerned the duration of those sucking and feeding habits. Because the prevalence of thumb-sucking was so low (9), we excluded it from the follow-up part of the study. The information about those children who were younger than 2 years at the baseline was completed from the dental health records of their status at the age of 2 years, where this information was available.

The mean age of the children at the follow-up examination was 4.7 years (range, 2.7–6.5 years). Of these children 79% had used a pacifier, and 57% had used a nursing bottle at night. At the age of 2 years 56% were still sucking a pacifier, and 20% were using a nursing bottle at night. At the age of 1 year 13% of the children were still breast-fed. The duration of breast-feeding was defined as the time during which the child received any amount of breast milk, regardless of supplementation with formula or other foods.

Because the socioeconomic status of the family has been shown to influence caries risk in preschool children (11, 12), we registered it for the multivariate analysis. The social class of the family was determined by the higher socioeconomic status of the parents. The socioeconomic

status was classified according to the classification of the Central Statistical Office of Finland (1989) on a scale from 1 to 7. Of the parents 25% were upper-level employees, 53% lower-level employees, 17% manual workers, and 3% students. For 2% of the children the socioeconomic status of the parents was unknown.

The Municipal Health Board of Oulu approved the study protocol and granted permission to use the children's dental health records.

Statistical analysis

Direct univariate associations were analyzed by cross-tabulation of the dichotomous variables. Differences were tested using the chi-square test. As the present study was designed as a cohort study defined by exposure, possible risk factors were analyzed by calculating their relative risks (RR) and 95% confidence intervals (CI).

Stepwise logistic multivariate modeling was used to control for confounding variables. The occurrence of caries at the follow-up was used as the dependent variable. The covariates were the positive lactobacilli or candida tests at the baseline, breast-feeding ≥ 12 months, the use of a nursing bottle at night ≥ 24 months, the use of a pacifier ≥ 24 months, mean follow-up time, children's age at the follow-up, and social class of the families. Forward stepwise logistic regression analysis was used in the logistic modeling.

The data for all subjects for whom information was available were used in the univariate analysis, whereas logistic multivariate modeling included only the subjects ($n = 134$) for whom data about all the variables in the model were available. The statistical analyses were performed using SPSSWin, version 7.5.

Results

At the baseline the caries prevalence was 14.5% ($n = 22$). Of the children 11.2% ($n = 17$) had initial caries and 3.3% ($n = 5$) manifest caries. Two years later at the follow-up examination, when the mean age was 4.7 years, 30.3% ($n = 46$) of the children exhibited one or more initial ($n = 22$) or manifest ($n = 24$) carious lesions. All of the children with caries development at the baseline had a progression of initial lesions into manifest caries, and they continued to develop new lesions.

According to the univariate analysis the children with caries at the follow-up were more often colonized with lactobacilli and candida at the baseline than the children without caries (Table 1). Those results were not statistically significant, but when the positive tests at the baseline were combined with prolonged pacifier-sucking, the differences between the caries group and the non-caries group were significant (Table 1).

Caries at the follow-up was significantly associated with the use of a nursing bottle at night ($P = 0.014$) and the use of a pacifier ($P = 0.001$) at the age of 2 years or more. The relative risk for a child to have caries at the follow-up was

Table 1. Comparison between children with and without caries at follow-up in relation to caries-associated variables registered at baseline, with relative risks (RR), 95% confidence intervals (CI), and *P* values

	Caries at follow-up		RR	CI	<i>P</i> value
	Yes, % (<i>n</i> = 46)	No, % (<i>n</i> = 106)			
Positive lactobacilli test	27	15	1.6	0.9–2.7	0.111
Positive candida test	29	19	1.5	0.8–2.5	0.189
Nursing bottle at night ≥ 24 months	33	15	1.9	1.2–3.0	0.014
Pacifier-sucking ≥ 24 months	76	46	2.5	1.4–4.4	0.001
Breast-feeding ≥ 12 months	13	13	1.0	0.5–2.0	0.978
Positive lactobacilli test + pacifier-sucking ≥ 24 months	21	8	2.1	1.2–3.5	0.019
Positive candida test + pacifier-sucking ≥ 24 months	19	8	1.9	1.1–3.3	0.057

almost double if the child had used a nursing bottle at night for more than 2 years (RR, 1.9; CI, 1.2–3.0) and more than double (RR, 2.5; CI, 1.4–4.4) if the child had sucked a pacifier for more than 2 years, compared with children without these habits (Table 1).

The harmful effect of pacifier-sucking on teeth was apparent when the sucking lasted more than 2 years (Fig. 1). Of the children with the prolonged sucking habit, 42.5% exhibited caries at the follow-up, compared with 21.4% of children who had that habit for less than 2 years and 15.6% of children who had never sucked a pacifier. A nursing bottle at night was a risk factor even when used for less than 2 years (Fig. 1).

Breast-feeding was not significantly associated with the caries development, but the results showed that those children who were breast-fed for less than 6 months or longer than 12 months had slightly more caries than others (Fig. 2).

Pacifier-sucking ≥ 24 months was the variable most strongly associated with caries at the follow-up in multivariate logistic regression analysis (RR, 3.5; CI, 1.5–8.2; *P* = 0.003). The use of a nursing bottle at night ≥ 24 months was also a risk factor for caries development, but less significant than pacifier-sucking (RR, 2.6; CI, 1.1–6.4; *P* = 0.03).

Discussion

The prevalence of caries in the present study (30.3%) is about the same as in a previous Finnish study in which 38% of 5-year-old children had caries (13). Recently, the caries prevalence in 3.5-year-old Swedish children has been reported to be 36.7% (14), slightly higher than in our study, in which the mean age was 4.7 years. This could partly be due to the higher proportion of children with an immigrant background in the Swedish study.

The use of a pacifier during infancy is common in Western countries. The study by Larsson et al. (6) showed that about 70% of the Swedish children developed a pacifier-sucking habit. The corresponding figures for 2- and 3-year-olds were about 57% and 46%, respectively. Our prevalence numbers are in accordance with those results; 79% of children had sucked a pacifier and, at the age of 2 years, 56% were still using a pacifier.

We found a borderline association between early colonization of oral lactobacilli and candida and an increased risk of developing dental caries in young children. This finding is in accordance with earlier studies that have demonstrated a relation between caries development and cariogenic microflora (1, 15, 16).

At the baseline of this study we found pacifier-sucking

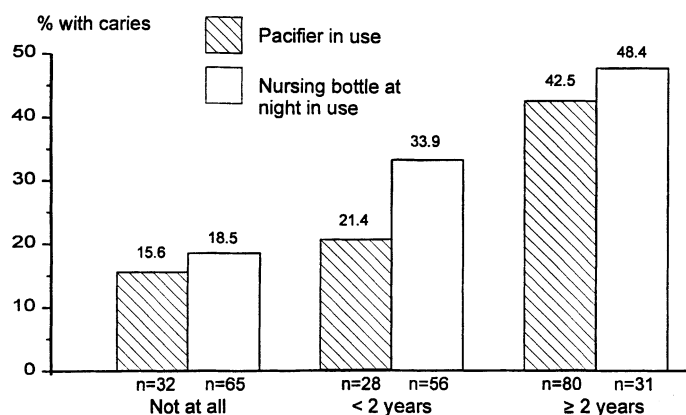


Fig. 1. Proportions of children with caries at follow-up, by duration of pacifier-sucking and use of a nursing bottle at night.

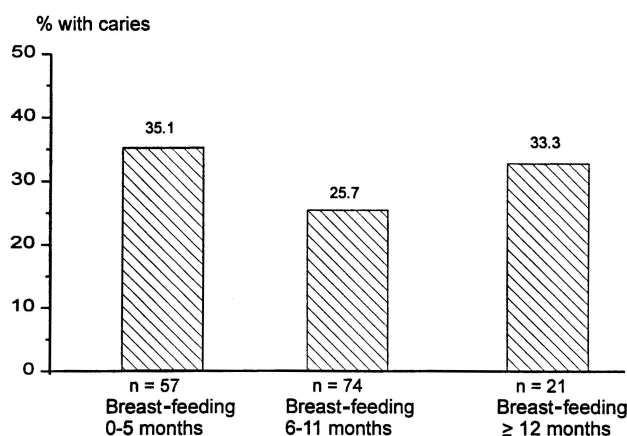


Fig. 2. Proportions of children with caries at follow-up, by duration of breast-feeding.

and the use of a nursing bottle at night to be risk factors for colonization of oral lactobacilli and candida (9). The results of the present follow-up confirm that those variables are also strong risk factors for caries development. The association between the use of a nursing bottle at night and caries in children has been demonstrated in many other studies (17–20), whereas the connection between pacifiers and caries development has been studied less frequently. Some studies have suggested that there may be a relation between pacifier-sucking and caries (7, 8).

We found that the use of a nursing bottle at night for even a relatively short period was able to increase the risk for caries development compared with pacifier-sucking, which took 2 years before this risk was clearly realized. A nursing bottle usually contains fermentable carbohydrates, which means that cariogenic oral microbes can easily and quickly use them. On the basis of our study it seems that pacifier-sucking, however, needs perhaps more time to alter circumstances in the oral cavity into a more caries-active direction. The change in local environmental conditions in the mouth may be one reason for this effect. A pacifier may affect oral sugar clearance in the same manner as removable dentures, which have been shown to contribute to less effective clearance (21). Reduction in clearance would prolong conditions of low pH in plaque and thereby favor the selection of aciduric microorganisms (22). A pacifier may also increase the number of receptor sites available for microbial adhesion. It may directly affect plaque accumulation, increasing it in the same manner as when a partial denture is placed in a patient's mouth (23, 24).

We did not observe an association between prolonged breast-feeding and caries development. Nevertheless, our results showed that, from a cariologic point of view, it may be favorable to breast-feed children for over a half-year but not longer than 12 months. This finding is in accordance with the results of the study by Eronat & Eden (25), who found that most children with rampant caries were breast-fed for less than 6 months or longer than

12 months. The results of other studies concerning the association between breast-feeding habits and caries prevalence are contradictory. Alaluusua et al. (26) and Roberts et al. (27) found no correlation between breast-feeding and caries prevalence. However, in studies by Williams & Hargreaves (28) and Wendt & Birkhed (8), an association between prolonged breast-feeding and caries was demonstrated.

We found a relation between prolonged pacifier-sucking (≥ 2 years) and caries development. If the sucking habit lasted less than 2 years, the effect was not so harmful. The duration of pacifier-sucking has also been demonstrated to increase the risk of recurrence of acute otitis media infections in children aged 2–3 years (29). Furthermore, it is generally known that sucking habits are connected with malocclusions and disturbances in dentofacial development (30, 31). To prevent the harmful effect of pacifier-sucking on occlusal development, it has been suggested that the use of a pacifier should be stopped by the age of 2 years (32). To prevent early caries development, the same recommendation seems to be justified.

At the baseline of this cohort study we found that pacifier-sucking and the use of a nursing bottle at night led to increased caries activity in the early primary dentition, as indicated by increased occurrence of salivary caries-related microorganisms (9). The present follow-up study further showed that this caries activity was realized in terms of initial or manifest carious lesions within 2 years. It is well known that dental caries is a disease with a multifactorial etiology (33). So there may be other risk factors behind the prolonged use of a pacifier and nursing bottle at night that have not been investigated in this study, such as unfavorable dietary habits and inadequate oral hygiene standards (e.g. lack of use of fluorides). Previous studies indicate that dental caries in preschool children is a life-style disease with both behavioral and social determinants (4, 5, 11, 12), so we need more information about those possible caries-promoting behavioral factors, which are perhaps related to prolonged pacifier-sucking and bottle-feeding. Also, the protective and preventive effects of fluorides and good oral hygiene in combination with caries-related risk factors are worthy of consideration, as has recently been reported (5).

Although there is not necessarily a cause-effect relation between these two factors and caries, our findings suggest that prolonged use of a pacifier and a nursing bottle at night are possible risk factors for the development of dental caries in children.

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