Community Dent Oral Epidemiol 2008; 36: 441–450

COMMUNITY DENTISTRY AND ORAL EPIDEMIOLOGY

Caries increment in children aged 3–5 years in relation to parents' dental attitudes: Oslo, Norway 2002 to 2004

Marit S. Skeie[1], Ivar Espelid[2], Paul J. Riordan[3] and Kristin S. Klock[1]

[1]Faculty of Dentistry, University of Bergen, Bergen, Norway, [2]Faculty of Dentistry, University of Oslo, Oslo, Norway, [3]Dental Health Services, Perth, WA, Australia

Skeie MS, Espelid I, Riordan PJ, Klock KS. Caries increment in children aged 3–5 years in relation to parents' dental attitudes: Oslo, Norway 2002 to 2004. Community Dent Oral Epidemiol 2008; 36: 441–450. © 2008 The Authors. Journal compilation © 2008 Blackwell Munksgaard

Abstract – *Objectives:* To assess the relationship between parents' dental attitudes and the caries increment in their children from the age of 3 to 5 years. *Methods:* Data based on parental questionnaires and dental examinations were collected from children participating in a follow-up study from age 3 years (n = 354) in 2002 to 5 years (n = 304) in 2004. The children were categorized as western-native (WN) and immigrants (IM). The items used were significantly related to caries experience in a multicentre study [Pine et al. (2004) *Community Dent Health*, vol. 21, pp. 121–30]. The responses to attitudinal items were weighted as positive if they would promote good dental health, and negative if not. Composite attitudinal variables relating to hygiene, diet and indulgence were calculated as a summation of the weighted responses to selected items. Regression analyses (bivariate and multiple) were performed to assess associations during the period between the attitudinal predictors/other control variables and caries increment ($\Delta d_{3\text{-}5}mfs$). *Results:* Bivariate logistic regression analyses revealed that 'Attitude to Diet' and 'Parental Indulgence' were clearly related to caries increment. The more exposed children were to negative parental attitudes, the higher the OR. 'Attitude to Diet' also persisted in a multiple logistic regression model, showing a higher OR value than caries experience. 'Immigrant Status' was the most potent predictor of caries increment. Parents were found to be more indulgent among IM than among WN groups. *Conclusion:* Parental dental attitudes are clearly shown to be associated with caries increment in early childhood. The relationship is of such strength that it deserves to be taken into account in future preventive dental strategies.

Key words: caries; child; dental health; parental dental attitudes

Marit S. Skeie, Department of Oral Sciences – Pedodontics, Faculty of Dentistry, University of Bergen, Aarstadveien 17, N-5009 Bergen, Norway
Tel: +47 55586576
Fax: +47 55586461
e-mail: marit.skeie@odont.uib.no

Submitted 25 June 2007;
accepted 20 December 2007

Parental beliefs and attitudes are known to be associated with the caries experience of their children (1, 2). It is not surprising that mothers who consider toothbrushing of primary teeth to be unimportant are more likely to have children with poor oral hygiene and teeth affected by caries. Furthermore, the attitudes of parents to the dental care of children may be influenced by prevailing child-rearing norms in their communities or 'living space'. Post-modern upbringing norms emphasize children as individuals with their own rights and voices to self-determination, of which obedience is not a virtue (3). Obliging their children to stick to strict oral hygiene regimes or controlled diets may, for many parents loyal to these norms, represent a dilemma. Adherence to oral health-promoting rules, however, requires a certain level of child compliance.

Similarly, upbringing norms followed by parents of non-western origin are likely to be shaped by their culture and their religious and ethnic backgrounds. It has been reported that parents

doi: 10.1111/j.1600-0528.2008.00430.x

belonging to some minority ethnic groups are indulgent towards their children's requests for sweets (4, 5). A relative lack of definite limits in the upbringing of children, i.e. allowing young children to be without duties and restrictions, is also an ingrained trait in some traditional religious groups (6, 7).

Parental beliefs and attitudes were more closely associated with caries experience in children than were regimes of toothbrushing or sugar-snacking habits as reported by parents (8). Consistent with this finding, the most significant variable predicting whether children would be caries-free in a large multicentre study was not the children's regular and effective toothbrushing, but parents' attitudes to their own perceived ability to perform toothbrushing for their children (1). However, to explore to what extent parental beliefs and attitudes affect dental caries in their children, longitudinal studies are needed. As far as we know, no such study covering the relationship between parents' attitudes and the corresponding changes in the dental health of their offspring exists. Only behavioural family determinants of preventive health behaviours are documented longitudinally (9, 10). This study aimed at assessing the relationship between parents' dental attitudes and the caries increment in their children from the age of 3 to 5 years.

Material and methods

The study was undertaken on children who lived in Oslo and was approved by the Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate (8, 11). The selection criteria for participating in the present study were that the child had taken part in the previous cross-sectional study in 2002 when aged 3 years (8), and that the child's mother or father had responded to a questionnaire. The children belonged to one of seven clinics. The clinics varied greatly with respect to the socioeconomic status of their patients and in some clinics there was a high proportion of immigrant children. The definition 'Immigrant Status' required that the mothers were first-generation immigrants. A child was either assigned to the immigrant group (IM group) if the mother was of non-western origin or to the western native group (WN group) if not. Non-western background meant originating from Eastern Europe, Asia, Africa, Turkey, South and Central America while Western Europe, North America, Australia and New Zealand were considered to be western (12).

Study participants

The follow-up sample in 2004 constituted 67.6% of the original 2002 sample and 85.9% of the 354 children examined at baseline (Fig. 1). The response rates in the WN and the IM groups from baseline examination to follow-up were 86.9% and 77.5% respectively.

The baseline sample size of 3-year-old children (n = 354) was determined in the previously published study (8). In the follow-up study, 304 (85.9%) 5-year-old children remained. There were 172 boys (IM = 17) and 132 girls (IM = 14). In 2002, 82.6% of the responders in the total group were mothers, while in 2004 the proportion of maternal responders was 80.2%.

Drop-out

The most important reason for not participating was relocation (internal migration and emigration). One child had transferred to a private dental clinic.

Examiner training and caries diagnostic system

Caries examinations of most of the participating children were undertaken from February to April both in 2002 and 2004. During that period, most parental questionnaires were also received. Thirteen children of the IM group, participating in the follow-up study, attended in November and

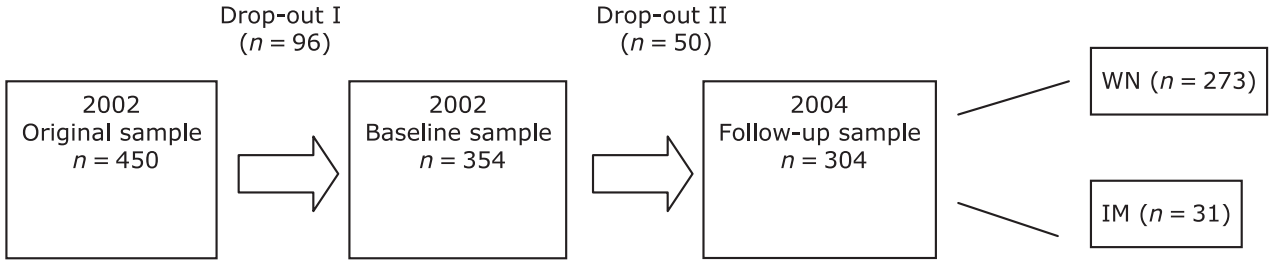

Fig. 1. Flow diagram: Progress of the study. All analyses in the present study were based on the same sample (304 children), both at baseline and follow-up.

December 2003, and the questionnaires in this group were collected before 2004.

Seven calibrated dental hygienists undertook the dental examinations. They had been trained and calibrated before the examinations in 2002 and also during the project period (11). One dental hygienist participating in 2002 had left the clinic and was replaced by another calibrated and experienced dental hygienist. In October 2003, a second calibration took place. Based on extracted teeth and photographs of teeth (n = 25), individual scores were discussed until consensus was reached based on the diagnostic criteria to be used in the study. In 2004, two additional clinical examination training sessions were arranged. Selected tooth surfaces supplemented with bitewing radiographs of five children (aged 6 years and older) were examined by all the examiners. The surfaces for which the examiners were least in agreement were discussed in plenary sessions and consensus reached after re-examination of each surface.

In the five-graded caries diagnostic system used in the study, grades 1 and 2 describe enamel lesions and 3–5 dentine lesions (13). The examinations were undertaken at dental clinics with good artificial lighting, dental probes, mouth mirrors, compressed air and cotton rolls. Bitewing radiographs were taken at the follow-up session only when the proximal surfaces could not be inspected clinically. Caries increment (both $\Delta d_{1\text{-}5}$mfs and $\Delta d_{3\text{-}5}$mfs) was calculated excluding molar-approximal caries. In this paper caries increment at $d_{3\text{-}5}$mfs level is denoted 'severe caries increment'. Out of ethical reasons bitewing radiographs were not taken of the 3-year-old children.

The reliability of the questionnaire

The original questionnaire was shortened from 127 items in 2002 to 82 items in 2004. Three quarters of the questions had also been used in an international collaborative multicentre study (2822 children from 17 countries) (1), among those, belief and attitudinal items. They were based on theoretical models regarding the psychology of health behaviour (14–16). The explanatory working model was influenced by the hypothesis of Conner and Norman (2), that beliefs and attitudes about particular behaviours might predict those behaviours. However, they are only mediated by the attitudes (17). Based on a review of caries risk factors among young children, the behaviours used in the model were oral hygiene and sugar-snacking. The international part of the questionnaire had been translated into Norwegian and back-translated by an independent bilingual translator. It had also been subjected to reliability and validity tests by the international research team (17), and a similar paper for the present study is under preparation. In 2004, items were deleted if they had not shown any significant relationship with caries experience in the multicentre study of 2822 children from 17 countries (1, 18). Both at baseline and follow-up, parents with immigrant background were offered interpreter assistance. The questionnaire also contained items that measured present and past dietary and toothbrushing habits, parental dental attendance, use of fluoride, family structure and demographic factors.

Constructed attitudinal variables

There were different groups of related items, and as in 2002, three composite variables, 'Attitude to Hygiene', 'Attitude to Diet' and 'Parental Indulgence', were constructed. The Likert scale responses 'agree' and 'strongly agree' (score 4 and 5) were given a positive value (+1) while responses 'strongly disagree' and 'disagree' (score 1 and 2) were given a negative score (−1). Score 3 was assigned the value 0. Based on the sum of the favourable and negative scores the related attitudinal items were added to create a total sum score. The content of the composite variables from 2004 is illustrated in Table 1. Two of them had reduced number according to the variables used in the cross-sectional study in 2002 (8). Two other composite variables were combined, based on the scores from both 2002 and 2004. 'Consistent Negative Attitude to Diet' included parents with negative dietary attitudes both in 2002 and 2004, while the variable 'Consistent Parental Indulgence' consisted of parents who were indulgent both in 2002 and 2004. The 2004 version of the composite variables (Table 1) was used in all analyses performed. For longitudinal analytical purposes the 2004 version of the composite attitudinal variables was employed both at baseline and follow-up and the same cut-off points for categorizing groups (positive/negative attitudes). For the three composite variables, the cut-off points of the respective sum scores were set above the value 0.

Control variables

'Social Status' was dichotomized as 'High Social Status', indicating both parents having attained university-level education, and 'Not High Social Status'. Other variables were as follows: 'Age

Table 1. Composite variables in 2004 with values of Cronbach's alpha: 'Attitude to Hygiene' (three items fewer than in 2002), 'Attitude to Diet' (two items fewer than in 2002), 'Parental Indulgence' (same items as in 2002)

Composite variable: Attitude to Hygiene; Cronbach's alpha: 0.74
As a family we intend brushing our child's teeth for him/her
We intend brushing our child's teeth for him/her twice a day
The people in my family would feel it was important to help brush our child's teeth twice a day
The people we know well would feel it was important to brush our child's teeth twice a day
We feel able to brush our child's teeth for him/her
I don't know how to brush my child's teeth properly
If we brush our child's teeth twice a day, we can prevent our child getting tooth decay in the future
If our child uses a fluoride toothpaste, it will prevent tooth decay
It would not make any difference to our child getting tooth decay, if we helped him/her brush every day
We don't have time to help brush our child's teeth twice a day
We cannot make our child brush his/her teeth twice a day
Composite variable: Attitude to Diet; Chronbach's alpha: 0.75
As a family, we intend controlling how often our child has sugary foods or drinks between meals
The people in my family would feel it was important to control how often our child has sugary foods and drinks between meals
Composite variable: Parental Indulgence; Chronbach's alpha: 0.71
If our child does not want to brush his/her teeth every day we don't feel we should make them
It is worthwhile to give our child sweets/biscuits to behave well.
In our family, it would be unfair not to give sweets to our child every day
It is often too stressful to say 'no' to my child when he/she wants sweets
It is not worth it to battle with our child to brush his/her teeth twice a day

This version was used in all analyses performed.

*The Likert scale responses 'agree' and 'strongly agree' (score 4 and 5) were given a positive value (+1), 'neither agree nor disagree' (score 3) the value 0, while responses 'strongly disagree' and 'disagree' (score 1 and 2) were given a negative score (−1).

Started Brushing' was dichotomized as having started brushing before 1 year of age, or having started at an older age. 'Sugary Drink at Bedtime' was dichotomized as yes or no while the variable 'Frequent Sugar' classified high sugar-related intake (eating/drinking) every day as a negative dietary behaviour, and other responses were classified as positive. The variable 'Supervised Brushing' was categorized as children whose teeth were brushed at least twice a day, or less frequently. The responses from the variable 'Age Started Brushing' were derived from the 2002 questionnaire. The variable 'Sugary Drink at Bedtime' was similarly handled, as it was felt that it was important to ascertain whether the habit had been present as early as 3 years of age.

Data management and statistical methods

In bivariate and multiple logistic regression analyses, the dichotomous dependent variable chosen was a positive caries increment at $d_{3\text{-}5}$mfs-level (severe caries increment). In one single analysis, 'modified severe caries increment' was used as dependent variable, excluding both anterior-approximal and molar-approximal caries.

Logistic analyses were first used to explore bivariate relationships between attitudinal variables and other control variables with 'severe caries increment'. Only statistically significant predictors were allowed to enter the multiple logistic regression model with the same dependent variable.

Observation of the same subjects on two occasions cannot be considered statistically independent. Allowance was made to control for this relationship by adding as an independent variable in the regression analysis the average of the $d_{3\text{-}5}$mfs scores at 3 years and 5 years ('Oldham's method') (19). The multiple logistic regression analyses in this study were therefore first performed without and then with 'Oldham's method'.

All data management and analyses were performed using SPSS version 14.0 (SPSS Inc, Chicago, IL, USA). Cronbach's α was used to assess the internal consistency of belief and attitudinal composite variables. Chi-squared statistics (with or without continuity correction) were used to compare the groups, and Spearman correlation tests to look for relationship among the attitudinal variables. Values of sensitivity and specificity were calculated to measure strength of caries prediction of certain variables at baseline. Odds ratios (OR) with 95% CIs were the outcome measurements in the regression analyses. The level of statistical significance was set at 5%.

Results

The questionnaire

The Cronbach's α of belief and attitudinal items in the questionnaire in 2004 was 0.84. The corresponding values in consolidated attitudinal variables (2004 version) run for 2002 and 2004 were 0.71–0.81 and 0.71–0.75.

Caries prevalence and caries increment

The caries prevalence of the 3-year olds who did not continue in the study, did not differ significantly at baseline from that of the study group (16.3% and 19.7% at $d_{1\text{-}5}$mfs level, respectively, $P = 0.574$). The prevalence of caries ($d_{1\text{-}5}$mfs) at baseline and follow-up are presented in Table 2, where caries on all surfaces is included. Almost four of 10 children had caries ($d_{1\text{-}5}$mfs) on primary second molars at the age of 5 years. The proportion of children that had caries increment at $d_{1\text{-}5}$mf level during the period was 40.1% ($n = 122$). At the $d_{3\text{-}5}$mfs level (severe caries increment) caries affected 18.4% of children ($n = 56$), and was not influenced by sex. The distribution of caries increment was skewed. Twenty-two (7.2%) of the participating children ($n = 304$) were responsible for 76.4% of all the 225 new carious surfaces at the $d_{3\text{-}5}$mfs level during the priod. There were 13 immigrant children (41.9% of the IM group) with three or more new caries lesions at the $d_{3\text{-}5}$mfs level.

Predictors of 'severe caries increment' ($d_{3\text{-}5}$mfs level)

Bivariate analyses

The Spearman correlation test revealed the following values: 0.28 between 'Attitude to Hygiene' and 'Parental Indulgence' ($P < 0.001$), 0.12 between 'Attitude to Hygiene' and 'Attitude to Diet' ($P = 0.033$), and 0.09 between 'Parental Indulgence' and 'Attitude to Diet' ($P = 0.141$). Table 3 displays various 'attitudinal exposure' categories. Different odds ratio values (OR values), results of bivariate logistic regression analyses, indicate the strength of relationship between each exposure category and the dependent variable 'severe caries increment'. The category with all three parental attitudes involved displayed to have the highest OR value, 3.6 (95% CI: 1.1–11.9), but the number of children exposed was 12. In the category singly exposed to 'Parental Indulgence' there were statistically significantly more children with immigrant background than without. Among children who were two or three times attitudinally exposed, there were relatively more children with immigrant origin than without. This group was overwhelmingly of Muslim background.

Table 2. Caries prevalence (%) at baseline and follow-up session ($n = 304$)

Diagnostic level	3-year 2002	5-year 2004
All teeth		
$d_{1\text{-}5}$mfs	20.1	48.0
$d_{3\text{-}5}$mfs	6.6	19.1
Second primary molar		
$d_{1\text{-}5}$fs	12.2	39.1
$d_{3\text{-}5}$fs	1.3	13.5

Caries registration presented in this table is based on clinical examination of children aged 3 years, but on clinical and radiographic examination of 5-year olds.

In the logistic analyses used to explore bivariate relationships between other control variables with 'severe caries increment', 'Immigrant Status' appeared to be the one with highest OR value (OR = 6.2, 95% CI: 2.8–13.6). Other variables showing significant relationship were 'Sugary Drink to Bed' (OR = 3.9, 95% CI: 1.9–7.7), 'Parental Dental Attendance' (OR = 3.2, 95% CI: 1.5–6.7), 'Social Status' (OR = 2.6, 95% CI: 1.4–4.9), 'Frequent Sugar' (OR = 2.5, 95% CI: 1.2–5.5) and 'Age Started Brushing' (OR = 2.3, 95% CI: 1.2–4.3).

Multiple regression analyses

Multiple logistic regression analysis was performed with all predictors in the model, having previously, by bivariate analyses, been shown to be significantly related to the dependent variable. In addition to 'Immigrant Status', both 'Attitude to Diet' and 'Baseline $d_{3\text{-}5}$mfs' (continuous variable) persisted (Table 4). In multiple regression analysis with 'Oldham method' instead of 'Baseline $d_{3\text{-}5}$mfs', three variables ('Immigrant Status', 'Attitude to Diet' and 'Oldham method') remained in the model, but the OR values were not interpretable for 'Oldham method'.

When the WN group of participants was analysed separately, only 'Attitude to Diet' with OR 2.4 (95% CI: 1.0–5.3) was a significant predictor of 'severe caries increment'. When using 'Baseline $d_{1\text{-}5}$mfs' instead of 'Baseline $d_{3\text{-}5}$mfs' also, this variable became significant (OR = 1.6, 95% CI: 1.3–2.1). Taking account of Oldham's method, only this calculated variable persisted.

The combination of negative 'Attitude to Diet' (2002) and 'Parental Indulgence' (2002) could to some extent predict severe caries increment the two next years (from 3 to 5 years of age) with sensitivity

Table 3. Children exposed to parental attitudes in 2002 (by one attitude or by two or three attitudes simultaneously)

2002 – Single and combined exposure groups to negative parental dental attitudes					
Exposed to one	OR (CI)	Exposed to two	OR (CI)	Exposed to three	OR (CI)
Attitude to Hygiene n = 85 [IM = 9 (6 Muslims)]	1.0 (0.5–1.9)	Attitude to Hygiene, Attitude to Diet n = 34 [IM = 5 (4 Muslims)]	2.6 (1.2–5.7)	Attitude to Hygiene, Attitude to Diet, Parental Indulgence n = 12 [IM = 3 (all Muslims)]	3.6 (1.1–11.9)
Parental Indulgence n = 50 [IM = 14 (8 Muslims)]	2.6 (1.3–5.3)	Attitude to Hygiene, Parental Indulgence n = 28 [IM = 6 (5 Muslims)]	2. 0 (0.8–4.9)	–	–
Attitude to Diet n = 95 [IM = 10 (6 Muslims)]	2.6 (1.3–4.7)	Parental Indulgence, Attitude to Diet n = 19 [IM = 5 (3 Muslims)]	3.0 (1.1–8.1)	–	–

Odds ratios (OR) with confidence intervals (95% CI) indicate the strength of relationship between 'exposure category' and the dependent variable, severe caries increment from 3 to 5 years of age.
IM, immigrant.

Table 4. The results of multiple logistic regression analyses, showing predictors in 3-year-old children associated with the dependent variable, without 'Oldham method'

	'Severe caries increment'[a]			
Predictors	Distribution of the variables ($n$total = 304)	OR	95% CI	P-value
Immigrant Status	WN (273), IM (31)	3.4	1.9–9.9	0.023
Attitude to Diet	Favourable (202), negative (95)[b]	2.4	1.2–4.9	0.015
Baseline $d_{3\text{-}5}$mfs (continuous variable)		2.2	1.4–3.7	0.001

OR, odds ratio; CI, confidence interval.
[a]Severe caries increment = $\Delta d_{3\text{-}5}$mfs, excluding molar-approximal caries.
[b]Not all the participants answered all the items.

0.65 (95% CI: 0.52–0.76) and specificity 0.63 (95% CI: 0.60–0.66). The corresponding sensitivity and specificity values for caries ($d_{1\text{-}5}$mfs level) at 3 years were 0.45 (95% CI: 0.33–0.56) and 0.86 (95% CI: 0.83–0.88). The combination of attitudes will correctly predict caries increment in 35 patients and previous caries experience at 3 years predicts a corresponding number of 25.

2004 Attitudes: description of their relationship to experienced caries increment

'Attitude to Hygiene' in 2002, not being related with 'severe caries increment', appeared in 2004 to be related to this dependent variable (OR = 2.1, 95% CI: 1.1–4.1). The frequency of negative 'Attitude to Hygiene' was found to be lower in 2004 than in 2002 ($P < 0.001$), and a similar reduction was also traced in the other two parental attitudes, 'Parental Indulgence' and 'Attitude to Hygiene'.

The children with parents with negative attitudes in 2004 were especially likely to have experienced new caries from the age of 3 years. Among children (5-year olds) with two or more new severe carious lesions during the period 2004, the proportion of indulgent parents was 5.3 times higher than among those children without any severe caries increment. Additionally, 5-year-old children who in 2004 were exposed to two negative parental attitudes, turned out to have gained many new carious lesions. A proportion of 75% of those being simultaneously exposed to negative 'Attitude to Diet' and 'Parental Indulgence' (n = 16) had attained new severe carious lesions from 2002 to 2004. On the contrary, of the group who in 2004 were exposed to the same attitudes but positive, 10.6% (23/218) had experienced new severe carious lesions. Concerning those 5-year-old children who in 2004 were exposed to both negative 'Attitude to Hygiene' and 'Parental Indulgence' (n = 17), new severe carious lesions affected 70.6%. With similar positive attitudes, only 14.3% (33/230) had this experience. Just nine children (IM = 6) were exposed to three negative attitudes simultaneously (negative 'Attitude to Hygiene', 'Parental Indulgence', negative 'Attitude to Diet'). Eight of them had experienced new severe carious lesions (IM = 6) during the 2-year period.

Combined parental dental attitudes in 2002 and 2004 and impact on caries increment

In a bivariate logistic regression model the variable 'Consistent Negative Attitude to Diet' (unfavourable parental attitudes both in 2002 and 2004, $n = 41$) appeared to be related to 'severe caries increment' (OR = 6.0, 95% CI: 2.7–13.4). The reference value had positive 'Attitude to Diet' in 2002 and 2004. Relationship to 'severe caries increment' was also documented when the 'Attitude to Diet' was positive in 2002 and negative in 2004 (OR = 5.0, 95% CI: 1.9–13.6). Being negative in 2002, but positive in 2004, did not show any significant difference from being positive at both sessions (continuity correction = 2.38, $P = 0.123$).

The same trend could be traced with respect to the variable 'Parental Indulgence', as 'Consistent Parental Indulgence' (negative both in 2002 and 2004, $n = 19$) was significantly related to the dependent variable (OR = 7.4, 95% CI: 2.8–19.7). The reference variable then chosen in OR statistics was not being indulgent in both 2002 and 2004.

In a bivariate logistic regression model, the independent variable 'Parental Indulgence' showed higher OR values with the dependent variable when appoximal caries on anterior teeth was included than when it was excluded (OR = 7.4, 95% CI: 3.5–15.8 vs OR = 6.7, 95% CI: 3.1–14.6). The same trend was documented for 'Attitude to Diet' (OR = 4.7, 95% CI: 2.4–9.2 vs OR = 4.2, 95% CI: 2.0–8.8).

Discussion

The present follow-up study shows that parental dental attitudes seem to be important for caries increment in young children. Although this association has been discussed for years based on cross-sectional studies, there is a lack of studies focusing on parental dental attitudes over time (20). Only the longitudinal design may open up for categorizing negative parental dental attitudes (the exposure) as caries-risk factors (the outcome: caries increment). Furthermore, the focus on non-biological determinants is important, because for too many years the concept of causation of caries has been restricted to biological processes only (21).

Caries data of the children were collected at the age of 3 years. Those experiencing caries so early in life are susceptible to developing new caries (22), meaning that past caries experience, shown as a potent caries predictor (23), at this age may also be considered. Simultaneously, the results from the present study confirm that at 3 years of age prediction of children at risk for developing new caries is difficult because of the complex aetiology of caries during early childhood (24). Nevertheless, at that age the sum of sensitivity and specificity when parental attitudes were predictors (sens. + spec. = 1.28) was very similar to the sum when past caries experience (sens. + spec. = 1.30) was the predictor. This indicates that a higher number of the 3-year-old children actually at risk were identified by using parental attitudes as predictor (sensitivity 0.65, 95% CI: 0.52–0.76) rather that past caries experience (sensitivity 0.45, 95% CI 0.33–0.56). Additionally, 'Attitude to Diet' showed a closer relationship with caries increment in the multiple regression analysis than the relationship between 'Baseline caries experience' and the dependent variable. Most children belonging to the combined exposure groups (Table 3) also showed higher relationship with caries increment than those who were singly exposed. These results suggest placing more emphasis on parental dental attitudes in targeted community-based health promotion programmes.

Details about the Cohen's kappa scores from 2002 have been previously described (8, 11), and the inter-observer reliability during the project period in 2002 was within an acceptable range. Both one session in 2003 and twice in 2004 were used to calibrate the oral hygienists, but no further Cohen's kappa calculations were performed. This is a limitation of the study seen in the light of the fact that so many examiners participated. Another concern was the degree of interrelatedness, but the values of Spearman's r attained in analyses between combinations of the attitudinal variables were estimated as moderate, allowing them to be acceptable as independent variables.

The response rate from baseline to follow-up during the 2-year period was high (25). The results were probably not affected by the attrition of participants from 2002 to 2004 because the baseline caries experience among drop-outs and included children was not statistically different. As described in a previous study (8), the drop-out from the original sample to the baseline sample in 2002 was higher among immigrant children. Considering the high caries increment in children with immigrant background, there are reasons to believe that if more immigrant children had participated, caries increment during the period would have

been higher. The low proportion of immigrants in the study suggests that a higher number could have been recruited if a randomized sample had been accomplished.

The questionnaire used has previously been shown to be a useful supplementary instrument in childhood caries epidemiology (1, 8). The present questionnaire compared with the multicentre study (1) might be enhanced in validity, as items in the former study not found linked to caries experience were deleted in the present study. Furthermore, Cronbach's α indicated good reliability (26). Higher response rate to various items among immigrant parents in 2004 than 2002 (8) might be seen as a consequence of longer stay in Norway and with it, improved language skills. It was also endeavoured to make the background conditions of caries examinations stable and comparable. By excluding approximal caries in molars (radiographs taken only at age 5 years), more relevant comparisons could be made realistic.

The severity of carious attack should be assessed relative to the age of the child (22, 27). This indicates that a child experiencing caries at the dentine level before the age of 5 years has a caries problem. The finding that the distribution of caries increment was heavily skewed, is in line with reports about caries distribution in preschool children (28) and with literature indicating that immigrant children dominate in the group responsible for most new carious lesions (29).

In the light of the documented impact of parental attitudes on caries increment, it was of interest to see whether their parents' changed dental attitudes from 2002 to 2004 were associated with children's dental health. The results showed that those parents with negative attitudes in 2002 and in 2004 had children with an especially high caries increment. The parents of 5-year olds with negative attitudes in 2004, though positive 2 years earlier, also had children with considerable severe caries increment. One explanation for this might be attributed to insufficient language capacity in the immigrant group. However, the children of parents who had changed from having negative attitudes in 2002 to positive attitudes in 2004, did not differ in severe caries increment from the children of parents who had been positive at both years. From this information it might be extracted that it is potentially beneficial to try to influence parents to change attitudes when their child is 3 years of age. However, caution should be exercised before concluding, as a 2-year period is too short an interval to monitor the changes over time.

Compared with the results from the previous cross-sectional study with caries prevalence as dependent variable (8), the present study showed higher ORs for attitudinal variables when severe caries increment was the dependent variable. The variable 'Attitude to Diet' proved to be the most persistent parental attitude related to children's caries increment. An additional indication of its robustness is the fact that it also remained in the model after adjusting for the modified baseline score ('Oldham's method').

Another feature of these results is that they seemed to fit with our knowledge of caries patterns. For instance, by being able to also check 2004-parental attitudes, when approximal carious lesions of anterior teeth are included in the dependent variable, the association with parental attitudes is stronger than when they are not. A pattern of caries in maxillary anterior teeth is typical for young children (27). Another finding which is not surprising is that parents who persist expressing negative attitudes towards oral health are the most likely to have children with high caries incidence.

The variables indicating dental behaviours, 'Supervised Brushing' or 'Frequent Sugar', however, did not show the same strength of association with severe caries increment as their respective background attitudes. This is also as previously reported (1, 8). One reason might be that parental attitudes differentiate better than do commonly practised behaviours like regular supervised toothbrushing. Responders know the acceptable norms and adapt their answers to accord with these norms (30). Recall bias might be another possible explanatory reason for questionnaire errors. Therefore the responses to 'Age started Brushing' and 'Sugary Drink at Bedtime' were obtained from the 2002 version of the questionnaire. Valuable information probably would have been lost if only parents of 5-year olds had been asked about these habits.

An important finding, consistent with literature, is that negative attitudes regarding children's dental health are relatively more frequent among IM than among WN parents. In low-caries communities with widespread use of fluoride, having a sugary diet, unlike previously, is not considered to be a threat to oral health (31). As fluoride use is not as widespread among immigrant and ethnic groups as among other children and dental knowledge is frequently poor, within these groups

sugary diet still represents a dominant caries risk factor (31). The pattern of use of sugar has also been changed in recent years, from pure sugar consumption to an increased intake of sweets and chocolates (32, 33).

Pregnant women or mothers with newborn children as a group are found to be receptive to oral health information (34). The present documented relationship between negative parental attitudes and caries development in children is concrete and should be easily made intelligible for those involved. Vulnerable and/or socially excluded groups of parents with low awareness and appreciation of dental health are in need of social support to develop skills to take care of their children's teeth. However, there is no guarantee that they will adapt newly acquired positive attitudes into positive dental behaviours for their children. For parents of low socioeconomic backgrounds or of ethnic minorities, it is extra important to address the parents early, but with oral promotion programmes given in their socio-cultural context (35). Mainstream promotion health programmes for these groups are shown not to be effective (36).

One of the crucial points in targeted community-based health promotion programmes is the identification of the specific groups of parents who are at greater risk of having or getting children with early childhood caries. In the literature, it is claimed that primary prevention of early childhood caries will fail unless it begins in the prenatal period and addresses the health of both mother and child (37). Dental health intervention programmes from early age are also documented to have better cost–benefit and cost-effectiveness ratios than other preventive programmes (38). One possible implication of the results from the present study might be that future mothers attending child healthcare clinics could by responding to the present key dental attitudinal questions, easily be identified as being in need of specialized community-based health promotion programmes. The assumption then is made that parental attitudes could predict caries development before the age period studied in the present study, even before plaque has accumulated on any tooth surface. Hitherto, in early childhood before caries is established, plaque accumulation been considered an important caries predictor (39).

In conclusion, parental dental attitudes are clearly shown to be associated with caries increment in early childhood. The relationship is of such strength that this risk factor deserves to be taken into account in future preventive dental strategies.

Acknowledgement

This study was funded by grants from the Norwegian Foundation for Health and Rehabilitation (EXTRA funds). We also acknowledge the assistance by the Norwegian Association for Promotion of Oral Health (Norsk Tannvern). Furthermore, we like to thank Public Dental Health Services, Oslo and Prof. C. Pine, University of Liverpool, UK.

References

1. Pine CM, Adair PM, Nicoll AD, Burnside G, Petersen PE, Beighton D et al. International comparisons of health inequalities in childhood dental caries. Community Dent Health 2004;21:121–30.
2. Conner M, Norman P. Predicting health behaviour. Buckingham, Philadelphia, PA: Open University Press; 1995.
3. Dencik L. Modern childhood in the Nordic countries: ''Dual socialisation'' and its complications. In: Chisholm L., editor. Growing up in Europe. Berlin: de Gruyter; 1995. p. 105–19.
4. Ng MW. Multicultural influences on child-rearing practices: implications for today's pediatric dentist. Pediatric Dent 2003;25:19–22.
5. Rudolph-Touba J. Marriage and the family in Iran. In: Singh Das M editor. The family in the Muslim world. New Delhi: M.D. Publications Pvt. Ltd; 1991. p. 78–120.
6. Kongar E. The family in Turkey. In: Singh Das M editor. The family in the Muslim world. New Dehli: M. D. Publications Pvt. Ltd; 1991. p. 121–30.
7. Khader N, Esmark L. Muslimske innvandrere i Norden - adfærd og kulturarv. Odontologi 99. 1999: 63–83.
8. Skeie MS, Riordan PJ, Klock KS, Espelid I. Parental risk attitudes and caries-related behaviours among immigrant and western native children in Oslo. Community Dent Oral Epidemiol 2006;34: 103–13.
9. Rossow I. Intrafamily influences on health behavior. A study of interdental cleaning behavior. J Clin Periodontol 1992;19:774–8.
10. Grytten J, Rossow I, Holst D, Steele L. Longitudinal study of dental health behaviors and other caries predictors in early childhood. Community Dent Oral Epidemiol 1988;16:356–9.
11. Skeie MS, Espelid I, Skaare A, Gimmestad A. Caries patterns in an urban, preschool population in Norway. Eur J Paediatr Dentistry 2005;6:16–22.
12. Vassenden E, Bjertnæs S, Hauge I. Barn og unge med innvanderbakgrunn: aktuell statisstikk [Children and adolescents with immigrant background: current statistics]. Kongsvinger: Statistisk sentralbyrå; 2000.
13. Amarante E, Raadal M, Espelid I. Impact of diagnostic criteria on the prevalence of dental caries in Norwegian children aged 5, 12 and 18 years. Community Dent Oral Epidemiology 1998;26:87–94.
14. Ajzen I. The theory of planned behaviour. Organizational Behav Human Decision Proc 1991;50: 179–211.

15. Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the Health Belief Model. Health Educ Q 1988;15:175–83.
16. Wallston KA, Wallston BS, DeVellis R. Development of the Multidimensional Health Locus of Control (MHLC) Scales. Health Educ Monogr 1978;6:160–70.
17. Pine CM, Adair PM, Petersen PE, Douglass C, Burnside G, Nicoll AD et al. Developing explanatory models of health inequalities in childhood dental caries. Community Dent Health 2004;21:86–95.
18. Adair PM, Pine CM, Burnside G, Nicoll AD, Gillett A, Anwar S et al. Familial and cultural perceptions and beliefs of oral hygiene and dietary practices among ethnically and socio-economicall diverse groups. Community Dent Health 2004;21:102–11.
19. Tu YK, Maddick IH, Griffiths GS, Gilthorpe MS. Mathematical coupling can undermine the statistical assessment of clinical research: illustration from the treatment of guided tissue regeneration. J Dent 2004;32:133–42.
20. Harris R, Nicoll AD, Adair PM, Pine CM. Risk factors for dental caries in young children: a systematic review of the literature. Community Dent Health 2004;21:71–85.
21. Holst D, Schuller AA, Aleksejuniene J, Eriksen HM. Caries in populations – a theoretical, causal approach. Eur J Oral Sci 2001;109:143–8.
22. Grindefjord M, Dahllof G, Modeer T. Caries development in children from 2.5 to 3.5 years of age: a longitudinal study. Caries Res 1995;29:449–54.
23. Powell L. Caries prediction: a review of the literature. Community Dent Oral Epidemiology 1998;26:361–71.
24. Ismail AI. Determinants of health in children and the problem of early childhood caries. Pediatr Dent 2003;25:328–33.
25. Salant P, Dillman D (editors). How to conduct your own survey. New York: John Wiley & Sons; 1994.
26. Campbell MJ, Machin D. Medical statistics. A commonsense approach. Chichester: Wiley; 1999.
27. Drury T, Horowitz A, Ismail A, Maertens M, Rozier R, Selwitz R. Diagnosing and reporting early childhood caries for research purposes. A report of a workshop sponsored by the National Institute of dental and craniofacial research, the health resources and services administration, and the health care financing administration. J Public Health Dent 1999;59:192–7.
28. Vehkalahti M, Tarkkonen L, Varsio S, Heikkila P. Decrease in and polarization of dental caries occurrence among child and youth populations, 1976-1993. Caries Res 1997;31:161–5.
29. Wendt LK, Hallonsten AL, Koch G. Oral health in pre-school children living in Sweden. Part III – a longitudinal study. Risk analyses based on caries prevalence at 3 years of age and immigrant status. Swed Dent J 1999;23:17–25.
30. Sjostrom O, Holst D. Validity of a questionnaire survey: response patterns in different subgroups and the effect of social desirability. Acta Odontol Scand 2002;60:136–40.
31. Zero DT. Sugars – the arch criminal? Caries Res 2004;38:277–85.
32. Haugejorden O, Birkeland JM. Evidence for reversal of the caries decline among Norwegian children. Int J Paediatric Dent 2002;12:306–15.
33. Moynihan P. The British Nutrition Foundation Oral Task Force report – issues relevant to dental health professionals. Br Dent J 2000;188:308–12.
34. Feldens CA, Vitolo MR, Drachler Mde L. A randomized trial of the effectiveness of home visits in preventing early childhood caries. Community Dent Oral Epidemiol 2007;35:215–23.
35. Dhawan N, Bedi R. Transcultural oral health care. 6 The oral health of minority ethnic groups in the United Kingdom – a review. Dent Update 2001; 28:30–4.
36. Schou L, Wight C. Does dental health education affect inequalities in dental health? Community Dent Health 1994;11:97–100.
37. Milgrom P. Response to Reisine & Douglass: psychosocial and behavioral issues in early childhood caries. Community Dent Oral Epidemiol 1998;26: 45–8.
38. Kowash MB, Toumba KJ, Curzon ME. Cost-effectiveness of a long-term dental health education program for the prevention of early childhood caries. Eur Arch Paediatr Dent 2006;7:130–5.
39. Alaluusua S, Malmivirta R. Early plaque accumulation–a sign for caries risk in young children. Community Dent Oral Epidemiol 1994;22:273–6.