Int J Public Health (2012) 57:207–215
DOI 10.1007/s00038-011-0291-3

ORIGINAL ARTICLE

The influence of social status on pre-school children's eating habits, caries experience and caries prevention behavior

Klaus Pieper · Simone Dressler · Monika Heinzel-Gutenbrunner · Anne Neuhäuser · Matthias Krecker · Klaus Wunderlich · Anahita Jablonski-Momeni

Received: 15 June 2010 / Revised: 1 June 2011 / Accepted: 1 August 2011 / Published online: 13 September 2011

Abstract
Objectives To assess the prevalence of Early Childhood Caries (ECC) in a county in Northern Hesse and to correlate this parameter to various independent variables. Additionally to investigate the relationship between preventive measures and the socioeconomic status (SES).
Methods In spring 2006, 1,082 preschool children were examined. According to WHO-criteria d_{3+4}mft scores were recorded. Information about eating habits and preventive measures were collected by structured questionnaires. To compare the mean caries scores and preventive measures of various subgroups, non-parametric tests were performed. Variables associated with caries were included in a binary stepwise backward logistic regression analysis.
Results The mean d_{3+4}mft score amounted to 1.88. Children with high SES had significantly less caries than children with low SES. Significant positive and negative associations of feeding practices and preventive measures to d_{3+4}mft scores were observed. Differences between feeding practices and preventive measures were dependent on SES.
Conclusions Long-term use of baby bottles at night is the most important factor of ECC. Differences in feeding practices and preventive measures in the various SES groups are evident but not that significant as supposed.

Keywords Early childhood caries · Caries experience · Preschool children · Socioeconomic status-health disparities · Germany

K. Pieper (✉) · S. Dressler · M. Heinzel-Gutenbrunner · A. Jablonski-Momeni
Department of Pediatric and Community Dentistry, Philipps-University Marburg, Georg-Voigt. Str. 3, 35033 Marburg, Germany
e-mail: pieper@med.uni-marburg.de

A. Neuhäuser
Butzbach, Germany

M. Krecker
Löhne, Germany

K. Wunderlich
Public Health Department, Korbach, Germany

Introduction

Implementing guidelines on fluoridation and instituting preventive measures in kindergartens and schools have improved the oral health of children and young people in most industrialized countries in the past decades (Marthaler 2004; Declerck et al. 2008). The results of a study organized by Deutsche Arbeitsgemeinschaft für Jugendzahnpflege ("German Association for children's dental care") in 2004 confirmed that this trend is found in Germany, as well (Pieper 2005; Schulte et al. 2006). Analyzing the situation shows that caries experience differs among various age groups and federal states in Germany. While the dental health of 12-year olds improved in all federal states, there is much more variation among 6- to 7-year olds. In some regions, dental health stagnated or worsened. State-specific differences in the prevalence of "early childhood caries" (ECC) could possibly be explained by differences in the sociodemographic development of the individual regions. A higher rate of immigrant families, unemployment and social discrimination of the younger generation are critical problems in certain regions and can be associated with a rise in caries prevalence (Stecksén-Blicks et al. 2004; Pieper 2005).

Many studies have shown a relationship between caries prevalence among pre-school children and the socioeconomic status of their parents (Schou and Uitenbroek 1995;

Grindefjord et al. 1996). The social status of the families was determined by the parents' level of education and earnings, as well as the absolute family income (Psoter et al. 2006; Momeni et al. 2007a). In industrial countries, children of high socioeconomic status consistently exhibit a lower caries experience than children of low social status (Truin et al.1998; Schiffner et al. 2001; Källestal and Wall 2002; Momeni et al. 2007b). This tendency is also valid for Germany according to the results of the "Fourth German Oral Health Study" (Micheelis and Reiter 2006). Despite a general improvement in dental health among children, large differences in caries experience were discovered between members of different social classes. A publication of an international longitudinal study emphasizes that early colonization with Mutans Streptococci and the consumption of sugar-sweetened beverages are the only significant risk factors for ECC (Warren et al. 2009). However, social status has an indirect influence on the risk of caries because it is associated with certain behaviors, such as inappropriate use of baby bottles, rarely taking advantage of preventive dental care, low frequency, and effectiveness of brushing, and a high level of sugar consumption (Litt et al. 1995). Children with immigrant background exhibit a significantly higher caries experience in their permanent teeth and rarely take advantage of preventive measures; they have been identified as a high-risk group (Kühnisch et al. 2001). The results of a study conducted regionally have shown that Turkish infants and kindergarten children go to the dentist later and less often when compared to German children (van Steenkiste 2003). International studies confirm that immigrants and their families make use of dentists' services less often (Adair et al. 2004). Along with linguistic and cultural communication deficits, some of the most common causes of immigrants' inadequate dental care include a lack of information and a low standard of education (Kühnisch et al. 2001).

An examination of 5-year olds in Amsterdam (Verrips et al. 1992) ascertained the parents' level of education as well as the gender and ethnicity of the children to be the most important indicators of caries risk. Further, the children's age when their parents began to brush their teeth, taking fluoride tablets and regular dental care in the past were discussed as relevant parameters.

This regional study in Hesse (Germany) aimed to record prevention behavior of the parents of pre-school children and to relate it to children's dental health. Additionally the influence of the socioeconomic status (SES) on various independent variables and the outcome variable caries experience was investigated.

Methods

The examinations were performed in northern Hesse in the district of Waldeck-Frankenberg from March to July 2006. This is a primarily rural region counting 167,121 residents, 5.1% with immigration background.

All 5 to 7-year-old children attending the local kindergartens in this region received information letters distributed by the kindergarten staff encouraging them to participate in this study. Families with immigration background received letters in their language. The common languages were Russian and Turkish. No additional information events were offered. Those parents who did not respond to the invitation letter were asked to participate in the study by the staff when taking their children to the kindergarten.

Only those children were included whose parents had filled in the questionnaire and had given written informed consent. Mentally or physically disabled children were not included in the study. The study was approved by the ethics committee of our medical faculty.

The examinations were performed by two dentists who were trained by an experienced dentist prior to the study. The training included theoretical information, preliminary diagnostic training with slides and examinations of extracted teeth. This was followed by practical training in which a sample of 5 to 7-year-old children was examined by each of the study examiners, and the diagnoses compared to those recorded by the reference examiner. Intra-examiner agreements (Kappa value) for both examiners were 0.69 and 0.76, respectively. Kappa values for agreement to the reference examiner (inter-examiner reproducibility) were 0.64 and 0.73, respectively.

In total, 1,082 pre-school children from 86 kindergartens took part in the study, representing 67.6% of the 5 to 7-year-old children of the study region. The sample comprised 165 5-year olds (15.2%), 584 6-year olds (54%) and 333 7-year olds (30.8%).

The dental examinations were performed using plane mirrors, dental probes, and artificial light. No radiographs were taken. Teeth were recorded using the d_{3+4}mft index (d = decayed, m = missing, f = filled and t = tooth/teeth) at the level of dentin caries (d_{3+4}) according to the criteria originally introduced by Marthaler (1966).

In addition to the clinical examination, specific aspects of the children's exposure to preventive measures were ascertained by having their parents fill in a questionnaire on their own. Distinctive aspects of eating habits in early childhood were recorded including all independent variables that can be related to dental health (Harris et al. 2004).

The following variables were surveyed:

(a) Duration of breast feeding (yes/no/duration in months).
(b) Sleeping in the parents' bed after the eighth month of life and frequent breast-feeding at night (yes/no/duration in months of life).
(c) Use of baby food or drinks from the bottle (yes/no/duration in months of life).

(d) Type and duration of the beverages drunk from the bottle (type/duration in months of life).
(e) Letting the child have the bottle at night (yes/no/duration in months of life).
(f) Using the bottle on trips after the 12th month (yes/no/duration in months of life).
(g) Frequency of daily consumption of sugar-sweetened food and beverages (× times/never/don't know).
(h) Frequency and type of cariogenic between-meal snacks (type/× times per week).
(i) Type, duration and frequency of systemic fluoridation, such as fluoride tablets and fluoridated table salt (yes/no/duration in years of life).
(j) Age at which tooth brushing started (year of life).
(k) Type of toothpaste used (children's toothpaste/adult toothpaste; fluoridated/non fluoridated).
(l) Age of starting to attend kindergarten (year of life/do not know).
(m) Who brushed the child's teeth in the first to third year of life or from the third to sixth year of life? (the child himself or herself/with the help of the parents/the parents only).
(n) Frequency and time of brushing teeth (actually not at all/once per week/two to three times per week/four to six times per week/once a day/twice a day and oftener).
(o) Time of first visit to dentist (year of life).
(p) Reason for going to dentist (pain, discomfort/sometimes for a checkup/regularly for a checkup/no visit to dentist so far).
(q) Type and frequency of fluoridating at the dentist's office (none/fluoride varnish/fluoride solution/do not know/× times).
(r) Parents' schooling (elementary school/eighth grade/tenth grade/*mittlere Reife* or *Realschulabschluss* (types of German high school diplomas)/technical secondary school/technical college/qualification for university/other graduation/none of the above, no graduation.
(s) Highest level of occupational training completed by the parents (apprenticeship/technical college/university degree/other vocation qualification/none).
(t) Employment and occupational category of the parents (academic, independent professional/self-employed/public official, judge, professional soldier/salaried employee/worker/in training or just finished with training/family worker/unemployed/other).

To develop potential class-specific approaches explaining differences related to caries experience, the social status of the parents was classified to three different groups. The following parameters determined to which social class they belonged: highest level of education, highest level of vocational training and occupational status. The data from the mother and the father were averaged.

To establish the class, the data on "highest level of education", "highest level of vocational training" and "occupational status" were transliterated (Jöckel 1998; Winkler 1998). An additive index was calculated from these three variables capable of accepting values between 3 and 21. Social status index values from three to six were assessed as "low social status", from nine to fourteen as "average social status" and from 15 to 21 as "high social status".

Data collection and statistical analysis

The results of the dental examination and the data gathered with the questionnaire were recorded with an especially designed computer program and collated in a Microsoft Excel database. The statistical analysis was performed using SPSS, Version 17.0.

To study the association between risk factors and caries, bivariate analyses were performed. To check the simultaneous influence of the independent variables on dental health a stepwise backward logistic regression analysis was used including the variables with P values < 0.05 in the bivariate tests.

The significance level was set at 0.05. Mann–Whitney U tests were used to test for differences of the averages. In the bivariate analyses, children with missing values were excluded. In the multivariate logistic regression, in order to avoid too many missing values, the categories missing and the high-risk behavior were collapsed, for instance no intake of fluoride tablets and no response were opposed to taking fluoride. This was because according to former studies caries in children with missing values in the questionnaire is at least as high as in children with high-risk behavior.

To evaluate potential associations between d_{3+4}mft and different preventive measures, adjustments were made for the most important confounders by using the binary logistic regression model. The children were divided into two groups, one with $d_{3+4}mft = 0$ and on with $d_{3+4}mft > 0$. Tables 1, 2, and 3 show how the dichotomies of the independent variables were performed. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated. The chi square test was used to determine how the social status related to the various behavior parameters contributed to eating habits and dental care.

Results

Among the 5- to 7-year olds, 55% had deciduous teeth free of dentin caries ($d_{3+4}mft = 0$) (Fig. 1). The largest d_{3+4}mft score observed was 16 out of a possible 20. The

Table 1 Bivariate analysis: association of different nursing habits with caries experience of 5 to 7-year-old children, Germany 2006

Variables	Dichotomization	*N* (%)	Mean d_{3+4}mf-t	Baseline risk	Odds ratio (CI)
Duration of breast feeding	<8 months	714 (66)	1.86	0.46	0.88 (0.68–1.13)
	≥8 months	368 (34)	1.92		
	P value		0.595		
Breast feeding in parents' bed at night	Yes	106 (9.8)	2.83	0.44	1.48 (0.99–2.22)
	No	802 (74.1)	1.80		
	Missing value	174 (16.1)			
	P value		0.008		
Duration of frequent breast-feeding in parents' bed at night	<8 months	809 (74.8)	1.79	0.44	1.36 (0.86–2.15)
	≥8 months	81 (7.5)	2.81		
	Missing value	192 (17.7)			
	P value		0.027		
Duration of baby bottle feeding	<8 months	226 (20.9)	2.2	0.48	0.87 (0.64–1.17)
	≥8 months	767 (70.9)	1.75		
	Missing value	89 (8.2)			
	P value		0.123		
Duration of night-time baby bottle use	<8 months	717 (66.3)	1.58	0.41	2.16 (1.54–3.04)
	≥8 months	169 (15.6)	2.88		
	Missing value	196 (18.1)			
	P value		<0.000		
Frequency of daily consumption of sugar-sweetened food	<3	550 (50.8)	1.90	0.46	1.09 (0.82–1.45)
	≥3	298 (27.5)	2.27		
	Missing value	234 (21.6)			
	P value		0.230		
Frequency of daily consumption of sugar drinks	<3	438 (40.5)	1.61	0.42	1.53 (1.15–2.03)
	≥3	337 (31.1)	2.47		
	Missing value	307 (28.4)			
	P value		<0.000		
Total sugar impulse in between main meals	<8	458 (42.3)	1.97	0.47	0.97 (0.74–1.26)
	≥8	402 (37.2)	2.08		
	Missing value	222 (20.5)			
	P value		0.892		
Use of baby bottle on trips after the 12th month	Yes	266 (24.6)	1.81	0.46	1.17 (0.86–1.58)
	No	452 (41.8)	2.34		
	Missing value	364 (33.6)			
	P value		0.113		
Frequency of cariogenic between-meal snacks	<2	163 (15.1)	1.74	0.44	1.17 (0.83–1.65)
	≥2	697 (64.4)	2.09		
	Missing value	222 (20.5)			
	P value*		0.193		
Start tooth brushing	<2 year of life	782 (72.3)	1.68	0.43	1.53 (1.16–2.02)
	≥2 year of life	279 (25.8)			
	Missing value	21 (1.9)	2.51		
	P value		0.000		
Frequency of brushing teeth	Once a day or more	1044 (96.5)	1.85	0.45	1.56 (0.70–3.47)
	Less than once a day	25 (2.3)	3.72		
	Missing value	13 (1.2)			
	P value		0.056		

Table 1 continued

Variables	Dichotomization	*N* (%)	Mean d_{3+4}mf-t	Baseline risk	Odds ratio (CI)
Brushing child's teeth by the parents after third birthday	Yes	731 (67.6)	1.56	0.41	1.75 (1.33–2.30)
	No	292 (27.0)	2.58		
	Missing value	59 (5.5)			
	P value		<0.001		
Intake of fluoride-supplements	Yes	971 (89.7)	1.82	0.44	1.56 (1.01–2.40)
	No	91 (8.4)	2.52		
	Missing value	20 (1.8)			
	P value		0.053		
Intake of fluoridated table salt	Yes	702 (64.9)	1.66	0.43	1.33 (1.03–1.72)
	No	363 (33.5)	2.31		
	Missing value	17 (1.6)			
	P value		0.003		

d_{3+4}mf-t decayed, missing, filled teeth, *CI* 95% confidence interval

Table 2 Binary logistic regression analysis: association between d_{3+4}mft (decayed, missing, filled teeth) and the most essential variables—final model, Germany 2006

Variable	β	Wald factor	*P* value	Odds ratio (95% CI)
Night-time bottle use	0.72	12.5	<0.001	2.05 (1.25–2.85)
Intake of fluoride-supplements	−0.54	2.8	0.095	0.58 (0.10–1.06)
Brushing by parents after third birthday	−0.42	4.9	0.027	0.66 (0.38–0.94)
High socio-economic status	−0.36	4.4	0.037	0.70 (0.44–0.96)

β adjusted coefficient of the regression, *CI* 95% confidence interval

average d_{3+4}mft was 1.88 and the care index (mf-t/d_{3+4}mf-t) amounted to 45.7% (Fig. 2).

In 12.9% of the 5- to 7-year olds cavities were localized in the upper deciduous incisors. However, ECC Type II according to Wyne's classification requiring four diseased upper incisors (Wyne 1999) was only found in 3.3% of the children.

The average d_{3+4}mft of 2.46 among children from families of low social status was nearly twice as high as that among children with a high social background (d_{3+4}mft = 1.33) (Fig. 3).

The results of the bivariate analysis are summarized in Table 1. Children who had been breast fed at night in their parents' bed for longer periods exhibited a significantly higher d_{3+4}mft, 2.81, than children without this habit (average d_{3+4}mft = 1.79). Children who had been repeatedly fed at night with a feeding bottle were more likely to develop dental caries (OR 2.16), they exhibited a significantly higher d_{3+4}mft score than other children.

Children drinking sugar-sweetened beverages at least three times a day had significantly higher d_{3+4}mft scores, averaging 2.47, than children who drank sugar-sweetened beverages less often (average d_{3+4}mft = 1.61) (Table 1). Pre-school children whose parents began caring for their teeth in the first year of life exhibited a significantly better state of dental health than children of the same age who began tooth care later. Children whose parents actively helped them brush their teeth after the third year of life exhibited a significantly lower d_{3+4}mft score (1.56) than children whose parents did not help brushing the teeth beyond the third year of life (d_{3+4}mft = 2.56) (Table 1).

The stepwise backward logistic regression analysis (Table 2) showed that the decisive factor in ECC is giving the child a feeding bottle at night. Children repeatedly fed at night with a feeding bottle apparently have twice the risk of developing ECC (odds ratio = 2.05). The baseline-risk (all influencing factors of the final model being at low risk-category) was 0.34.

In order to reveal status-specific differences in caries experience, the response behavior of the parents was broken down by class (Table 3). The results show that breast feeding for 8 months or longer was significantly more frequent in higher social classes than in middle class or in lower class. The proportion of children who drank from feeding bottles was lower in the higher class than among middle-class or low-class children. No significant class-related differences were found neither in the reported frequency of daily consumption of sugar-sweetened drinks nor in the intake of cariogenic between-meal snacks (sugar impulse < 8 per day).

Parents of high and middle social status began caring for their children's teeth significantly earlier than parents of

Table 3 Bivariate analysis: association of different nursing habits and preventive measures in relation to the SES (socio-economic status), Germany 2006

Variable	High SES *N* (%)	Medium SES *N* (%)	Low SES *N* (%)
Duration of breast feeding			
<8 months	156 (54.7)	242 (66.7)	228 (75.7)
≥8 months	129 (45.3)	121 (33.3)	73 (24.3)
P value	<0.001		
Breast feeding in parents' bed at night			
Yes	29 (11.4)	35 (11.3)	24 (10.3)
No	225 (88.6)	274 (88.7)	208 (89.7)
P value	0.381		
Baby bottle use			
Yes	215 (76.5)	302 (83.2)	254 (85.8)
No	66 (23.5)	61 (16.8)	42 (14.2)
P value	0.002		
Duration of bottle feeding			
<8 months	70 (29.1)	70 (21.6)	55 (21)
≥8 months	170 (70.8)	254 (78.4)	199 (78.3)
P value	0.030		
Duration of night-time baby bottle use			
<8 months	178 (79.8)	266 (86.4)	192 (76.2)
≥8 months	45 (20.2)	42 (13.6)	60 (23.8)
P value	0.146		
Use of baby bottle on trips after the 12th month			
Yes	67 (37.6)	80 (33.1)	86 (41.5)
No	111 (62.4)	162 (66.9)	121 (58.5)
P value	0.211		
Frequency of daily consumption of sugar drinks			
<3	202 (70.9)	256 (70.5)	205 (68.1)
≥3	83 (29.1)	107 (29.5)	96 (31.9)
P value	0.255		
Total sugar impulse in between main meals			
<8	114 (50.2)	144 (50.7)	132 (54.3)
≥8	113 (49.8)	140 (49.3)	111 (45.7)
P value	0.195		
Intake of fluoride supplements			
Yes	249 (87.7)	338 (93.1)	272 (91.3)
No	32 (11.3)	23 (6.3)	21 (7.0)
Do not know	3 (1.1)	2 (0.6)	5 (1.7)
P value	0.091		
Type of fluoridated table salt used			
Salt with iodine and fluoride	200 (70.4)	245 (68.1)	186 (62.6)
Other salt	84 (29.6)	115 (31.9)	111 (37.4)
P value	0.026		
Start tooth brushing			
<2 years of life	219 (78.2)	281 (78.1)	198 (66.7)
≥2 years of life	61 (21.8)	79 (21.9)	99 (33.3)
P value	<0.001		
Brushing child's teeth up to 3rd birthday			
Child himself/herself	4 (1.4)	4 (1.1)	10 (3.4)
With the help of the parents	165 (59.8)	231 (64.3)	187 (64.5)
The parents only	107 (38.8)	124 (34.5)	93 (32.1)
P value	0.023		
Brushing child's teeth after 3rd birthday			
Child himself/herself	59 (21.6)	85 (24.4)	94 (33.1)
With the help of the parents	208 (76.2)	260 (74.5)	185 (65.1)
The parents only	6 (2.2)	4 (1.1)	5 (1.8)
P value	0.002		
Time of first visit to dentist (year of life)			
1	44 (16.4)	42 (12.1)	22 (8.1)
2	85 (31.6)	110 (31.7)	71 (25.9)
3	93 (34.6)	126 (36.3)	96 (35.0)
>3	47 (17.4)	69 (19.9)	75 (31.0)
P value	<0.001		
Reason for going to dentist			
Never been at dentist	13 (4.6)	12 (3.5)	24 (8.2)
Pain, discomfort	8 (2.8)	6 (1.7)	10 (3.4)
Sometimes for a check up	37 (13.1)	50 (14. 0)	59 (20.1)
Regularly for a check up	225 (79.5)	287 (80.8)	200 (68.3)
P value	0.002		
Type of fluoridating at the dentist's office			
Fluoride varnish or fluoride solution	60 (21.1)	86 (23.7)	43 (14.3)
Non-fluoride varnish or fluoride solution	189 (66.3)	234 (64.5)	204 (67.8)
Do not know	36 (12.6)	43 (11.8)	54 (17.9)
P value	0.006		
Frequency of brushing teeth			
Once a day or more	278 (98.6)	357 (98.9)	290 (97.0)
Less than once a day	4 (1.4)	4 (1.1)	9 (3.0)
P value	0.097		

lower social status (Table 3). In the third to sixth year of life, children of low social status brushed their teeth significantly more often alone (without their parents' help) than middle or upper class children in the same age group. Upper and middle class parents took their children to the dentist during their first year of life significantly more often than parents of low social status (Table 3). 73.8% of the children had their teeth brushed with a fluoridated toothpaste from age 3 onwards.

At the time of the examination, 8.2% of lower class children had never been to a dentist, which occurred

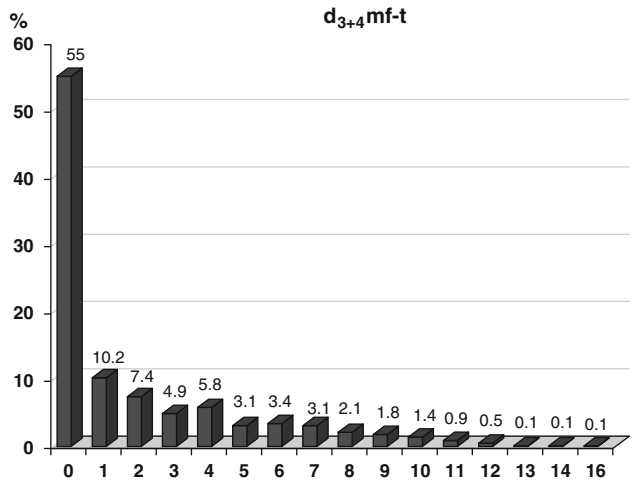

Fig. 1 Relative frequency distribution of the d_{3+4}mft (decayed, missing, filled teeth) values of the 5 to 7-year olds ($n = 1{,}082$), Germany 2006

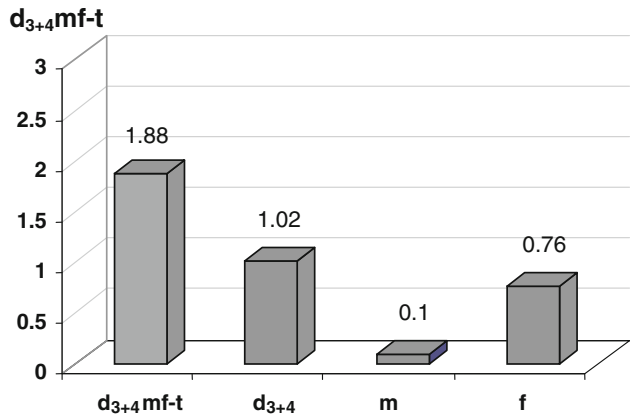

Fig. 2 Mean d_{3+4}mft (decayed, missing, filled teeth), d_{3+4}-t, m-t and f-t of the 5 to7-year olds ($n = 1{,}082$), Germany 2006

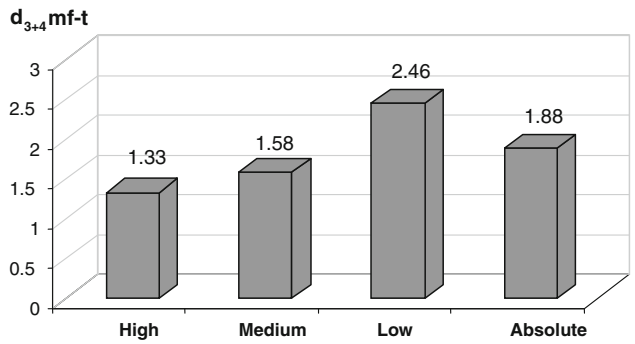

Fig. 3 Caries experience of the 5 to 7-year olds in relation to the socio-economic status (SES), Germany 2006

significantly more often compared to children of high and middle social status (4.6 and 3.5%, respectively). Parents of lower social status more frequently visited a dentist only when their children had pain or discomfort, while upper and middle class parents more frequently brought their children in for preventive checkups.

Discussion

This study registered a comparatively low level of caries prevalence among the pre-school children examined. Of the 5- to 7-year olds, 55% had no caries experience and the average d_{3+4}mft score was 1.88. These figures are somewhat better than those of the most recent study performed in Hesse (50.6% dmft = 0) (Pieper 2005). A regional longitudinal study in Germany reported a rise in caries prevalence among children 2–4 years old. The average d_{3+4}mft scores increased between 2000 and 2002 from 0.36 to 1.15 (Borutta et al. 2005). An increase in early childhood caries has also been detected in other countries (Skeie et al. 2006). A comparison of caries experience among 4-year olds in Sweden shows a slight increase in caries prevalence since 1997, following a decrease in the seventies and eighties (Wendt et al. 1999, Stecksén-Blicks et al. 2004). In 2002, 54% of 4-year olds had no caries experience, the average dmft score was 1.7. In Denmark, no further decline of caries in the primary dentition of 3- to 6-year olds was registered in the early 1990s (Poulsen 1996). An examination using data from public dental clinics in Norway even reports an increase in caries prevalence between 1997 and 2000 among 5-year olds, from 30.4% in 1997 to 38.9% in 2000 (Haugejorden and Birkeland 2002).

In our study, only 3.3% of the examined children showed carious lesions which correspond to ECC Type II according to Wyne (1999). This low number might be because 30.8% of examined children were 7-year olds who might already have exfoliated deciduous incisors. Studies which report the prevalence of early childhood caries usually include children of 5-year-old age and younger. A study in Brazilian pre-school children showed an ECC prevalence of 4.9% among 3 to 5-year-old-children (Traebert et al. 2009). In 3-year-old children in Belgium, a $d_3$mft-score between 1 and 4 was seen in 6.1%; 0.8% presented a $d_3$mft score of 5 or higher which could also be interpreted as the presence of early childhood caries.

The results of our study clearly show that preventive measures applied at home can substantially help to improve dental health. The widespread use of fluoridated children's toothpaste is a positive sign. The recommendations of professional dentists' associations appear to have gained acceptance (Oulis et al. 2000). Active support of dental care by parents in particular helps pre-school children remain free of caries. According to data from Gülzow et al. (2006) 27% of 3- to 6-year olds receive no help at all from

their parents when it comes to dental hygiene. A low level of parents' education and social status correlated with deficits in preventive steps taken at home and thus remain as limiting factors in the prevention of early childhood caries. As other studies have shown, there is a downward gradient related to social status as far as dental hygiene is concerned (Wenhall et al. 2002). The lower the socioeconomic status, the larger the relative number of children who brush their teeth less often (Schenk and Knopf 2007).

The tendency of this conclusion was also revealed by our study (Table 3). The parents' response behavior shows class-specific differences in eating and prevention habits. For instance, higher class children were shown to have been breast fed for significantly longer than middle or lower class children (duration of breast feeding $\geq$ eight months). Parents of low social status gave their children the bottle significantly longer than parents of a higher social class. In addition, differences in preventive behavior related to social status can be identified. For instance, upper and middle class parents start taking care of their children's teeth significantly more often before the second year of life and also help them brush their teeth between the third and sixth year of life. Children of lower social status more frequently do not visit a dentist for the first time until after the completion of the third year of life. Families of high socioeconomic status also go to a dentist earlier and with more interest in checkups. Overall, the differences in eating habits and preventive measures applied reported by the different classes were not as great as the differences in the d_{3+4}mft scores would lead one to expect. The factors relating to individual behavior were registered using questionnaires. This could result in a distortion of the parents' responses toward what is socially more desirable, i.e. there was an increased risk of recall bias. There is also the risk of potential bias caused by the cross-sectional study design, which involves surveying a population about an outcome and the independent variables at one point in time. A cross-sectional study design is able to reveal associations but it cannot identify cause-and-effect relationships. Difficulty in recalling past events may also contribute to bias. Regarding the sample size, it could be argued that not all children took part in the study and this could lead to a selection bias and make the data not representative. The participation level obtained in this survey reached almost 68% and can be regarded as representative at least for this region. It could be assumed that families with low SES tend to refuse participating in such studies. Based on earlier studies, we know that the "drop out rate" in such studies could also be due to families from middle and high SES who refuse to participate. Nonetheless, questionnaires were the best possible way to gather the information needed for a study in the targeted population.

Despite the significant association between the frequency of tooth brushing with fluoridated toothpaste and the d_{3+4}mft scores, tooth brushing programs to prevent caries are still not adequately used. Deficits in socially disadvantaged children's oral hygiene at home may be offset by daily-supervised tooth brushing in kindergartens. They represent a target group–specific intervention enabling access to high-risk groups and may reduce health inequalities (Pienihäkkinen and Jokela 2002; SIGN 2005). Children who do not cultivate dental care in their family, or only inadequately, can profit from regular oral hygiene with fluoridated toothpaste in the institutions. Ideally, tooth-brushing programs should be accompanied by instruction for the parents on proper dental care as well as demonstrations of tooth brushing technique. In this context, it is important to promote a new way of thinking about eating habits. It is especially important to make people aware of the danger of early childhood caries resulting from repeated consumption of sugar-sweetened foods and beverages before going to bed. This dental prevention program makes it possible for risk-oriented dental treatment to get off to an early start.

It counts as a certainty that carious lesions on deciduous molars are predictors of later caries on the permanent teeth (Skeie et al. 2006). This fact emphasizes the great importance of working out and implementing caries prevention strategies for toddlers and pre-school children. It appears expedient to institutionalize preventive care of pre-school children with a higher need of dental care in order to prevent carious lesions in the permanent dentition.

Prospective trials are needed to check the efficiency of supervised tooth brushing programs in kindergarten. The focus should be on comparing the dental health of pre-school children who are given intensive preventive care and those who do not participate in the institutional prophylaxis at all or only irregularly.

Acknowledgments Supported by GABA International, Therwil, Switzerland.

Conflict of interest None.

References

Adair PM, Pine CM, Burnside G et al (2004) Familial and cultural perceptions and beliefs of oral hygiene and dietary practices among ethnically and socio-economically diverse groups. Community Dent Health 21:102–111

Borutta A, Kneist S, Chemnitius P, Hufnagl S (2005) Veränderungen im Ernährungsverhalten und in der Mundgesundheit bei Vorschulkindern. Oralprophylaxe Kinderzahnheilk 27:100–104

Declerck D, Leroy R, Martens L, Lesaffre E, Garcia-Zattera MJ, Vanden Broucke S, Debyser M, Hoppenbrouwers K (2008) Factors associated with prevalence and severity of caries

experience in preschool children. Community Dent Oral Epidemiol 36:168–178
Grindefjord M, Dahllöf G, Nilsson B, Modéer T (1996) Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 30:256–266
Gülzow HJ, Hellwig E, Hetzer G (2006) Flouridierungsmaßnahmen. Leitlinie der Zahnärztlichen Zentralstelle Qualitätssicherung (ZZQ) im Institut der Deutschen Zahnärzte, Köln
Harris R, Nicoll AD, Adair PM, Pine CM (2004) Risk factors for dental caries in young children: a systematic review of the literature. Community Dent Health 21:71–85
Haugejorden O, Birkeland JM (2002) Evidence for reversal of the caries decline among Norwegian children. Int J Peadiatr Dent 12:306–315
Jöckel KH (1998) Messung und Quantifizierung soziodemographischer Merkmale in epidemiologischen Studien. In: Ahrens W, Bellach BM, Jöckel KH (eds) Messung soziodemographischer Merkmale in der Epidemiologie. RKI-Schriften 1/98. MMV Medizin Verlag, München
Källestal C, Wall S (2002) Socio-economic effects on caries. Incidence data among Swedish 12–14-year-olds. Community Dent Oral Epidemiol 30:108–114
Kühnisch J, Heinrich-Weltzien R, Senkel H (2001) Dental health and caries topography in 8-year-old German and immigrant children. Eur J Paediatr Dent 2:191–196
Litt M, Reisine S, Tinanoff N (1995) Multidimensional causal model of dental caries development in low-income preschool children. Public Health Rep 110:607–617
Marthaler TM (1966) A standardized system of recording dental conditions. Helv Odontol Acta 10:1–18
Marthaler TM (2004) Changes in dental caries 1953–2003. Caries Res 38:173–181
Micheelis W, Reiter F (2006) Soziodemographische und verhaltensbezogene Aspekte oraler Risikofaktoren in den vier Alterskohorten. In: Institut der Deutschen Zahnärzte (ed) Vierte Deutsche Mundgesundheitsstudie (DMS IV). Deutscher Ärzteverlag, Köln
Momeni A, Stoll R, Schulte A, Pieper K (2007a) Kariesprävalenz und Behandlungsbedarf bei 15-Jährigen in Deutschland im Jahr 2004. Dtsch Zahnärztl Z 62:168–175
Momeni A, Hartmann T, Born C, Heinzel-Gutenbrunner M, Pieper K (2007b) Association of caries experience in adolescents with different preventive measures. Int J Public Health 52:393–401
Oulis CJ, Raadal I, Martens L (2000) Guidelines on the use of fluoride in children: an EAPD policy document. Eur J Paediatr Dent 1:7–12
Pieper K (2005) Epidemiologische Begleituntersuchungen zur Gruppenprophylaxe 2004. Deutsche Arbeitsgemeinschaft für Jugendzahnpflege (DAJ), Bonn
Pienihäkkinen K, Jokela J (2002) Clinical outcomes of risk-based caries prevention in preschool-aged children. Community Dent Oral Epidemiol 30:143–150
Poulsen S (1996) Dental caries in Danish children and adolescents 1988–94. Community Dent Oral Epidemiol 24:282–285
Psoter W, Pendrys D, Morse D, Zhang H, Mayne S (2006) Associations of ethnicy/race and socioeconomic status with early childhood caries patterns. J Publlic Health Dent 66:23–29
Schenk L, Knopf H (2007) Mundgesundheitsverhalten von Kindern und Jugendlichen in Deutschland. Erste Ergebnisse aus dem Kinder- und Jugendgesundheitssurvey (KiGGS). Bundesgesundheitsbl-Gesundheitsforsch-Gesundheitsschutz 50:653–658
Schiffner U, Gülzow H-J, Schulte T, Wandel C (2001) Zahngesundheit und Kariesbefall an bleibenden Zähnen Hamburger Schulkinder von 1988 bis 1997. Dtsch Zahnärztl Z 56:388–392
Schou L, Uitenbroek D (1995) Social and behavioural indicators of caries experience in 5-year-old children. Community Dent Oral Epidemiol 23:276–281
Schulte AG, Momeni A, Pieper K (2006) Caries prevalence in 12-year-old children from Germany. Results of the 2004 national survey. Community Dent Health 23:197–202
Skeie MS, Raadal M, Strand GV, Espelid L (2006) The relationship between caries in the primary dentition at 5 years of age and permanent dentition at 10 years of age—a longitudinal study. Int J Paediatr Dent 16:152–160
Stecksén-Blicks C, Sunnegårdh K, Borssén E (2004) Caries experience and background factors in 4-year-old Children: time trends 1967–2002. Caries Res 38:149–155
The Scottish Intercollegiate Guidelines Network (SIGN) (2005) Prevention and management of dental decay in the pre-school child. Edinburgh http://sign.ac.uk/giudelines/published/index.html
Traebert J, Guimaraes Ldo A, Durante EZ, Serratine AC (2009) Low maternal schooling and severety of dental caries in Brazilian preschool children. Oral Health Prev Dent 7:39–45
Truin GJ, König KG, Bronkhorst EM, Frankenmolen F, Mulder J, van't Hof MA (1998) Time trends in caries experience of 6- and 12-year-old children of different socioeconomic status in The Hague. Caries Res 32:1–4
Van Steenkiste M (2003) Zahngesundheitliches Verhalten bei türkischen und deutschen Vorschulkindern. Oralprophylaxe 25: 121–129
Verrips GH, Frencken JE, Kalsbeek H, ter Horst G, Fieldt Kok-Weimar TL (1992) Risk indicators and potential risk factors for caries in 5-years-olds of different ethnic groups in Amsterdam. Community Dent Oral Epidemiol 2:256–260
Warren JJ, Weber-Gasparoni K, Marshall TA, Drake DR, Dehkordi-Vakil F, Dawson DV, Tharp KM (2009) A longitudinal study of dental caries risk among very young low SES children. Communitiy Dent Oral Epidemiol 37:116–122
Wendt LK, Hallonsten AL, Koch G (1999) 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 23:17–25
Wenhall I, Matsson l, Schröder U, Twetman S (2002) Caries prevalence in 3-year-old children living in a low socio-economic multicultural urban area in Southern Schweden. Swed Dent J 26:166–172
Winkler J (1998) Die Messung des sozialen Status mit Hilfe eines Index in den Gesundheitsurveys der DHP. In: Ahrens W, Bellach BM, Jöckel KH (eds) Messung soziodemographischer Merkmale in der Epidemiologie. RKI-Schriften 1/98. MMV Medizin Verlag, München
Wyne AH (1999) Early childhood caries: nomenclature and case definition. Community Dent Oral Epidemiol 27:313–315