Dietary habits related to caries development and immigrant status in infants and toddlers living in Sweden

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Wendt L-K, Birkhed D. Dietary habits related to caries development and immigrant status in infants and toddlers living in Sweden. Acta Odontol Scand 1995;53:339–344. Oslo. ISSN 0001-6357.

The purpose of this study was to describe the dietary habits of infants and toddlers living in Sweden with special reference to caries prevalence at 2 and 3 years of age and to immigrant status. The study was designed as a prospective, longitudinal study starting with 671 children aged 1 year. At 3 years, all children were invited to a further examination. A total of 298 individuals, randomly selected from the original group, were also examined at 2 years. The accompanying parent was interviewed about the child's dietary habits. Children with caries at 2 and 3 years of age and immigrant children had, when they were 1 year old, consumed caries-risk products and been given nocturnal meals and sweetened liquid in a feeding bottle more often than caries-free 2- and 3-year-olds and non-immigrant children. Although a great variation in dietary habits was found in infants and toddlers, the use of sugar-containing products is widespread in Sweden even in early childhood. □ *Breast feeding; feeding bottle; night meals; pre-school children; sucking habit*

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Although dental caries has decreased substantially in Swedish pre-school children during the last few decades (1, 2), many young children still develop caries. Recent epidemiologic studies carried out in Sweden have shown that 28% of the children have developed carious lesions before 3 years of age (3, 4). Children with manifest caries in their primary dentition are those who later will develop further caries in their primary dentition and thus constitute a caries-risk group (5, 6). Furthermore, children with caries in their primary dentition are more likely to have caries in their permanent dentition (7–9). In a study by Greenwell et al. (10), the importance of caries prevention in young children was demonstrated. They found that if caries was not allowed to progress and involve other tooth surfaces in the late primary dentition, it was not likely to do so in the mixed dentition. Thus, it is essential to detect and institute preventive dental care for infants and toddlers with caries at an early stage.

Although the role of diet in dental caries is very complex (11), the Vipeholm study emphasized the importance of intake frequency in the etiology of caries as long ago as in the 1950s (12). However, longitudinal studies of the influence of dietary factors on caries prevalence in children less than 3 years old are scarce. Persson et al. (13) and Grytten et al. (14) found that caries prevalence in 3-year-olds was associated with consumption of caries-risk products at 12 and at 18 months of age. Most studies in these young children have been focused on nursing caries (also called baby bottle tooth decay or nursing bottle caries), defined as dental caries involving the primary maxillary incisors, followed by the maxillary and mandibular first molars with timing before 2 years of age (15). The etiology has been shown to be bottle feeding of a sleeping infant or toddler (15–17). Some studies have shown an association between nursing caries and prolonged or excessive breast-feeding habits (16, 18, 19), whereas other studies could not prove such a relationship (20, 21).

Several studies have demonstrated that immigrant pre-school children in Sweden have significantly poorer dental health than non-immigrants (3, 22–26). Studies focused on dietary habits in immigrant and non-immigrant pre-school children are scarce and the results contradictory. Some studies have demonstrated that immigrant children have a higher sugar consumption than non-immigrant children (25, 27). On the other hand, Neiderud et al. (28) found no differences in dietary habits between Greek immigrant children and Swedish children.

The purpose of the present study was to describe dietary habits in infants and toddlers living in Sweden with special reference to caries prevalence at 2 and 3 years of age and to immigrant status.

Materials and methods

Population

This study is part of a prospective, longitudinal study of oral health in pre-school children, living in the community of Jönköping, Sweden, and followed up from the age of 1 year to the age of 3 years. All children 1 year of age in 1988 living within the area of 4 of the 13 child

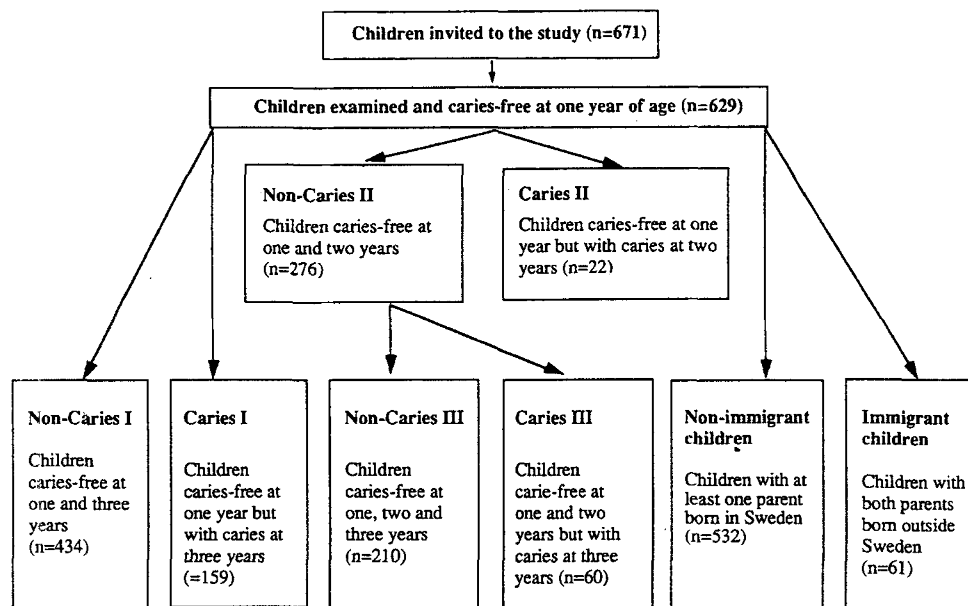

Fig. 1. Number of children, divided into eight subgroups on the basis of age, caries experience, and immigrant status.

welfare centers in the community of Jönköping, Sweden, were invited to take part in the study. The total number of invited children was 671, which is about half of all 1-year-olds in the community of Jönköping (1346). The areas included town, suburb, and countryside and were chosen to reflect the socioeconomic levels of the population living in the community of Jönköping. Nineteen per cent of the children were immigrants. Details of participation, dropouts, and caries incidence at 1, 2, and 3 years of age have been given previously (3, 26).

Of the original group of 671 children, 632 were examined at 1 year of age; there were thus 39 dropouts. Three children had carious lesions. Those 629 children who were caries-free at 1 year of age were invited to be re-examined at 3 years of age, and 593 children were examined. A group of 325 children, caries-free at 1 year of age, was randomly selected from the original group. Of these, 298 were examined again at 2 years of age. Twenty-two children had caries at 2 years of age. The 276 caries-free children were invited to the third examination, and 270 children turned up and were examined at 3 years of age. The children were divided into eight subgroups by age, caries incidence, and immigrant status, as shown in Fig. 1. In accordance with the design of the study children in groups Non-Caries II and III and children in groups Caries II and III also were included in groups Non-Caries I and Caries I, respectively.

Clinical examination and diagnostic criteria

All examinations and interviews were conducted between 1988 and 1990 by one of the authors (L.-K. Wendt). The presence of caries, including initial carious lesions, was clinically diagnosed on all tooth surfaces by visual examination and probing. In the 3-year-olds radiographic examinations were performed when proximal contacts existed that made clinical examination impossible. Details of caries criteria and the clinical examination have been presented elsewhere (3, 26).

Interview

As an integral part of the examination of the 1- and 2-year-olds, the accompanying parents were interviewed by the person who made the clinical investigation. By using a semi-structured form, the parents were asked about the children's dietary habits during the past year—that is, i) breast-feeding habits, ii) bottle-feeding habits, iii) nocturnal meals, iv) regular meals during the daytime, v) eating problems, vi) what kind of food the child preferred to eat, vii) number of daily intakes of caries-risk products, such as a feeding bottle with sugar-containing liquid, soft drinks, fruit soup, sweets, ice cream, or biscuits. The intake frequency of each caries-risk product was assigned points corresponding to its regularity: 7 points indicated once a day, 1 point once a week, and so forth. The sum of the points for each child was then divided by seven to calculate the average number of intakes of caries-risk products per day. Besides this, the parents of the 2-year-olds were asked about the children's habits of sucking on fingers or dummies. The sucking frequency

Table 1. Answers (in percentage) about breast feeding and other dietary habits. For explanation of the groups, see Fig. 1

	Groups							
Habit	Non-Caries I ($n = 434$)	Caries I ($n = 159$)	Non-Caries II ($n = 276$)	Caries II ($n = 22$)	Non-Caries III ($n = 210$)	Caries III ($n = 60$)	Swedes $n = (532)$	Immigrants ($n = 61$)
Breast fed ≤2 months	31	41	32	46	–	–	31	51
	└─ * ─┘						└─ ** ─┘	
Still breast-fed	5	12	4	14	0	2	6	12
	└─ ** ─┘							
Sugar-containing liquid in feeding bottle	13	22	16	50	6	12	14	31
	└─ ** ─┘		└─ *** ─┘				└─ *** ─┘	
Falling asleep in connection with the last formula meal	52	57	54	50	27	35	52	67
							└─ * ─┘	
Formula during night	14	18	17	14	10	17	13	26
							└─ ** ─┘	
Regular meals ≥5 a day	35	48	40	59	34	50	35	75
	└─ ** ─┘				└─ * ─┘		└─ *** ─┘	
Regular meals ≥6 a day	5	13	5	23	4	8	5	28
	└─ *** ─┘		└─ * ─┘				└─ *** ─┘	
Refusing to drink milk or formula	4	10	4	36	1	2	4	13
	└─ ** ─┘		└─ *** ─┘				└─ ** ─┘	
Refusing to eat	3	7	3	5	5	3	3	8
	└─ * ─┘							

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

was scored in one of four classes: 1) only nighttime, 2) sporadic, 3) often in the daytime, and 4) almost always.

There were no dropouts at the interview of the 1-year-olds. When the parents of the 2-year-olds were interviewed, two did not answer the questions on regular meals, nocturnal meals, eating problems, and sucking habits, whereas four parents did not answer the questions on caries-risk products.

Statistical analysis

The chi-square test and Fisher's exact test were used to assess significance between subgroups. Fisher's exact test was used when the number of children in a group was five or less. The level of statistical significance was set to $p < 0.05$.

Results

Data on the number of children with caries and the answers given during the interviews are presented in Tables 1 and 2. For identification of the different groups, see Fig. 1.

Breast-feeding habits

A total of 196 children (33%) had either never been breast-fed or had been breast-fed for 2 months or less. At 1 year of age, 7% of the children were still breast-fed (Table 1). Of the children still breast-fed at 1 year, 49% had developed carious lesions at 3 years of age.

Sucking habits

At 2 years of age 79% of the children were sucking on a dummy or finger. Sixty-five per cent were dummy-suckers and 14% finger-suckers. Of the children with sucking habits at 2 years of age and with caries at 3 years of age 46% had been sucking 'often/almost always', compared with 27% of the children with sucking habits at 2 years of age but without caries at 3 years of age ($p < 0.02$).

At 1 and 2 years of age 86% and 56% of the children, respectively, used a feeding bottle. There was no significant difference between the groups. With regard to use of sugar-containing liquid in the feeding bottle, there was a significant difference between the groups Non-caries I versus Caries I and Non-Caries II versus Caries II (Table 1).

Formula was given more than twice a day at 1 year of age to 2% of the children in the Non-caries I group, compared with 12% in the Caries I group ($p < 0.001$) and 21% in the Non-caries II group, compared with 41% in the Caries II group ($p < 0.04$).

Sleeping habits

Of the children caries-free at 1 year, seven were given sugar-containing liquid during the night. Five of these children had developed caries at 3 years of age. There

Table 2. Answers (in percentage) about consumption of caries-risk products. For explanation of the groups, see Fig. 1

	Groups							
Caries-risk product	Non-Caries I ($n = 434$)	Caries I ($n = 159$)	Non-Caries II ($n = 276$)	Caries II ($n = 22$)	Non-Caries III ($n = 210$)	Caries III ($n = 60$)	Swedes $n = (532)$	Immigrants ($n = 61$)
Soft drink	26	43	27	54	27	35	29	49
≥ once a week	*** (Non-Caries I vs Caries I)		** (Non-Caries II vs Caries II)				** (Swedes vs Immigrants)	
Fruit soup	19	28	22	27	54	70	22	20
≥ once a week	*				*			
Sweets	27	43	29	59	76	92	30	44
≥ once a week	***		**		**		*	
Ice cream	57	73	59	82	84	82	59	75
≥ once a week	***		*				*	
Biscuits	54	64	57	68	57	62	55	75
> once a week	*						**	
Total intake of caries-risk products > once a day	43	64	46	82	87	95	45	75
	***		**				***	
Sugar-containing liquid when thirsty	13	26	16	46	18	35	15	38
	***		**		**		***	
Sweet-tasting food preferred	33	47	35	77	55	68	34	56
	**		***				***	

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

were no significant differences between the groups on the basis of whether formula was given during the night or not or whether the child fell asleep in connection with the last formula meal or not (Table 1).

Consumption of caries-risk products

With regard to the intake frequency of caries-risk products (soft drinks, fruit soup, sweets, ice cream, or biscuits) there were significant differences for all products between the groups Non-caries I and Caries I and for almost all investigated variables between the groups Non-caries II and Caries II (Table 2).

Compared with children in the Non-caries III group, more children in the Caries III group consumed soft drinks more than once a day (12% and 23%, respectively; $p < 0.04$) and had a total intake of caries-risk products exceeding four times a day (17% and 33%, respectively; $p < 0.02$).

The change in consumption pattern of caries-risk products during infancy is illustrated by the fact that sweets were consumed at least once a week by 31% of the 1-year-olds and by 80% of the 2-year-olds. At 1 year of age 49% of the children had a total intake of caries-risk products exceeding once a day, compared with 89% of the 2-year-olds.

Meal patterns

Children in the Caries I and Caries II groups refused to drink formula or milk at 1 year of age more often than children in the Non-caries I and Non-caries II groups (Table 1).

Dietary habits in relation to immigrant status

For all investigated dietary habits at 1 year of age, except consumption of fruit soup, prolonged breast feeding habits, and eating problems, there were significant differences between the immigrants and the non-immigrants (Tables 1 and 2).

Discussion

This study has clearly shown that differences in dietary habits at the age of 1 year existed between children who had developed carious lesions at the age of 3 years and children who had not. This is in agreement with the findings of both Persson et al. (13), who found that 3-year-olds with caries had consumed cakes, soft drinks, and sweets more frequently at the age of 1 year than 3-year-olds without caries, and Grytten et al. (14), who showed that the frequency of sugar consumption at 18 months was significantly related to caries experience at 36 months. Although the present study has shown a wide variation in dietary habits in infants and toddlers, the use of sugar-containing products is widespread even in early childhood. Snacks, such as biscuits and ice cream, have often been introduced to the children before 1 year of age.

The frequency of use of a baby feeding bottle shown in this study is of the same magnitude as in the study by O'Sullivan & Tinanoff (29). Neither this habit nor the habit of giving the child a bottle containing formula at bedtime or during the night seems to influence the caries prevalence in 3-year-olds. These findings are in

agreement with other studies (30, 31). However, formula more than twice a day at 1 year of age was given more frequently to children with carious lesions at 2 or 3 years of age than to children without carious lesions at that age. The fact that nocturnal meals with formula at 1 year of age had no impact on caries prevalence in 2- or 3-year-olds may indicate that in children who were given formula more than twice a day at 1 year of age other caries-promoting habits could exist.

In the present study significantly more children with than without caries at the age of 3 had been breast-fed either for a period 2 months or less or for a period longer than 12 months. The fact that both long and short breast-feeding periods were associated with caries development could be one explanation of the different results found in earlier investigations (16, 18, 21). These findings support the theory that it is not the breast feeding per se that causes dental caries but that the breast-feeding habit may have an association both with the child's dietary habits and with the rearing practice of the family (19, 32).

As in other studies (16, 25, 27), the immigrant children in the present study generally consumed more caries-risk products than non-immigrants. The frequent consumption of caries-risk products among immigrant pre-school children may contribute to the high caries prevalence of this population. It is therefore important to adapt early dental health information (given, for example, at child welfare centers) to the needs of immigrants in Swedish society.

In studies on the prediction of dental caries in pre-school children, intake frequency, amount of sugar, misuse of sugar, or daily intake of caries-risk products has been used as a dietary habit index (4, 33, 34). In the present investigation almost all dietary variables at 1 year of age differed significantly between children who had developed carious lesions at the age of 3 years and children who had not. This reflects the complexity of the diet with regard to dental caries and the difficulties in expressing dietary habits as a simple index. Further studies on dietary habits and caries prevalence in pre-school children and on the interactive effect of confounding factors (such as oral hygiene and use of fluorides) are therefore of great importance.

It has been shown that the intake frequency of sugar-containing products increases from the age of 10 months to the age of 2 years (35). This may explain why in this study dietary habits at 1 year of age had a greater impact on caries prevalence in 3-year-olds than that the impact of dietary habits at 2 years on caries prevalence in 3-year-olds. The fact that different ages may have different consumption patterns must be taken into consideration when parents of pre-school children are interviewed about the child's dietary habits.

In conclusion, to identify children with caries-risk screening at 1 year of age seems as accurate as screening performed later. Early establishment of suitable dietary habits appears to be essential to achieve good oral health in infants and toddlers.

Acknowledgements.—This study was supported by grants from the Jönköping County Council Research Committee, the Swedish Patent Revenue Fund for Dental Prophylaxis, and the Swedish Dental Society.

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Received for publication 15 December 1994
Accepted 6 February 1995