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Association of preventive measures with caries experience expressed by outcome variables

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Summary

The aim of the study was to investigate the effect of various preventive measures on the dental health of twelve-year-olds and to determine the extent to which these variables are linked to the prevention of incipient ($D_{1,2}$) and dentinal (D_3) lesions. 1,237 twelve-year-old children were examined in Marburg (Germany) in the year 2002. Various caries indices (D_3MFT, $D_{1,2}S$, D_3FS, $D_{1-3}FS$) and the number of teeth with fissure sealants were recorded. Information about preventive measures carried out in the past was collected by structured questionnaires. Mann-Whitney U-Tests and Kruskal-Wallis-Tests were used to test the significance of the averages, the significance level was set at $\alpha = 0.05$. Logistic regression analyses were conducted to discover associations between dental caries and potentially predictive variables. The mean D_3MFT score amounted to 0.78, the mean D_3FS was 1.05 and the mean $D_{1,2}S$ was 1.74. An average of 3.5 teeth with sealants was recorded per child. All caries indices showed a positive association between fissure sealants and caries prevention. Fluoridated table salt yielded similar findings. Children who had received fluoride tablets at least up to their second year of life had significantly lower D_3MFT scores than those children who had never had fluoride tablets. To investigate correlations between specific parameters and dental caries in a population, it is useful to record incipient lesions ($D_{1,2}$) and dentine caries (D_3) as well.

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Introduction

Traditionally, caries is recorded at cavitation level in public dental health programmes in schools. This is standard practice in the WHO recommendations (WHO 1997) for caries diagnosis. Non cavitated lesions are often not taken into consideration. But having the latter information may help to design targeted prevention programmes to prevent the progression of initial carious lesions (Ismail 2004).

Various preventive measures have contributed to reduce caries substantially among children and young people in Germany in

recent years (SCHULTE et al. 2006). While recommendations in the 1980s primarily concentrated on the administration of fluoride tablets to children, salt fluoridation has become more and more important as a practical and cheap measure in the past fifteen years (GÜLZOW et al. 2000, SCHULTE 2005). Another important measure was the introduction of fissure sealing. In 1993 preventive sealing of fissures on molars was incorporated into the range of services covered by statutory health insurance in Germany.
The administrative district of Marburg achieved particular success by introducing as early as 1981 a school-based fluoride varnish programme (the "Marburg Model") along with the other preventive measures common in Germany (SCHMIDT 1982). This programme included oral hygiene instructions, dietary counselling and a twice-yearly application of fluoride varnish (Duraphat) in the schools (first to sixth grade). Various studies documented the success of this concept (SCHMIDT et al. 1986, SCHULTE et al. 1993).
As preventive measures were increasingly introduced in Germany in the last 25 years we investigated the association of different variables on dental health in the Marburg district. In doing so, we especially focussed on the extent to which these variables could be related to the prevention of incipient lesions ($D_{1,2}$) on the one hand and dentine caries (D_3) on the other.

Materials and methods

Study area and population

The German county of Marburg has a population of about 253,500 (in the year 2002). A total cohort of 2,100 twelve-year-olds was available for the study in 2002. A 12-year-old child was defined as anyone who had completed the twelfth but not the thirteenth year of life on the day of examination. These twelve-year-olds from public schools in Marburg formed the population from which 1, 237 children were allowed to participate by their parents. Only those children were included in the study whose parents had filled in the questionnaire. Thus, the participants represented 58.9% of the population.
The examinations were performed between April and July 2002. Mentally or physically disabled adolescents were not included in the study. The study was approved by the ethics committee of our medical faculty and informed consent was given by the parents of the participating children.
The tap water in the selected area had constant fluoride concentrations since many years not exceeding the 0.25 mgF/l limit.

Methods

When diagnosing caries, a distinction was made between enamel lesions on the one hand and dentine lesions or fillings on the other. An incipient lesion ($D_{1,2}$) was scored when there was evidence of (i) white, chalky or brown enamel on the pit and fissure surface or (ii) a chalky white spot on a smooth surface. WHO criteria (1997) were used to register dentine caries (D_3). Each surface was coded according to its status: sound, decayed, filled, filled decayed (secondary caries) or missing. The dental examinations were performed using plane mirrors, dental probes and artificial light. No radiographs were taken. The presence of sealants was recorded, without taking into account whether they were complete or not.
The outcome variables surveyed provided the basis for calculating the following indices: D_3MFT, $D_{1,2}$S, D_3FS, D_{1-3}FS.
The examinations in the schools were conducted by three examiners specially trained for this purpose (K.P., T.H. and C.B.). During a pre-survey training period, examiners were calibrated by an experienced dental examiner (K.P.) combining theoretical information and preliminary diagnostic training with slides and examination of patients. The theoretical training was followed by practical training in which a sample of twelve-year-old children was examined by each of the examiners, and the diagnoses compared to those recorded by the reference examiner.
In the course of the study each examiner examined 30 children twice. The presence or absence of caries and fillings were used as the target figure. The inter-examiner reliability of the recordings (kappa) ranged between 0.84 and 0.94, the intra-examiner reliability between 0.80 and 0.91.

Ascertaining exposure to preventive measures

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.
The following variables were surveyed: (a) Current frequency of tooth brushing at home (once a week/ less than once a day/once a day/more than once a day); (b) Use of fluoridated toothpaste (don't know/no/yes); (c) Use of fluoride supplements at home in the past (don't know/no/yes) and if so, for how long; (d) Use of fluoridated salt at home (don't know/no/yes) and if so, since when.
The children were all born around 1990. At that time, the following doses were recommended for fluoride tablets: 0.25 mg in the first and second years of life, 0.5 mg in the third and fourth years of life, 0.75 mg in the fifth and sixth years of life, and 1 mg of sodium fluoride after the sixth birthday (REICH et al. 1992).
The records of the Marburg county dental public health service were used to investigate which preventive measures had been applied to the individual child during their school careers. The frequency of oral hygiene instructions, dietary counselling and topical fluoridation using Duraphat varnish was recorded.

Data collection and statistical analysis

The findings were recorded during the examinations on a documentation form noting type of school, sex and the date of examination of the child. A special documentation form was used for recording the group prevention measures. At the end of the dental examination, the documentation form for the findings, the parents' questionnaire and the documentation form for school based preventive measures were collated.
The findings and the data collected on the questionnaires were entered into an Excel database. Then a statistical analysis was performed using SPSS, Version 12.0. Mann-Whitney U-Tests and Kruskal-Wallis Tests were used to test the significance of the differences between averages and the significance level was set at $\alpha = 0.05$. To evaluate potential correlations between the dental indices (D_3MFT, $D_{1,2}$S, D_3FS, D_{1-3}FS) and different preventive measures, adjustments were made for possible confounding effects of the recorded preventive measures by using a binary logistic regression model. Due to insofar incomplete questionnaire data, not all subjects could be considered for the logistic regression analyses. The children were dichotomised into groups with D_3MFT = 0 vs. D_3MFT > 0, $D_{1,2}$S = 0 vs. $D_{1,2}$S > 0, D_3FS = 0 vs. D_3FS > 0 and D_{1-3}FS = 0 vs. D_{1-3}FS > 0. Table I shows how the dichotomies of the independent variables were performed. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated.

Results

Data regarding recorded caries experience and items on the questionnaires were available from 1,237 children twelve years

Tab. I Bivariate analysis: relation of different preventive measures to oral health of twelve-year-old children

Variables		N (%)	D_3MFT (95% CI)	$D_{1,2}S$ (95% CI)	D_3FS (95% CI)	$D_{1-3}FS$ (95% CI)
Frequency of tooth brushing	1× daily or more	1169 (94.5)	0.76 (0.67–0.84)	1.68 (1.53–1.83)	1.04 (0.88–1.19)	2.69 (2.45–2.93)
	<1× daily	49 (4)	1.39 (0.77–2.01)	2.94 (2.08–3.79)	1.61 (0.93–2.29)	4.41 (3.39–5.42)
	not reported	19 (1.5)				
	p-value*		0.005	<0.001	0.07	<0.001
Use of fluoridated toothpaste	yes	1040 (84.1)	0.71 (0.62–0.80)	1.7 (1.54–1.85)	0.94 (0.79–1.1)	2.61 (2.37–2.85)
	no	98 (7.9)	1.24 (0.72–1.52)	2.01 (1.43–2.59)	1.79 (1.09–2.48)	3.4 (2.72–4.66)
	not reported	99 (8)				
	p-value*		0.07	0.18	0.05	0.013
Use of fluoride tablets in the past	yes	942 (76.2)	0.64 (0.55–0.72)	1.57 (1.41–1.73)	0.82 (0.69–0.95)	2.36 (2.13–2.59)
	no	190 (15.3)	1.35 (1.06–1.64)	2.46 (2.01–2.91)	2 (1.34–2.67)	4.4 (3.56–5.24)
	not reported	105 (8.5)				
	p-value*		<0.001	<0.001	<0.001	<0.001
Use of fluoridated domestic salt	yes	627 (50.7)	0.63 (0.53–0.74)	1.45 (1.25–1.65)	0.89 (0.67–1.11)	2.32 (1.99–2.64)
	no	571 (46.2)	0.92 (0.78–1.05)	2.03 (1.81–2.25)	1.20 (1.00–1.41)	3.19 (2.86–3.51)
	not reported	39 (3.1)				
	p-value*		<0.001	<0.001	<0.001	<0.001
Fluoride varnish (Duraphat®)	regularly (10–12×)	397 (32.1)	0.57 (0.45–0.68)	1.55 (1.32–1.79)	0.71 (0.55–0.86)	2.25 (1.93–2.56)
	others	706 (57.1)	0.76 (0.66–0.87)	1.60 (1.41–1.78)	1.07 (0.89–1.28)	2.63 (2.32–2.93)
	not reported	134 (10.8)				
	p-value*		0.034	0.48	0.04	0.23
Fissure sealant	with	998 (80.7)	0.57 (0.49–0.64)	1.36 (1.22–1.50)	0.79 (0.63–0.94)	2.13 (1.91–2.35)
	without	239 (19.3)	1.66 (1.37–1.94)	3.36 (2.92–3.81)	2.11 (1.77–2.57)	5.41 (4.78–6.05)
	p-value*		<0.001	<0.001	<0.001	<0.001

CI = 95% confidence interval; * Mann-Whitney U-Test

Tab. II Frequency distribution (%) of twelve-year-old children according to D_3MFT, $D_{1,2}S$, D_3FS and $D_{1-3}FS$ values

	0	1	2	3	4	5	6	7	8	9	10	>10
D_3MFT	68.9	12.0	7.0	3.6	4.8	1.8	1.2	0.2	0.2	0	0.2	0.1
$D_{1,2}S$	50.6	13.5	10.5	7.2	4.7	3.5	2.2	2.3	1.9	1.1	0.8	1.7
D_3FS	69.2	10.4	6.6	3.4	2.7	2.1	1.5	1.2	1.1	0.7	0.2	0.9
$D_{1-3}FS$	42.4	11.5	10.4	6.8	6.0	5.2	3.3	2.8	2.6	1.9	1.5	5.6

Tab. III Mean D_3MFT values, standard deviation and 95% confidence interval

	Mean value (standard deviation)	95% confidence interval
D_3MFT	0.78 (1.50)	0.69–0.86
$D_{1,2}S$	1.74 (2.66)	1.60–1.89
D_3FS	1.05 (2.67)	0.90–1.20
$D_{1-3}FS$	2.77 (4.10)	2.54–2.99

of age. The mean age was 12.5. Of these twelve-year-olds, 68.9% had $D_3MFT = 0$ (Tab. II). When precavitation symptoms were included, 42.4% were caries-free ($D_{1-3}FS = 0$). The mean D_3MFT value amounted to 0.78, the mean D_3FS was 1.05 and the mean $D_{1,2}S$ was 1.74 (Tab. III). Fissure sealants were observed in 80.7% of the pupils, and an average of 3.5 teeth with sealants was recorded among all children. Table I shows the association of different independent variables to the caries experience of twelve-year-old children in Marburg. Children who brushed their teeth at least once each day exhibited significantly lower D_3MFT, $D_{1,2}S$ and $D_{1-3}FS$ values than the minority of children who did not brush regularly. The mean caries indices of children who were reported to have used fluoride tablets were significantly lower than the caries scores of those children who had never taken fluoride supplements (Tab. IV). There was no significant difference between the mean caries indices of children who received fluoride tablets up to different ages.

Children who had received fluoride tablets at least up to their second year of life had significantly lower D_3MFT scores than those children who had never had fluoride tablets. Intake of fluoride tablets beyond the second year of life did not seem to be associated with lower caries indices than intake up to the age of two.

Use of fluoridated domestic salt was reported by 50.7% of the families of the twelve-year-olds in Marburg (Tab. I). Children living in families who used fluoridated salt at home exhibited significantly lower D_3MFT, $D_{1,2}S$, D_3FS and $D_{1-3}FS$ scores than those coming from families who did not use this kind of salt.

During their first six years of school, 32.1% of the children had been given fluoride varnish on a regular basis (i.e., at least ten times). Their average D_3MFT and D_3FS was significantly lower than the average D_3MFT and D_3FS of children who didn't receive fluoride varnish in school on regular basis. The average $D_{1,2}S$ and $D_{1-3}FS$ values did not differ significantly, however, between participants in the "Marburg Model" and non-participants (Tab. I).

The binary logistic regression incorporating all the registered prevention variables (Tab. V) revealed the following: All caries indices showed a positive association between fissure sealants

Tab. IV Mean D_3MFT, $D_{1,2}S$, D_3FS and $D_{1-3}FS$ values in relation to how long fluoride tablets were taken

Length of time fluoride tablets were taken	N	Mean D_3MFT (SD)	Mean $D_{1,2}S$ (SD)	Mean D_3FS (SD)	Mean $D_{1-3}FS$ (SD)
Never	118	1.33 (2.06)	2.75 (3.28)	1.64 (2.86)	4.30 (4.71)
Up to 1st year of life	108	0.89 (1.53)	1.52 (2.26)	1.31 (2.90)	2.80 (3.93)
Up to 2nd year of life	133	0.74 (1.28)	1.74 (2.35)	0.84 (1.53)	2.56 (3.09)
Up to between 3rd and 5th year of life	92	0.60 (1.27)	2.00 (2.88)	0.86 (1.99)	2.80 (3.86)
Up to 6th year of life or longer	65	0.65 (1.22)	1.95 (2.42)	0.88 (1.79)	2.80 (3.09)
	p-value*	0.042	0.036	0.044	0.038
Never vs.:			**p-value****		
Up to 1st year of life		0.197	0.006	0.836	0.028
Up to 2nd year of life		0.022	0.023	0.053	0.003
Up to between 3rd and 5th year of life		0.006	0.255	0.113	0.042
Up to 6th year of life or longer		0.033	0.300	0.211	0.085

* Kruskal-Wallis Test; ** Post hoc comparisons according to Tukey

Tab. V Binary logistic regression analysis: relationship between the different caries indices and the most important variables (including 940 subjects in the calculation)

D_3MFT	ß	SE	Wald	p-value	OR (CI)
Frequency of tooth brushing (1× daily or more)	0.57	0.41	1.92	0.166	1.77 (0.79–3.97)
Use of fluoridated toothpaste	0.05	0.27	0.04	0.852	1.05 (0.62–1.77)
Use of fluoride tablets in the past	0.51	0.20	6.71	**0.01**	1.67 (1.13–2.46)
Use of fluoridated domestic salt	0.34	0.15	5.11	**0.024**	1.41 (1.05–1.89)
Fluoride varnish regularly (10–12×)	0.23	0.16	2.27	0.132	1.26 (0.93–1.72)
Fissure sealants	0.60	0.18	10.84	**0.001**	1.82 (1.27–2.60)

$D_{1,2}S$	ß	SE	Wald	p-value	OR (CI)
Frequency of tooth brushing (1× daily or more)	0.73	0.44	2.76	0.097	2.07 (0.88–4.89)
Use of fluoridated toothpaste	0.10	0.25	0.17	0.676	1.11 (0.69–1.80)
Use of fluoride tablets in the past	0.21	0.19	1.23	0.267	1.24 (0.85–1.80)
Use of fluoridated domestic salt	0.38	0.14	7.83	**0.005**	1.47 (1.12–1.91)
Fluoride varnish regularly (10–12×)	–0.07	0.14	0.25	0.616	0.93 (0.71–1.22)
Fissure sealants	0.82	0.18	21.03	**< 0.001**	2.26 (1.60–3.20)

D_3FS	ß	SE	Wald	p-value	OR (CI)
Frequency of tooth brushing (1× daily or more)	0.57	0.41	1.94	0.164	1.78 (0.79–3.98)
Use of fluoridated toothpaste	0.06	0.27	0.05	0.832	1.06 (0.63–1.78)
Use of fluoride tablets in the past	0.52	0.20	6.94	**0.008**	1.68 (1.14–2.48)
Use of fluoridated domestic salt	0.36	0.15	5.70	**0.017**	1.44 (1.07–1.93)
Fluoride varnish regularly (10–12×)	0.24	0.16	2.42	0.120	1.28 (0.94–1.73)
Fissure sealants	0.61	0.18	11.35	**0.001**	1.85 (1.29–2.64)

$D_{1-3}FS$	ß	SE	Wald	p-value	OR (CI)
Frequency of tooth brushing (1× daily or more)	1.05	0.51	4.26	**0.039**	2.86 (1.05–7.75)
Use of fluoridated toothpaste	0.33	0.25	1.66	0.197	1.39 (0.84–2.28)
Use of fluoride tablets in the past	0.34	0.20	3.07	0.080	1.41 (0.96–2.07)
Use of fluoridated domestic salt	0.36	0.14	6.94	**0.008**	1.43 (1.10–1.87)
Fluoride varnish regularly (10–12×)	–0.05	0.14	0.12	0.725	0.95 (0.73–1.25)
Fissure sealants	0.73	0.18	15.59	**< 0.001**	2.07 (1.44–2.97)

ß = adjusted coefficient of the regression; SE = standard error of estimate; Wald = Wald statistic; OR = odds ratio; CI = 95% confidence interval

and caries prevention. Fluoridated table salt yielded similar findings. Whereas administering fluoride tablets was positively associated with the outcome variables D_3MFT and D_3FS, the frequency of tooth brushing influenced the $D_{1-3}FS$ value.

Discussion

The study conducted in 2002 showed that caries experience among the twelve-year-olds studied can be generally classified

as low. While 68.9% of the young people had teeth exhibiting neither obvious decay nor fillings, the proportion of children without any caries experience upon visual inspection was still 42.4% ($D_{1-3}FS = 0$). The frequency distributions of the individual D(M)F counts were skewed (Tab. II).

Pitts & Fyffe (1988) observed in groups with low caries prevalence that the percentage of individuals considered "caries-free" decreased from 28.2% (D_3) to 7% (D_1) when enamel and initial lesions were included in the calculation of DMFT. Amarante et al. (1998) also observed that, when enamel caries is included, the percentage of caries-free children decreases dramatically. In their study, 37% of twelve-year-olds had caries-free teeth (DMFS), while this figure dropped to 9.4% when enamel lesions were included.

The overall DMFT and DMFS findings were in fact the accumulated caries experience in the period 1996 to 2002 (this was the year of the dental examinations). In the children who were 12 years old in 2002, few permanent first molars were already present in the oral cavity in 1996. The overall average of 68.9 children with a DMFT = 0 and only 3.7% having more than four decayed teeth (Tab. II) shows that general prevention had reached a stage of strong caries-preventive effectiveness already in the period 1996–2002. This is confirmed by other surveys, including a national one, in various parts of Germany (Pieper & Schulte 2004, Schulte et al. 2006). Similar low DMFT averages have been reported from the Netherlands (Truin et al. 2005), Switzerland (Marthaler et al. 2005) and the United Kingdom (Pitts et al. 2006). It is a consensus that topical fluorides, brought into the oral cavity by dentifrices, are the main reason for this low prevalence (Bratthall et al. 1996, Richards & Banting 1996).

The results of the bivariate analysis in our study (Tab. I) suggest that in the study population with substantial exposure to topical fluorides systemic fluoridation measures (domestic salt and possibly fluoride tablets) on the one hand, and fissure sealing on the other, are associated with the prevention of caries at the $D_{1,2}$ as well as at the dentine level.

Slightly more than half of the participants reported to use fluoridated domestic salt (Tab. I). This agrees with the general situation in 2002, when the national market share of fluoridated salt was 60.4% (Schulte 2005). However, when the children were six years old in 1996, its market share was approximately 18.5% but rose rapidly then. About one fifth of the children studied had been consuming fluoridated salt already at the age of eruption of the first molars. Both the results of the bivariate analysis as well as the binary logistic regression illustrate that the use of fluoridated salt at home was beneficial to reducing the occurrence of incipient lesions as well. This is presumably a consequence of the fact that fluoridated salt was still being used at the time of examination. Various studies show that the use of fluoridated salt causes an increase in salivary fluoride concentration (Björnström et al. 2004, Hedman et al. 2006).

The caries preventive effect of fluoride tablets and fluoridated salt has been amply studied (Stephen 1994, Menghini et al. 1995, Burt & Marthaler 1996, Estupian-Day et al. 2001, Schulte et al. 2001). Since drinking water in Germany is not fluoridated, fluoridation in the form of tablets or salt taken at home is the most important source of systemic fluoridation in caries prevention. However, only one form of systemic fluoridation is recommended in Germany (Gülzow et al. 2006). The increasing switch from fluoride in tablets to fluoridated salt is justified in the light of the present study.

The intake of fluoride tablets was consistently associated with lower caries prevalence in the bivariate analysis but only on the cavitation diagnostic level in the logistic regression analysis. The fact that the children who had received fluoride in the first year of life had lower D(M)F experience on all counts, with longer F-tablet administration not being more effective, suggests that in this study it was not a fluoride-mediated effect. Above-average interest in prevention of the parents was at least in part the cause for the lower caries experience.

At present results of research on the effect of fluoride in caries prevention strongly suggest that the post-eruptive or the topical effect is the predominant one (Thylstrup 1990, Ten Cate & Featherstone 1991, Featherstone 2000). There is also evidence that the caries reducing effect can be increased by supplementation of pre-eruptive fluoride (Groeneveld et al. 1990). Recently, on close analysis of the *Grand Rapids* data, such an effect was confirmed (Marthaler 2003), suggesting a reduction by 1.4 DMFT. Recently, pre-eruptive protective effects were again demonstrated by a careful analysis of caries data from 19,885 children with varying exposure to water fluoridation in Australia (Singh et al. 2007). There is no doubt that the long-term DMFT decline in Australia, obtained in 40 years, was due to strong effects of topical fluorides, particularly via toothpastes, but the systemic fluoride from fluoridated water was still evident. Finally, in Australia and Germany as well, almost all of the caries experience at the cavitation level occurs in fissures and pits (Schiffner & Reich 1999). A detailed analysis (Marthaler 1979) showed that a systemic protective effect is probably confined to these predilection sites, which would again be in accordance with the present situation in which the D_3MF counts were mainly due to fissure caries.

Besides the low caries prevalence in the child population at large, it must be kept in mind that retrospective data cannot identify causative factors with certainty. Families reporting the use of fluoride tablets over years are still frequent in Germany (because of the paediatricians' conviction of their usefulness in caries prevention) and must be assumed to have an above-average consciousness regarding the importance of caries prevention.

An influence of the participation rate on the results cannot be discounted, although this is rather improbable. After all, the distribution of the young people across social strata accorded with the distribution in the population in both groups.

Regular application of fluoride varnish at school was shown to have a significant effect on the prevention of dentine caries in the bivariate analysis (Tab. I). The average $D_{1,2}S$ and $D_{1-3}FS$ values did not significantly differ between participants and non-participants in the "Marburg Model", however. It is quite understandable that fluoride varnish would not significantly contribute to the prevention of incipient lesions, since it is only applied twice a year and thus can hardly influence the balance between demineralisation and remineralisation. It appears rather to prevent an incipient lesion from becoming cavitated. It would be possible to take advantage of this effect when caring for caries-active children with incipient lesions by including them more actively in prevention programmes involving applications of fluoride varnish. While a systematic review of clinical trials produced limited evidence for the caries preventive effect of topical applications of fluoride varnishes in permanent teeth (Petersson et al. 2004), a randomised clinical study confirms that school-based fluoride varnish treatment every six months in adolescents is an excellent way to prevent approximal caries in areas with medium and high risk of caries (Moberg Sköld et al. 2005).

Our study showed that daily tooth brushing with F-paste influenced the $D_{1-3}FS$ score significantly (Tab. V) ($p = 0.039$, OR = 2.86), even though the proof of this effect, particularly on the

prevention of incipient lesions, was not as obvious as for fluoridated salt and fissure sealing. The effect of supervised daily brushing of teeth with fluoride toothpaste was shown recently in a randomised clinical study (Al-Jundi et al. 2006). The low percentage of the children reporting less than one time daily brushing (4%) agrees with the frequent use of the toothbrush nowadays. However, this frequency may be subject to considerable change throughout the six years preceding our study. The question was asked once at the age of 12 years but the risk of caries, now mostly in first molars, were the years 1996 to 1999, i.e. three to six years prior to asking the question about toothbrushing habits. Toothbrushing with fluoridated toothpastes is generally accepted as an efficient measure to control caries in individuals (Thylstrup 1990). It may be due to their almost complete ubiquity that their effect was not consistently evident in the bivariate analyses and even less clear in the logistic regression which corrects for confounding by the other factors studied in this study.

If we look at the results of the binary logistic regression analysis (Tab. V), we see that fissure sealants may have been the most important factor associated with low caries prevalence in 2002 in Marburg. Adolescents with sealed teeth are about twice as likely (OR between 1.82 and 2.26) to have no caries experience as are those without fissure sealants. According to common policy, sealants should be applied to children with above-average risk of fissure and pit caries (Kühnisch & Hickel 2007). The average of 1.66 D_3MFT (Tab. I), that is the highest subgroup average, in children without sealants casts some doubt of such a selection having been frequently considered in dental practices.

Pieper & Schulte (2004) postulated that fissure sealants were the most important factor contributing to the caries decline in Germany from 1994 to 2000. Thus developments in Germany were very similar to those in Slovenia, where sealants played a major part in caries decline between 1987 and 1998 (Vrbic 2000). Allowing dentists to charge for individual preventive measures led those in private practice to increase preventive care. A systematic review about the caries-preventive effect of fissure sealants revealed that resin-based sealants on permanent first molars showed a relative caries risk reduction of 33% (Mejare et al. 2003).

The results of our study suggest that systemic fluoridation measures and fissure sealing made the greatest contribution to keeping children free of caries. Topical fluoridation (brushing teeth with fluoride toothpaste and fluoride varnish treatment) was also beneficial to dental health, but the correlation is not as explicit.

To project long-term trends and, above all, remain comparable with earlier studies, epidemiological investigations should continue to use the D_3MFT (that is, the WHO Standard). To investigate correlations between independent and outcome variables in a specific population, the results of our study demonstrate that it is necessary to record incipient lesions ($D_{1,2}$), as well. Certain connections between the outcome variables for caries and the independent variables can only be shown on the basis of $D_{1,2}$.

Accordingly, the examiners must be specially calibrated. Assaf et al. (2006) showed that it is possible to obtain excellent mean intra- and inter-examiner Kappa values for both diagnostic thresholds.

Zusammenfassung

Ziel der vorliegenden Studie war es, einen Zusammenhang zwischen der Zahngesundheit und verschiedenen Prophylaxevariablen herzustellen und festzustellen, wie diese Variablen mit der Prävention von Schmelzläsionen ($D_{1,2}$) und Dentinkaries (D_3) in Zusammenhang stehen.

Im Jahr 2002 wurden in Marburg (Deutschland) in den sechsten Klassen 1237 12-jährige Schülerinnen und Schüler untersucht. Dabei wurden D_3MFT, $D_{1,2}$S, D_3FS, D_{1-3}FS und die Anzahl versiegelter Zähne registriert. Informationen über präventive Massnahmen in der Vergangenheit wurden mithilfe von Fragebögen erhoben. Die statistischen Auswertungen erfolgten mit dem Mann-Whitney-U-Test und dem Kruskal-Wallis-Test, das Signifikanzniveau wurde auf $\alpha = 0{,}05$ festgelegt. Logistische Regressionsanalysen wurden durchgeführt, um den potenziellen Zusammenhang zwischen der Zahnkaries und verschiedenen Prophylaxevariablen zu ermitteln.

Der mittlere D_3MFT-Wert betrug 0,78, der mittlere D_3FS 1,05 und der mittlere $D_{1,2}$S 1,74. Im Durchschnitt waren bei jedem Kind 3,5 Zähne versiegelt. Ein positiver Einfluss der Fissurenversiegelung zeigte sich bei allen Kariesindizes. Ähnliches gilt für das fluoridierte Haushaltssalz. Kinder, die mindestens bis zum zweiten Lebensjahr Fluoridtabletten erhalten hatten, zeigten signifikant bessere D_3MFT-Werte als diejenigen ohne Tablettenfluoridierung.

Um den Zusammenhang von bestimmten Prophylaxeparametern mit der Zahngesundheit zu bestimmen, ist es sinnvoll, Karies sowohl auf Schmelz- ($D_{1,2}$) als auch auf Dentinebene (D_3) zu registrieren.

Résumé

Le but de l'étude présente était d'établir un rapprochement entre la santé des dents et différentes variables prophylactiques, de déterminer leur rapport avec la prévention de lésions sur l'émail ($D_{1,2}$) et sur la dentine.

En 2002, on a procédé à Marburg (R.F.A.) à l'examen de 1237 élèves âgés de 12 ans. Plusieurs valeurs de caries (D_3MFT, $D_{1,2}$S, D_3FS, D_{1-3}FS) ont été repertoriées ainsi que le nombre de dents portant des plombages. Des informations concernant les mesures préventives prises antérieurement ont été prélevées à l'aide de questionnaires. Les évaluations statistiques qui suivirent ont été effectuées avec les tests «Mann-Whitney U» et «Krustal-Wallis», l'indice de résultat a été placé à $\alpha = 0{,}05$. Des analyses de régression logistiques ont été conduites afin de déterminer le rapport potentiel entre les caries dentaires et différentes variables prophylactiques.

Les valeurs moyennes se montaient à 0,78 pour D_3MFT, 1,05 pour D_3FS et 1,74 pour $D_{1,2}$S. En moyenne, 3,5 dents par enfant étaient plombées. Le plombage des fissures a montré un impact positif sur tous les indices de caries. Il en va de même pour le sel de ménage contenant du fluorure. Pour les enfants qui ont reçu des comprimés de fluorure jusqu'à leur deuxième année, les résultats de la valeur D_3MFT sont nettement plus probants que pour ceux à qui on ne les a pas administrés.

Afin de fixer une corrélation entre des paramètres prophylactiques précis et la santé des dents, il faut répertorier les caries développées à la fois sur l'émail et sur la dentine.

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