

# **Paper 3**

# Caries in primary teeth at 5 and 10 years of age: a longitudinal study

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**Abstract. Aim** This was to explore the caries development in the primary dentition in children aged 5 and later when they were 10, with an emphasis on the caries increment according to type of teeth and surfaces. **Methods** The study was a prospective, longitudinal survey where the children were examined in 1993 when they were 5 years of age (n=217) and re-examined in 1998 when they were 10 (n=186). Caries was examined clinically and with radiographs by calibrated dentists based on a caries diagnostic grading system from 0 to 5. Primary incisors were excluded from the registrations at 10 years of age, while teeth exfoliating during the period were included, based on notes from the dental records. **Results** Intra- and inter-examiner reliability ranged from kappa 0.62 to 0.90. Dmfs at 5 years was 5.4 (incisors included) and 7.4 at 10 years (incisors excluded, other exfoliated teeth included). The mean caries increment during the age period showed no significant difference between children with and without caries at 5 years of age. Molar-approximal lesions dominated the increment, and when such lesions were diagnosed at 5 years of age, there was an increased risk for more severe caries (denture lesions) during the period. **Conclusion** The caries increment in the primary dentition is considerable for the majority of children during the age period 5-10 years. Even if a risk assessment based on the prevalence of approximal caries at 5 years of age may be useful for deciding individual recall intervals, the results of this study seem to suggest frequent check-ups are needed for the whole population.

**KEYWORDS:** Child, Dental caries, Risk.

## Introduction

Even if the age period from 5 to 10 years is a period of both shedding of primary teeth and eruption of permanent teeth, the primary dentition is still important for normal function of the dentition as a whole. For nutritional reasons masticatory function is of equal importance to other periods as is the importance of a good dental occlusion. The probability of normal development of the dental arch is enhanced when extractions are avoided before the age of 7-8 years [Ronnerman and Thilander, 1977]. This period is also susceptible to influences of psychological nature as the likelihood of initiating dental fear and odontophobia after experiencing pain and discomfort during restorative treatment is considerable [Skaret et al., 1998; Raadal et al., 2002].

The health of the primary and permanent dentitions is strongly correlated. Infections from primary teeth to the jaws during the period may harm the germs of

permanent teeth, and studies have shown that caries in the primary dentition favours the initiation and progression of caries in the permanent teeth [Holt, 1995; Mejåre and Stenlund, 2000]. The start of the age period 5-10 years coincides with the eruption of the first permanent molar, the most caries-susceptible tooth in the young permanent dentition [Mejåre et al., 1998; Whittle and Whittle, 1998]. As its extensive fissure system facilitates caries related bacterial colonization [Carvalho et al., 1989], the primary teeth morphology may enhance the susceptibility to caries. During this period the dentition is characterized by synchronously shedding and eruption of teeth, which presents difficulties in tooth cleaning and may lead to increased plaque accumulation.

Despite the reasons mentioned here, there is today a tendency to neglect the health of the primary dentition during this period. Pointing to the transient nature of the primary teeth, their care is frequently not seen as a priority [Pitts et al., 2003], and some authors [Tickle et al., 2002; Milsom et al., 2002] have also questioned the need for restoring primary teeth when decayed.

In Norway, where all children have free dental care in the Public Dental Service from birth to 18 years of age,

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there are tendencies that, because of a lack of resources, lead to less treatment of primary teeth during this age period. This approach has resulted in some negative remarks from the Ministry of Health.

Most studies on caries in the primary dentition during the period from 5 to 10 years of age are cross-sectional. The few longitudinal studies are either without the use of radiographs or are lacking details concerning the severity and location of the lesions [Greenwell et al., 1990; Holt, 1995; Mattila et al., 2001; Li and Wang, 2002].

Recording of initial caries is essential if the treatment concept aims at intervention before the lesions reach cavitation (interceptive caries treatment), which should be the major principle for caries therapy in future paediatric dentistry [Raadal, 2002]. Initial lesions on the approximal surfaces of the primary molars among 5-year-olds are rather frequent [Amarante et al., 1998; Raadal et al., 2000], and their progression is more rapid than in the permanent dentition [Peyron et al., 1992; Mejåre et al., 2001]. This calls for the use of radiographs in order to apply this treatment concept.

The overall aim of this study was to gain more knowledge as a basis for planning of caries prevention and treatment during the age period from 5 to 10 years. More specifically, the aim was to explore the caries development in the primary dentition with emphasis on severity grading of the caries increment on the different teeth and surfaces. We hypothesized that the majority of children who were caries-free at 5 years of age would remain so during the period or, at least, they would develop only few dentine lesions indicating a need of restorative treatment. We also expected that among children with caries at 5 years, the majority of enamel lesions on approximal surfaces in the primary molars would progress into manifest dentine lesions and need restorative care.

## Material and methods

**Study design.** This was a prospective, longitudinal study based upon two caries examinations of a group of children, first when they were 5 years old in 1993, and secondly in 1998 as 10-year-olds. The parents answered questionnaires at baseline and follow-up. Written informed consent from the parents was obtained, and the study was approved by the Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate. Data from the baseline examination of the 5-year-olds have been published previously [Amarante et al., 1998; Raadal et al., 2000].

**Subjects.** The original sample represented one cohort, born in 1988, in three dental clinics of the Public

Dental Service in the city of Bergen, Norway. The clinics represented areas of different socioeconomic backgrounds, but with a higher educational level of the parents than the average of the country [Amarante et al., 1998]. From the baseline sample of 217 5-year-old children, 186 showed up for the dental examination when they were 10 years old. All parents of these children finished the questionnaire at home before the dental examination. The reasons for drop-out (14.3%) were various: moving, unwillingness to participate or the fact that they just did not show up. Several attempts to recall this group were made. Details of the sample are given in Table 1.

**Examinations.** Five calibrated dentists examined the children in 1993, while another dentist carried out the re-examination five years later. Prior to the study all examiners attended a calibration program with radiographic and clinical trainings sessions. Each examiner checked a group of 20 patients, randomly selected, and intra- and inter-examiner reproducibility were measured by repeating the clinical examination.

**Caries examinations.** After polishing the teeth, they were dried and examined by use of probes and plain mirrors under favourable light conditions. Bitewings were taken at both sessions, whenever the approximal surface could not be inspected clinically. The same diagnostic system, using five caries grades (from 1 to 5) [Espelid et al., 1990; Tveit et al., 1990] was used both at baseline and follow-up. Grades 1 and 2 were enamel lesions, grades 3, 4 and 5 were dentine lesions. Teeth extracted or restored due to trauma were not counted in the dmf index. The primary incisors were not included in the data as most of them exfoliated during the age period. The caries status of other primary teeth that exfoliated before 10 years of age, was recorded based on notes in the dental records. A total of 341 canines and 347 molars exfoliated during the follow-up period, which was 30.8% of the total number of these teeth present at the age of 5 years. Missing teeth or teeth indicated for extractions were counted as two affected surfaces in the dmfs index.

	Sex		Total
	Boys	Girls	
Baseline (5 year-olds in 1993)	108	109	217
Follow-up (10 year-olds in 1998)	90	96	186
Drop-outs	18	13	31

TABLE 1 - Sample sizes at baseline and follow-up for a longitudinal study on caries in a Norwegian child population.

**Risk group.** A risk group of children was defined as those with the most severe caries increment during the follow-up period, and the criteria were as follows: 1) the total dmfs increment was more than one SD above the mean for the whole group, or 2) one or more teeth had been extracted due to caries, or 3) the increment of dentine lesions and fillings on the approximal surfaces of the molars was more than one SD above the mean for the whole group. In order to evaluate possible factors at 5 years of age, hypothesized as predictive for assignment to the risk group, the following variables were defined:

- 'Total dmfs more than one SD above the mean';
- 'At least one caries lesion on the approximal surfaces of the molars';
- 'Dmfs on anterior teeth (incisors and canines) more than one SD above the mean'.

**Data handling and analyses.** The data were analysed in the Statistical Package for the Social Sciences (SPSS), version 11. Differences in means between groups were tested by the use of independent-samples t test. A simple logistic regression analysis was first used to explore the bivariate relationship to the dependent variable 'risk group' (severe caries increment from 5 to 10 years of age) and the possible predictive variables at 5 years of age as independent variables. These were dichotomised into 0-1 variables, where score 1 indicates a hypothesised positive relationship to the dependent variable. Stepwise logistic regression was then assessed using only independent variables with a significant relationship to the dependent variable in the bivariate analysis, to evaluate the individual predictive values of the 5-year-old variables.

## Results

**Examiner agreement.** The intra- and inter-examiner reliability of the caries examination at baseline varied between kappa 0.71 to 0.90 [Amarante et al., 1998]. At the follow-up examination, with only one examiner, the test-retest kappa value was 0.62.

**Caries prevalence.** The caries prevalence at 5 years of age in children who dropped out from the follow-up examination was  $d_{1-5}mfs = 5.29$  ( $SD \pm 5.15$ ), which was not significantly different from the study group ( $d_{1-5}mfs = 5.40$ ,  $SD \pm 7.61$ ) ( $t = -0.076$ ,  $p = 0.940$ ). As previously reported [Amarante et al., 1998], there were no sex differences in caries prevalence at the age of 5 years. When the caries status of the exfoliated teeth (30.8%, incisors excluded) was added to the caries experience of the remaining teeth at 10 years of age, the mean  $d_{1-5}mfs$  for the whole group was 7.42 ( $SD \pm 7.12$ ), and there was still no significant difference between boys ( $d_{1-5}mfs = 7.73$ ,  $SD \pm 7.35$ ) and girls ( $d_{1-5}mfs = 7.13$ ,  $SD \pm 6.93$ ) ( $t = 0.581$ ,  $p = 0.562$ ).

At 5 years of age 30.6% of the children were caries-free when the incisors were included. This portion was reduced to 15.1% at 10 years of age when incisors were excluded and the other exfoliated teeth were included. Additionally, 8 children (4.3%), who had been recorded with caries at the age of 5, were registered as caries-free at the age of 10, so that the total portion of caries-free children, exfoliated teeth included, at the age of 10 years was 19.4%.

Table 2 shows the mean  $d_{1-5}mfs$  values at both ages for the whole study group, as well as the different portions of the  $d_{1-5}mfs$  index. While the d-portion comprised the majority of the  $d_{1-5}mfs$  index at 5 years,

	5 years (incisors included)	5 years (incisors excluded)	10 years (incisors excluded, exfoliated teeth included)
	Mean (SD)	Mean (SD)	Mean (SD)
$d_{1-2}S$	2.60 (3.34)	2.27 (2.73)	1.59 (1.99)
$d_{3-5}S$	1.92 (4.77)	1.39 (3.07)	1.15 (1.74)
$d_{1-5}S$	4.52 (6.51)	4.52 (6.51)	2.74 (2.93)
ms	0.18 (0.83)	0.14 (0.63)	0.56 (1.51)
fs	0.69 (1.76)	0.58 (1.63)	4.12 (5.38)
$d_{3-5}mfs$	2.80 (5.90)	2.10 (4.12)	5.83 (6.73)
$d_{1-5}mfs$	5.40 (7.61)	4.37 (5.41)	7.42 (7.12)

**TABLE 2** - Caries prevalence ( $d_{1-5}mfs$  and its portions) at 5 and 10 years of age for the whole group. Caries status at 10 years includes both present and exfoliated canines and molars.  $d_{1-2}$  denotes enamel lesions,  $d_{3-5}$  dentine lesions and  $d_{1-5}$  all lesions.

the f-portion was the largest at 10. The number of enamel lesions was larger than dentine lesions at both ages. In Figure 1 the children have been grouped according to their caries status at 5 and 10 years of age, where the status of exfoliated teeth is added. Among those who were caries-free at 5 years, about half remained caries-free throughout the age period, while the majority of those with caries at 5 years increased their  $d_{1-5}mfs$ .

*Caries increment from 5 to 10 years of age.* The caries increment during the follow-up period was calculated by subtracting the  $d_{1-5}mfs$  value at 5 years from that of the 10 year-olds after having included exfoliated canines and molars and excluded the incisors. The mean increment for the whole group was  $d_{1-5}mfs = 3.05$  ( $SD \pm 4.52$ ), including teeth that had been extracted due to caries. Twenty-four children (13.1% of the total sample) had one or more teeth extracted (2 canines, 28 first molars, 9 second molars) during the period. The caries increment scores among boys was  $d_{1-5}mfs = 3.22$  ( $SD \pm 3.94$ ) and girls  $d_{1-5}mfs = 2.89$  ( $SD \pm 5.02$ ), which were not significantly different ( $t = 0.507$ ,  $p = 0.613$ ). In Table 3 the  $d_{1-5}mfs$  increment, excluding extracted teeth, is distributed on the different teeth and surfaces. More than half of these lesions occurred on the approximal surfaces of the second molars, while about one third was on the approximal surfaces of the first molars. Approximal lesions on the distal surfaces of the second molars contributed to about 48.1% of the total increment of approximal molars. Approximately in molars, the number of initial lesions ( $d_{1-2}$ ) was slightly higher than that of manifest lesions ( $d_{3-5}$ ), while 28.1% of these distal lesions were filled.

*Children caries-free at 5 years.* At 5 years of age 31% (57/186) of the children were caries-free, and 49% of them (28/57) remained so during the period. The mean  $d_{1-5}mfs$  at 10 years of age for the whole group ( $n=57$ ) was 2.67 ( $SD \pm 4.36$ ) (exfoliated teeth included), and there were no sex differences. The mean  $d_{1-5}mfs$  of those who developed caries ( $n=29$ ) was 5.24 ( $SD \pm 4.91$ ), varying between 1 and 19. Nine children (31.0%) showed only enamel lesions, while the rest (69.0%,  $n=20$ ) had at least one dentine lesion or filled surface. None of them had any teeth extracted or indicated for extraction. The teeth and surfaces most frequently affected in this group are shown in Table 4. About two thirds of the caries were confined to the approximal surfaces of the molars, evenly distributed among the first and second molars. The distal surfaces of the second molars contributed to about 35.7% of the total approximal caries, of which initial lesions comprised 62.8%.

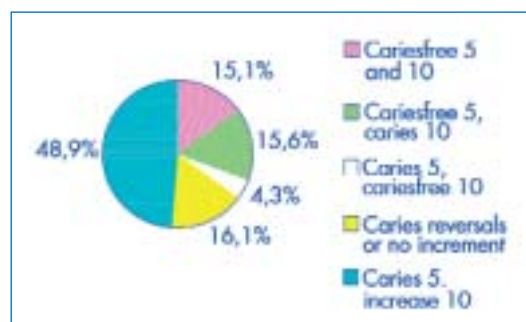


FIG. 1 - Pie chart showing grouping of a Norwegian child population based on their caries experience at 5 and 10 years of age according to their  $d_{1-5}mfs$ .

Teeth	Surfaces	$d_{1-2}s$ (n)	$d_{3-5}s$ (n)	fs (n)	$d_{1-5}fs$ (n)	Percent (%)
Canines	Approximal	1	4	23	28	5.8
	Buccal/lingual	-18	-5	5	-18	-3.7
First molars	Occlusal	-25	-11	109	73	15.0
	Approximal	11	-37	187	161	33.1
	Buccal/lingual	-13	-8	11	-10	-2.1
Second molars	Occlusal	-77	-31	130	22	4.5
	Approximal	51	55	155	261	53.7
	Buccal/lingual	-52	-10	31	-31	-6.4
Net sum		-122	-43	651	486	100

Note: Extracted teeth are not included. Negative numbers indicate either caries progression to more severe stages or reversals or inter-observer variation.

TABLE 3 - Distribution of the  $d_{1-5}mfs$ -increment during the age period from 5 to 10 years for the whole sample.

*Children with caries at 5 years.* The mean caries increment during the period among children with caries at 5 years was  $d_{1-5}mfs = 3.22$  ( $SD \pm 4.59$ ), which was slightly higher than in the caries-free group, but the difference was not statistically significant ( $t = 0.765$ ,  $p = 0.445$ ). Thirty-eight children (29.5%) had no or negative caries increment during the age period, while the increase was from 1 to 5  $d_{1-5}mfs$  in 57 (44.2%) children, 6 to 10  $d_{1-5}mfs$  in 22 (17.1%) children, and more than 10  $d_{1-5}mfs$  in 12 (9.3%) children. In Table 5 the caries increment on different teeth and surfaces is displayed. The approximal surfaces of the second molars were most frequently affected, as almost two thirds of the increment was here. The majority of these were either dentine lesions or fillings. Distal surfaces of the second molars contributed to about 51.9% of the total

approximal lesions in this group, and dentine/filled lesions predominated (67.9%).

*Risk group.* Based on the criteria for inclusion in the risk group, a total of 58 (31.2%) children were included. The bivariate relationships between assignment to the risk group and the independent variables measured at the age of 5 years are shown in Table 6. All three independent variables were positively related to inclusion in the risk group, with the ‘Total  $d_{1-5}mfs$  more than one SD above the mean’ as the highest ranked according to odds ratio. In the final stepwise regression for group assignment, the independent variable ‘Dmfs on anterior teeth (incisors and canines) more than one SD above the mean’ (Table 7) did not enter the model. The independent variable ‘At least one caries lesion on the approximal surfaces of the molars’ was the most predictive.

Teeth	Surfaces	$d_{1-2}s$ (n)	$d_{3-5}s$ (n)	fs (n)	$d_{1-5}fs$ (n)	Percent (%)
Canines	Approximal	3	5	1	9	5.9
	Buccal/lingual	0	0	1	1	0.7
First molars	Occlusal	2	1	17	20	13.2
	Approximal	12	11	23	46	30.3
	Buccal/lingual	0	0	0	0	
Second molars	Occlusal	9	1	12	22	14.5
	Approximal	28	11	13	52	34.2
	Buccal/lingual	2	0	0	2	1.3
Total		56	29	67	152	100

**TABLE 4** - Distribution of the  $d_{1-5}mfs$ -increment during the age period from 5 to 10 years among children who were caries-free at 5 years of age.

Teeth	Surfaces	$d_{1-2}s$ (n)	$d_{3-5}s$ (n)	fs (n)	$d_{1-5}fs$ (n)	Percent (%)
Canines	Approximal	- 2	-1	26	23	6.9
	Buccal/lingual	-18	-5		-23	-6.9
First molars	Occlusal	-27	-12	92	53	16.0
	Approximal	-1	-48	164	115	34.6
	Buccal/lingual	-13	-8	11	-10	-3.0
Second molars	Occlusal	-86	-32	116	-2	-0.6
	Approximal	23	44	142	209	63.0
	Buccal/lingual	-54	-10	31	-33	-9.9
Net sum		-178	-72	582	332	100

Note: Extracted teeth are not included. Negative numbers indicate either caries progression to more severe stages or reversals or inter-observer variation.

**TABLE 5** - Distribution of the  $dmfs$  increment during the age period from 5 to 10 years among children with caries at 5 years of age.



Variables at 5 years of age	n	% in target group	Odds Ratio	95% CI	p
Total d <sub>1-5</sub> mfs > one SD above mean	Yes 20 No 166	75.0 25.9	8.6	2.9-25.0	<0.001
d <sub>1-5</sub> fs > 0 approximally on molars	Yes 81 No 105	51.9 15.2	6.0	3.0-11.9	<0.001
d <sub>1-5</sub> fs > one SD above mean on anterior teeth (incisors and canines)	Yes 15 No 171	60.0 28.7	3.7	1.3-11.1	0.017

Yes = score 1; No = score 0

**TABLE 6** - Bivariate relationship between the dependent variable 'risk group' (severe caries increment from 5 to 10 years of age) and independent variables at the age of 5 years.

Variables at 5 years of age	Coefficient	Odds Ratio	95% CI	P<
d <sub>1-5</sub> mfs > 0 approximally on molars	1.485	4.4	2.1-9.2	0.001
Total d <sub>1-5</sub> mfs > one SD above mean	1.329	3.8	1.2-11.7	0.021

Yes = score 1; No = score 0

**TABLE 7** - Multiple logistic regression model for assignment to 'risk group' (severe caries increment from 5 to 10 years of age).

## Discussion

As previously reported, the average educational level of the parents in this sample was higher than in the general adult population in Norway. As it is well established that caries is less prevalent in children of parents with high educational level [Verrips et al., 1993; Li and Wang, 2002], the prevalence of caries in the group studied here is probably lower than in the corresponding Norwegian child population. The fact that the baseline prevalence of caries in the drop-out group was not statistically different from the follow-up group suggests that the drop-out problem has not affected the results.

The inter- and intra-reliabilities of the caries diagnosis here found were remarkably high, particularly at baseline. This was based on the fact that a graded diagnostic system from 1 to 5 was used.

In the present study 30.8% of the canines and molars had been exfoliated during the follow-up period. Some uncertainties are related to registrations on these teeth because they were based on dental record registrations

made during regular check ups and treatment sessions. Since the actual caries diagnostic system has been used in these clinics for many years, it is believed that the consistency of these registrations is not very different from the ones found in the reliability tests.

To our knowledge there are no other longitudinal studies covering this age period using both bitewing radiographs and a detailed caries registration system, and which also registered caries status of exfoliated teeth. By following the fate of the exfoliated teeth, the caries information of the affected teeth and surfaces is conserved, which is necessary if the true caries increment shall be measured. On the other hand, the actual caries prevalence at 10 years of age is thereby overestimated. Mattila et al. [2001], in their study of children in the same age group, have come to the opposite conclusion, namely a halt of caries during the years from 7 to 10, but their data were based on a merge of the dmft and DMFT index. This could be explained by the substitution of exfoliated teeth with new healthy permanent teeth. This exemplifies that a

true comparison of the caries prevalence found in our study with other studies dealing with this age period is impossible to render. However, the location of the caries increment in the present study has some traits in common with other works. We found, as did Holt [1995] and Greenwell et al. [1990] that the approximal surfaces of the molars were identified as the major sites for the caries increase. The finding that the distal surface of the second primary molar was specially caries prone was also previously mentioned by Mejäre and Stenlund [2000], who found that 64% of a group of 9-year-old children had caries in one or more distal surfaces of the second primary molar.

The fact that the portion of children with caries-free primary teeth was reduced from 31% at the age of 5 years to 19% at the age of 10, that the average increase in  $d_{1-5}mfs$  was 3.05 and that 13% of the children had one or more teeth extracted due to caries, indicates a rather high disease activity during this age period. This finding is consistent with a recent Swedish study [Alm et al., 2003], where it was found that the majority of the restorative treatment in the primary dentition was performed after 6 years of age, and particularly during the period 7-9 years.

There are probably different reasons for this. The mixed dentition with teeth at various levels complicates a proper hygiene regime, and the children's growing independence during these years makes supervised tooth brushing difficult. The percentage of 7-year-old children getting brushing help was only 55% in a Flemish study [Vanobbergen et al., 2001] and 84% in a Danish [Sundby and Petersen, 2003], while a Swedish study with children of higher age (8-12 years) showed that only 16% received daily help or assistance from an adult [Arnrup et al., 2001]. Kuusela et al. [1997] reported that in their study as few as one third of 11 year-old Finnish boys brushed their teeth more than once a day. Gingivitis was also recorded in 26% of a 10-year-old child group in Finland [Mattila et al., 2002]. Furthermore, during early school years an increasing socialization outside the family unit takes place, making the children at once more susceptible for surrounding pervasive "snacking culture" [Murphey, 1992; Honkala, 1993; Moynihan, 2000; Overby and Andersen, 2002].

In contrast to our hypothesis, more than half of the children who were caries-free at 5 years of age developed caries during the period, and more than half of the approximal lesions in this group were in the dentine or had been filled. Thus the caries progression through enamel was less than 5 years in many instances. When considering the total group of children, approximal caries lesions in the molars seem

to be the biggest clinical problem during this age period. The majority of the approximal lesions were either in the dentine or had been restored. The restorative treatment on these surfaces is usually more complicated and demanding for both child and dentist than one-surface fillings.

The number of filled surfaces in the dentition was more than 6 times higher at 10 than at 5 years of age, so the need for restorative treatment during the period was considerable. This should be considered as a serious finding, particularly in light of the fact that restorative treatment in this age group is a risk factor for dental anxiety disorders later in life [Locker et al., 1999; Raadal et al., 2002].

It should be noted that the risk for caries increment during a period of time is dependent upon the caries prevalence at baseline, due to the so-called ceiling effect, described in the permanent dentition [Birkeland et al., 2003]. A higher number of surfaces affected at baseline implied a lower number of surfaces at risk in the future. Our finding that there was no significant difference in increment between the groups with and without caries at 5 years of age may partly be explained by this phenomenon. The high proportion of caries on the distal surface of the second molars may be explained by the fact that these surfaces were caries-free before the eruption of the permanent first molars.

There was no information about the caries status of the extracted teeth during the follow-up period, which means that the reason for extraction could not be determined. It may be questioned whether this may have biased the finding that the caries increment was dominated by approximal lesions. We found, however, significantly more approximal lesions at 5 years of age in children who later had extractions than in the children without, and this may lend support to the finding that approximal lesions also were most prevalent in extracted teeth.

In accordance with previous findings it was found that future caries to a certain extent might be predicted by past caries experience [Powell, 1998; Li and Wang, 2002]. This is a reasonable finding as caries is a chronic infectious disease with different activity and severity levels. On this background it must be expected that some of the new lesions that were recorded at 10 years of age in children who were caries-free at 5 had been present as undiagnosed initial lesions at that time, while some of them had developed on surfaces that were sound at 5 years of age. False negative recordings are likely because it is well known that both visual inspection and radiography have limited sensitivity in revealing the initial phases of the caries process [Ismail,



1997; Heinrich-Weltzien et al., 2002]. Also the fact that 8 children who had initial lesions at the age of 5 were recorded as caries-free at 10 years may be explained as either a lack of consistency of diagnosis or actual reversal of initial caries lesions (healing).

When analysing the sample as a whole, the caries increment on buccal and lingual surfaces showed negative net sum. One possible explanatory factor could be that a proper hygiene regime is easier to attain on these surfaces, and that remineralisation of the caries process is easier to obtain here. The caries pattern affecting these smooth surfaces also belongs to early childhood, and after 5 years of age constitutes a minor problem [O'Sullivan and Tinanoff, 1993; Tinanoff and O'Sullivan, 1997]. According to our criteria for risk group assignment, 31% of the sample was included based on their caries increment during the age period from 5 to 10 years. This proportion is similar to the criteria for the Significant Caries Index (33.3%), used by some other authors [Bratthall, 2000], which indicates that our criteria are reasonable for possible comparisons with other studies. In order to evaluate if the ceiling effect [Birkeland et al., 2003] might have influenced the size of the risk group, we did a caries attack rate calculation (new caries \* 100/surfaces at risk) of the dmfs criteria that were used for assignment to the group. This revealed that only one more child would have been included by the use of this calculation.

On the basis of the fact that lesions on the approximal surfaces of the molars comprised the largest portion of the increment, it was an interesting finding that one or more such lesions at 5 years of age were the strongest predictor of inclusion into the risk group. In clinical practice this would mean that any patient at 5 years of age with such lesions, even if it is a single initial lesion, should be estimated as at risk for more severe caries during the next 5-year-period. As priority on preventive and non-invasive treatment is the principle of child dental care today [Pitts, 1997; Raadal, 2002], the present findings suggest that children in this age group should be monitored rather frequently in order to avoid restorations.

## Conclusion

It is concluded that the caries increment in the primary dentition is considerable during the age period from 5 to 10 years, also among those who are recorded as caries-free at 5 years of age. Molar-approximal lesions dominate the increment, and when such lesions are diagnosed at 5 years of age, there is an increased risk for more severe caries (dentinal lesions) during the next 5 years. Even if a risk assessment based on the

prevalence of approximal caries at 5 years of age may be useful for deciding individual recall intervals, the results of this study seem to suggest frequent check-ups of the whole population are needed.

## References

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