

Paper 1

Caries patterns in an urban preschool population in Norway

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ABSTRACT. *Aim* This was to describe the prevalence, severity and distribution of caries in a preschool population in Oslo, Norway, and to compare the findings in subgroups according to immigrant status and age. Furthermore, the present data should serve as a baseline for longitudinal studies. *Methods* The participating children (n=775), chosen from 7 clinics in the Public Dental Health Service, were of various socioeconomic backgrounds and immigrant status (IM, immigrant group-mother of non-western origin or WN, western native group-mother of western background). The study design was descriptive cross-sectional. The caries examinations were carried out by calibrated examiners, and a detailed 5-graded caries diagnosis system including incipient caries was used. Radiographs (BW) were taken of the 5-year-old children. *Results* The percentage of caries free children, aged 3 years (mean 3.0) and 5 years (mean 4.8) were 80.1% and 48.0% respectively. The subgroup of immigrant children showed a considerably higher caries prevalence, it was more often affected by severe caries and experienced an earlier onset of the disease than the subgroup of western native children. The most marked skewness of the caries data was seen within the WN group, especially at 3 years of age. *Conclusions* The present study has revealed disparities in dental health associated with ethnic origin seen at the age of 3. The disparities in dental health are still evident at 5 years of age, but then caries is more common for the whole population.

KEYWORDS: Caries, Epidemiology, Immigrant, Children, Primary teeth.

Introduction

During the period 1997-2001 Norway experienced a 10% reduction in the number of caries free 5-year-old children [Statens helsetilsyn, 2001; Haugejorden and Birkeland, 2002]. A similar decrease has not been recorded in Denmark [Poulsen and Malling Pedersen, 2002] or Sweden [Socialstyrelsen, 2002], but both countries have reported a levelling out. These national data are based on different definitions of "caries" and cannot be directly compared, but "caries" in this context is often used synonymously with need for operative restorative care which is not always a static term [Espelid et al., 2001; Gimmestad et al., 2003]. Thus, national reports often underestimate the true prevalence of carious processes [Pitts, 1997a; Amarante et al., 1998]. Due to a change in treatment philosophies related to incipient, non-cavitated lesions, emphasis has been placed on the importance of including the incipient lesions in caries

registration using a severity grading of caries [Pitts, 1997b; Raadal, 2002]. The progression of caries is higher in the primary dentition compared with the permanent dentition [Peyron et al., 1992; Mejàre et al., 2001]. More detailed data are thus needed to judge the burden of caries in the preschool children, especially in the youngest ones, to evaluate the potential of alternative, non-restorative treatment options.

Among immigrants in developed countries, oral health in preschool children is poor [Dhawan and Bedi, 2001]. The growing immigrant child population in Copenhagen, Denmark, makes up about 25% of the population under the age of 18 and is believed to have a major impact on the caries pattern [Sundby and Petersen, 2003]. During recent years, the proportion of immigrant children (0-17 years) in Norway has increased to 6% of the total child population [Vassenden et al., 2000]. In Oslo, where 4 out of 10 immigrant children in Norway live, the immigrant group constitutes 27% of the children and of these 94% come from the non-western world [Vassenden et al., 2000]. Nevertheless, the increasing proportion of immigrant children cannot explain the decline in the number of caries free children in Norway [Haugejorden and Birkeland, 2002].

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The aims of the present study were to describe the prevalence, severity and distribution of caries in a preschool population in Oslo and to compare the findings in subgroups according to immigrant status and age. Furthermore, the study aimed to collect baseline data for future studies on possible changing patterns of caries occurrence and of determinants for caries. The hypotheses to be tested were that the caries prevalence is higher among immigrant children compared with western native children, and that caries among immigrant children is more severe and starts earlier.

Materials and methods

Sample population. Based on a sample size calculation, 900 3- and 5-year-old children were included in the study. The sample of preschool children was drawn from 7 different clinics in the Public Dental Health Service in Oslo, and included individuals with different socioeconomic and ethnic background. The study design was descriptive cross-sectional and the inclusion of individuals at each clinic was randomised. The Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate approved the study. A written, informed consent was obtained from each child's parents. Attendance reminders were provided both by post and by telephone.

Oral examinations. All patient examinations were completed in a standard clinical setting, using good artificial light, dental probes, mouth mirrors and compressed air. The 5-year-old group was radiographed (BW). Five-graded caries diagnoses based on written descriptions and photographs [Amarante et al., 1998] were used. In this paper caries is denoted d_{1-5} , where the subscript indicates the caries grades. The two most incipient grades of caries (1 + 2) were denoted "initial" lesions and the others "manifest" lesions. When a tooth was extracted or indicated for extraction due to caries, the tooth was counted as having two surfaces with caries.

Calibration. Seven dental hygienists carried out the caries registrations. Calibration consisted of 12 hours of lectures, training on extracted teeth and radiographs. The hygienists also examined clinically preselected tooth surfaces in 16 10-year-old children. Before the 8 first patients were dismissed, consensus about the caries diagnoses was reached. A kappa score was calculated for the last 8 patients (Test 1). Furthermore, the reproducibility of the examiners was re-assessed during the middle of the project period. One of the authors (MSS) re-examined 2-5 patients from each observer, and in cases of disagreement, consensus was reached after examination of each surface (Test 2). Both tests represented a comparison of the dental hygienists with

MSS. The dental hygienists' scores were pooled. The examiners' training program included a specially designed computer software program with exercises based on radiographs and clinical pictures of sound and carious teeth. Specific feedback was given for each diagnosis. Inter-examiner reliability was expressed as Cohen's kappa score (weighted and unweighted). For weighted kappa, 66% and 33% credit was given for scores deviating one or two grades respectively.

The participants were divided into subgroups according to immigrant background. The immigrant group (IM) was defined as children with mothers of non-western origin whereas the western native group (WN) had mothers with western background. Non-western origin meant participants from Eastern Europe, Asia, Africa, Turkey, South and Central America, while the Nordic countries, Western Europe, North America, New Zealand and Australia were the areas referred to for western origin [Vassenden et al., 2000].

Statistical evaluation. Data were entered on a computer using a database program (Access, Microsoft) and analyses were carried out with SPSS (version 11) using descriptive methods. Lorenz curves were applied to show differences in caries distribution between the groups at each age level [Poulsen et al., 2001].

Results

Calibration and reproducibility. Test 1, based on the caries examination on 39 surfaces in 8 individuals, showed unweighted and weighted (linear) Cohen's kappa values of 0.49 and 0.68. The corresponding values of Test 2 were 0.67 and 0.75.

Sample population. The study sample comprised 775 individuals, 86.1% of the original sample of 900 (Table 1). The IM group constituted 11.4% (n=88) of the study sample. There were statistically significantly more dropouts in the IM group ($\chi^2 = 43.10$, $p < 0.001$) (Table 1). The individuals were grouped as 3-year-olds

	All	WN	IM
Original sample	900 (100.0)	770 (100.0)	130 (100.0)
Dropouts	125 (13.9)	83 (10.7)	42 (32.3)
Examined	775 (86.1)	687 (89.2)	88 (67.7)
Column percentages in parenthesis			

TABLE 1 - Data for a Norwegian (Oslo) study showing the origin of children as WN (western native), with mothers from western countries, and IM (immigrant), with mothers from non-western countries.

(n=371, mean age 3.0 year, range 2.2-3.6 year) and 5-year-olds (n=404, mean age 4.8 year, range 4.2-5.2 year).

Caries scores. The distribution of caries in the total sample showed marked positive skewness. Sixty-seven percent of carious surfaces were found in 10.7% of the children; the IM group made up 42.2% of this high caries experience group. The proportions of caries free 3- and 5-year-olds were 80.1% and 48.0% respectively. Among all the 3-year-olds, 12.7% had only initial lesions while the corresponding proportion in the 5-year-old group was 25.5%. The proportions of caries free 3- and 5-year-olds in the WN groups were 84.1% and 52.5%, and 50.0% and 11.4% in the IM

groups respectively. The frequencies of restorations and/or manifest lesions were 3.7% and 21.1% in the 3- and 5-year-old WN groups. The corresponding values among IM children were 34.1% and 70.5% respectively. Four individuals had restorations at 3 years of age (1.1%), and 39 at the age of 5 (9.6%). Teeth extracted due to caries (n=12) were localized to eight 5-year-olds, two of them being immigrants. Children at ages 3 and 5 showed different caries patterns with respect to prevalence and sites affected (Fig. 1). Only small caries increments were noted from 3 to 5 years of age in anterior teeth, but in other surfaces prevalence increased considerably.

The disparities in caries distribution between the IM and WN groups are illustrated by Lorenz curves for each age level in Figures 2 and 3. These curves demonstrate the proportion of individuals who are responsible for the burden of caries.

Of children with caries experience, 48.6% of the 3-year-olds and 33.8% of the 5-year-olds had caries on smooth surfaces, 5.4% and 40.0% had approximal caries in molars and 70.3 and 76.2% had occlusal caries. Figures 4 and 5 show how caries $d_{1-5}fs$ components distribute according to type of surface. Incipient caries dominates at both ages in all surfaces except in the front where the number of manifest lesions exceeds the incipient lesions. More than 50% of the approximal lesions are confined to the enamel in the oldest group.

The d-component (both on surface and tooth level) was significantly higher at both ages in the IM groups compared to the WN groups ($p < 0.001$) (Table 2). The decayed portion comprised almost the total $d_{1-5}mfs$ value at 3 years and 84.5% at 5 years. The proportion of initial ($d_{1-2}s$) caries exceeded manifest ($d_{3-5}s$) caries

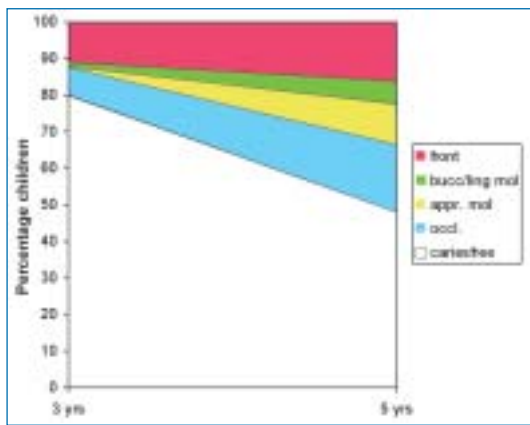


FIG. 1 - Distribution of all children at 3 and 5 years of age according to caries ($d_{1-5}fs$) severity pattern. The severity is considered highest in the group with caries in anterior teeth and then caries on buccal/lingual surfaces. Participants were classified according to the most severe type of caries they had.

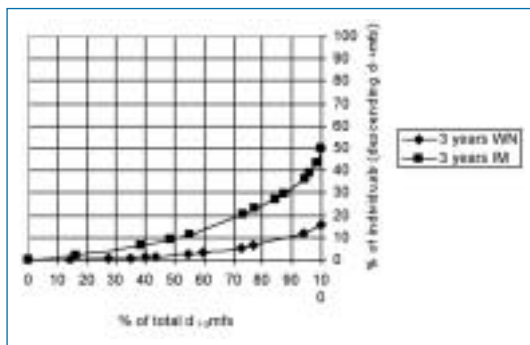


FIG. 2 - Lorenz curve for caries distribution in the 3-year-old groups. The curve-points indicate $d_{1-5}mfs$ numbers starting at value 1 at the outermost position to the right on each curve (intersection with the vertical axis) and increasing by one unit moving to the left on the curve.

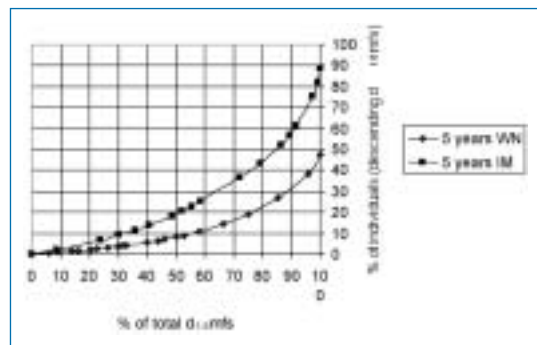


FIG. 3 - Lorenz curve for caries distribution in the 5-year-old groups in a sample of Norwegian children.

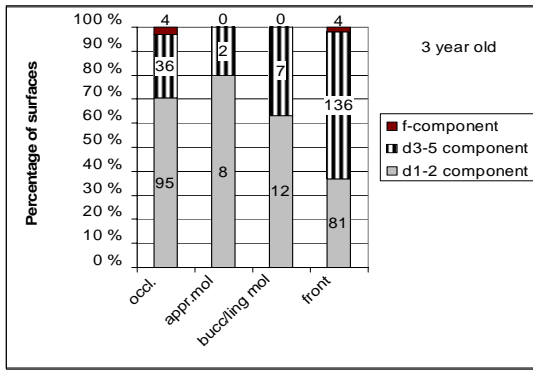


FIG. 4 - Surfaces affected by caries at 3 years of age. The different bars indicate location and number of surfaces. The relative distribution of d_{1-5} components is represented.

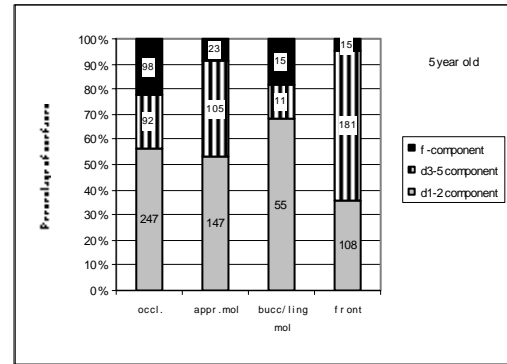


FIG. 5 - Surfaces affected by caries at 5 years of age. The different bars indicate location and number of surfaces. The relative distribution of d_{1-5} components is represented.

	3-yr-olds (n=371)	5-yr-olds (n=404)	WN: 3-yr-olds (n=327)	IM: 3-yr-olds (n=44)	WN: 5-yr-olds (n=360)	IM: 5-yr-olds (n=44)
d_{1-2} t	0.44 (1.20)	1.15 (1.69)	0.29 (0.86)	1.55 (2.30)**	1.05 (1.65)	1.93 (1.82)**
d_{3-5} t	0.30 (1.34)	0.73 (1.80)	0.17 (1.07)	1.23 (2.37)**	0.47 (1.37)	2.84 (3.10)**
f-t	0.02 (0.19)	0.26 (1.00)	0.00	0.16 (0.53)*	0.24 (0.93)	0.50 (1.49)
m-t	0.00	0.03 (0.25)	0.00	0.00	0.03 (0.26)	0.05 (0.21)
d_{1-5} mft	0.76 (2.14)	2.18 (3.22)	0.47 (1.47)	2.93 (4.17)**	1.79 (2.87)	5.32 (4.14)**
d_{1-2} s	0.53 (1.52)	1.38 (2.11)	0.32 (0.94)	2.07 (3.22)**	1.23 (2.01)	2.66 (2.43)**
d_{3-5} s	0.49 (2.71)	0.96 (2.67)	0.33 (2.39)	1.68 (4.28)*	0.57 (1.79)	4.14 (5.33)**
f-s	0.02 (0.22)	0.37 (1.59)	0.00	0.18 (0.62)	0.34 (1.51)	0.68 (2.12)
m-s	0.00	0.06 (0.51)	0.00	0.00	0.06 (0.51)	0.09 (0.42)
d_{1-5} mfs	1.04 (3.51)	2.77 (4.77)	0.65 (2.71)	3.93 (6.36)**	2.19 (4.00)	7.57 (7.25)**

Statistically significant differences between WN and IM groups are marked * $p < 0.05$ or ** $p < 0.01$

TABLE 2 - Caries data as dmf values (\pm SD) and its components given at tooth and surface level according to age grouping and immigrant status in a sample of children living in Oslo (Norway).

	3-yr-olds (n=74)	5-yr-olds (n=210)	WN: 3-yr-olds (n=52)	IM: 3-yr-olds (n=22)	WN: 5-yr-olds (n=171)	IM: 5-yr-olds (n=39)
d_{1-2} t	2.22 (1.82)	2.21 (1.77)	1.85 (1.36)	3.09 (2.41)*	2.22 (1.77)	2.18 (1.79)
d_{3-5} t	1.50 (2.69)	1.41 (2.30)	1.10 (2.52)	2.45 (2.89)*	1.00 (1.85)	3.21 (3.11)**
f-t	0.09 (0.41)	0.51 (1.35)	0.00	0.32 (0.72)	0.50 (1.30)	0.56 (1.57)
m-t	0.00	0.06 (1.35)	0.00	0.00	0.06 (0.37)	0.05 (0.22)
d_{1-5} mft	3.81 (3.37)	4.19 (3.40)	2.94 (2.54)	5.86 (4.19)**	3.77 (3.14)	6.00 (3.90)**
d_{1-2} s	2.65 (2.45)	2.66 (2.27)	2.02 (1.48)	4.14 (3.51)*	2.58 (2.24)	3.00 (2.37)
d_{3-5} s	2.45 (5.69)	1.85 (3.48)	2.06 (5.73)	3.36 (5.62)	1.20 (2.45)	4.67 (5.44)**
f-s	0.11 (0.48)	0.72 (2.13)	0.00	0.36 (0.85)	0.71 (2.13)	0.77 (2.24)
m-s	0.00	0.11 (0.70)	0.00	0.00	0.12 (0.74)	0.10 (0.45)
d_{1-5} mfs	5.20 (6.35)	5.34 (5.48)	4.08 (5.71)	7.86 (7.10)*	4.61 (4.76)	8.54 (7.15)**

Statistically significant differences between WN and IM groups are marked * $p < 0.05$ or ** $p < 0.01$

TABLE 3 - Caries data as dmf values (SD) and its components given at tooth and surface level for individuals with $dmf > 0$ in a sample of children living in Oslo (Norway).

at both ages, 52.0% versus 48.0% at 3 years and 59.0% versus 41.0% at 5 years of age. Table 3 shows that among individuals with caries experience there are only small differences between the 3- and 5-year groups with respect to the number of surfaces with caries experience ($d_{1-5}mfs$). The same tendency is also reflected at tooth level (Table 3).

Occlusal restorations constituted about 2/3 of the restorations at 5 years (Fig. 5). The frequency was slightly higher in the first primary molar compared to the second primary molar.

Discussion

Considering that the clinical examinations were carried out in an everyday, clinical setting during ordinary dental check-ups by 7 dental hygienists, the inter-observer reliability was within an acceptable range.

The participation rate of 86.1% for clinical examination was considered satisfactory (Table 1). Immigrant children were over-represented in the 13.9% dropout group, a finding consistent with other studies regarding immigrants' attendance pattern. It is well established that the utilisation of preschool dental services is associated with social background factors and immigrant status [Dasanayake et al., 2002; Azogui-Levy et al., 2003]. Due to the small sample size of the immigrant group, it was not possible to further analyse the data in subgroups.

The proportion of initial lesions relative to manifest lesions in 3-year-olds ranged from 56% to 63% in the IM and WN groups respectively and from 40% to 69% among the 5-year-olds (Table 2). Raadal et al. [2000] reported that initial lesions comprised 60% of the d component and 50% of the total $d_{1-5}mfs$ in 5-year-olds. In the present study, in the 5-year-old immigrants the d_{1-2} component made up only 36% of the total $d_{1-5}mfs$. In other words, the immigrants seemed to have more lesions with caries and more severe caries compared with western native children. The relatively high proportion of initial caries in the whole group indicates a great potential for non-operative caries treatment to arrest or retard caries progression to avoid restorative therapy in primary teeth, a treatment which is known to have poor prognosis [Mjör et al., 2002; Forss and Widstrom, 2003].

The f -component was 9% of $d_{1-5}mfs$ index among 5-year-old immigrants and 13 among similarly aged western native children (Table 2). Both numbers indicate many unrestored surfaces with caries penetrating dentine. As this was recorded at the initial check-up, the restorations will probably be provided

during the subsequent treatment period, but some undertreatment is likely to occur in the preschool group, although the service is offered free of charge. Four different types of obstacle to optimal caries treatment have been identified, with factors associated with the child, the family, the dental operator and the public dental health care system [McGrath and Frager, 1996; Edelstein, 2002].

When comparing individuals with caries at 3 or 5 years of age (Table 3), it is surprising that the average caries experience is of the same magnitude. The variation (SD) is also within the same range. This tendency is the same, irrespective of immigrant status with quite different caries experience at the age of 3. Caries measured by the $dmfs$ index will accumulate over time, but for the affected children up to 3 years of age, caries progression is more rapid due to a combination of unfavourable dietary habits and newly erupted teeth with poor posteruptive maturation [Kotsanos and Darling, 1991; Schulte et al., 1999].

Lorenz curves (Figs. 2 and 3) illustrate the skewness in caries distribution in different groups. From the curves it can be seen which proportion of each cohort carries the burden of caries. The proportion indicated by the intersection of the curve with the vertical axis on the right is the proportion with caries. The most skewed distribution of caries is thus seen in the WN groups because caries is more evenly distributed among immigrants, especially at 5 years of age (Fig. 3). During recent decades the distribution of caries has become more skewed in preschool populations [Vehkalahti et al., 1997; Macek et al., 2004] and this may be occurring in the immigrant population if the preventive approach succeeds. In a workshop held in the USA, the "zero tolerance" concept was recommended; this requires that no child under 6 years of age should develop caries [Ismail, 2003].

The big difference found in the present study between immigrants (IM group) and western native children (WN group) with respect to caries prevalence and extent is in accordance with many studies from different industrialised countries [Dhawan and Bedi, 2001]. The dental health disparities related to immigrant status are in general most prominent in primary teeth [Dhawan and Bedi, 2001; Sundby and Petersen, 2003].

The prevention of caries among preschool children should start early [Hugoson et al., 2002] as many studies, including the present, indicate that caries is prevalent in 3-year-olds, especially among underprivileged children. The national guidelines for

child health centres recommend that information about oral health should be given at consultations at 5, 11, and 24 months of age. At 24 months an oral inspection should be included. The interest of the public health nurse or paediatrician determines if the information is given or not. In Norway dental professionals are not in contact with the child or parents before the child is 3-4 years old. According to Wendt et al. [2001], an early risk assessment starting at the age of 1 year with different preventive measures based on risk grouping showed improved dental health at the age of 6 compared with other neighbouring districts (no control group).

At 3 years of age caries is quite common among children with an immigrant background, while most of other 3 year-olds are caries free. It is evident that immigrant background is, therefore, an important factor for the prevalence of caries at both ages, but at 5 years of age nearly half of the population with western native background is affected. A population strategy [Hausen, 1997; Sheiham and Watt, 2000] seems reasonable in combination with a risk strategy [Wendt et al., 2001]. Such a focus requires allocation of more resources or reallocation of existing manpower and economical resources.

Selection of children at risk for caries in the age span 12-24 months is reported to have very high predictive value [Hausen, 2003]. Grindefjord et al. [1995] combined factors, such as ethnic background, mother's education, frequency of sugar-containing beverages and candies and mutans streptococci at 24 months of age, to predict caries at 3.5 years of age. Sensitivity and specificity values were 0.87 and 0.83 respectively. Alaluusua and Malmivirta [1994] demonstrated that visible plaque on the labial surface of maxillary incisors at the age of 19 months predicted caries at the age of 3 years with sensitivity and specificity values of 0.83 and 0.92 respectively.

The present study has revealed disparities in dental health associated with immigrant status at the age of 3 years. Differences in dental health are still evident at 5 years of age, but then caries is more common in the whole population. To prevent early childhood caries in the first 5 years of a child's life, many lifestyle factors must be modified and the use of topical or systemic fluorides introduced once teeth are present in the mouth. Parental educational programs that focus on such dental health promoting behaviours from birth will be of great value in ensuring the child achieves good dental care. For disadvantaged groups such as those with immigrant background, specially tailored and targeted preventive programmes are urgently needed.

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