

# The relationship between erosion, caries and rampant caries and dietary habits in preschool children in Saudi Arabia

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**Summary.** *Objectives.* The aim of this study was to investigate the possible association between dental erosion and caries, and variables including socio-economic status, reported dietary practices and oral hygiene behaviour, in a sample of children in Jeddah, Saudi Arabia. A cross-sectional study including dental examination and questionnaire survey was carried out at a number of kindergartens.

*Sample and methods.* A sample of 987 children (2–5-year-olds) was drawn from 17 kindergartens. Clinical examinations were carried out under standardized conditions by a trained and calibrated examiner (MAM). Information regarding diet and socio-economic factors was drawn from questionnaires distributed to the parents through the schools. These were completed before the dental examination.

*Results.* Of the 987 children, 309 (31%) showed signs of erosion. Caries were diagnosed in 720 (73%) of the children and rampant caries in 336 (34%). Vitamin C supplements, frequent consumption of carbonated drinks and the drinking of fruit syrup from a feeding bottle at bed- or nap-time when the child was a baby, were all related to erosion. Consumption of carbonated drinks and fruit syrups was also related to caries but they were part of a larger number of significant factors including socio-demographic measures and oral hygiene practices.

*Conclusions.* There was no clear relationship between erosion and social class, or between erosion and oral hygiene practices; the reverse was true for caries. Dietary factors relating to both erosion and caries and/or rampant caries were found in this sample of children.

## Introduction

Dental erosion and dental caries both arise from acid attack on dental enamel. Caries result from acid produced by bacteria being held against the tooth surface; this results in localized lesions [1]. The disease demonstrates a characteristic pattern of attack in the dentition, having a predilection for sites of plaque accumulation. In contrast, erosive lesions are caused by acid repeatedly ‘washing’ the enamel

surface; they are often shallow and most often affect teeth and sites that are consistently free of plaque [1,2].

Erosion has been regarded as multifactorial in aetiology, as have caries. Both intrinsic and extrinsic sources of acid are able to contribute to erosion. The process may be affected by a number of determinants, including life-style, which affects the frequency of acid consumption, and oral hygiene practices, which may promote the removal of weakened, demineralized enamel [3].

Previous studies have linked a wide variety of foods and drinks to erosion in children and adults [4–7]. The majority of these were either experimental investigations or case-studies confined to one or a small number of reported cases. There appears to

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be less widely-based epidemiological evidence that clearly links specific foods and/or drinks to erosion. In one study where this was considered, the *National Diet and Nutrition Survey* carried out in the UK in 1995 in children aged 1.5–4.5 years, evidence failed to show a significant link between erosion and dietary behaviour [8].

Some foods and drinks contain both potentially erosive acids and cariogenic sugars, theoretically promoting both types of tooth tissue loss [3,9,10]. To date, however, no common dietary risk factors have been demonstrated. One reason for this may be that erosion has been mostly studied in populations where the prevalence of caries is low and where the relationship may be more difficult to demonstrate in consequence.

The aim of this study was to investigate the relationships between socio-economic status, dietary habits, oral hygiene behaviour and erosion and caries recorded at a dental examination. The study was carried out in Jeddah, Saudi Arabia, where caries levels in children are high. Traditional dietary practices continue in the country but foods and drinks more typical of western diets are now widely available.

## Methods

A sample of children was drawn from 2–5-year-olds attending kindergarten schools in the city of Jeddah. Approval for the study was obtained from the Ministry of Higher Education and the President General for Girls' Education office in Saudi Arabia. Permission was given to visit schools, collect information and to carry out clinical examinations of the children. A pilot study involving 30 children from two schools was carried out prior to the start of the main survey.

To derive the sample, kindergarten schools in Jeddah were stratified by funding source (private or public) and by the area of the city. Of the 152 schools, 20 were public schools (attended by 2621 children) and 132 were private schools (11 317 children). A random sample was selected from public and private schools in each of the four geographical areas of the city. This allowed for less than 100% consent and the achievement of a sample of approximately 400 children from public schools (100 from each area of the city) and 600 children from private schools (150 from each area). These numbers were designed to ensure the sample represented all areas of the city and to allow an estimation of the effect

of school type attended in addition to other variables studied.

All children in the 17 selected schools (six public and 11 private) were eligible to take part. Letters were sent to the parents explaining the nature and purpose of the study and to seek consent. They were also asked to complete a short questionnaire. Forms were sent to the parents of 1554 children and 1063 (68%) forms were returned. Thirty-three children were absent at all school visits and 43 were unable to co-operate sufficiently in order to take part. The results therefore relate to 987 children for whom a questionnaire had been completed and who had been dentally examined.

## Clinical examination

Clinical examinations were carried out for erosion of maxillary incisor teeth and for caries and rampant caries by a single calibrated examiner (MAM). Examination for erosion was confined to primary maxillary incisors and used the scoring system tested previously [11]. All teeth and surfaces were examined for caries using BASCD criteria and scoring systems [12]. Rampant caries was defined as occurring when caries affected smooth surfaces of two or more maxillary incisor teeth [13,14].

## Questionnaire

The questionnaire was designed to collect general information on each child's age and gender, any chronic illness and medication taken by the child, as well as socio-economic background questions including parental occupation and education. The classification of occupation used was based on that used in a previous oral health survey in Saudi Arabia. This was as follows: higher professionals (professors, doctors, architects and businessmen); professionals (managers and teachers); middle class (governmental, private and self-employed and skilled workers); and unskilled and other occupations (military personnel, trade, students, the unemployed and those not indicating any occupation). Dietary information sought included: infant feeding practices; past and current intake of drinks including fruit juices, diluted fruit syrups, herbal drinks and carbonated drinks; current frequency of intake of selected foods, particularly fruit; and past and current use of sweetened comforters.

Questions relating to the age at which the child's teeth were first brushed; frequency of brushing; and

whether brushing was carried out with or without assistance were also included. The questionnaire was composed in English before translation into Arabic; it was tested in a pilot study and minor adjustments were made.

#### Data analysis

All data were entered onto a computer using SPSS. Both descriptive and analytical approaches were used in the data analysis. Tests of the association between erosion or caries and other factors were carried out using a  $\chi^2$  (chi-squared) test. Statistical significance was established at the 5% level. A non-parametric test (Mann–Whitney *U*-test) was used to compare mean dmft and dmfs values. Multivariate analysis was carried out using logistic regression analysis for the outcomes of erosion, caries and rampant caries.

#### Results

At examination, 309 of the 987 children (31%) showed evidence of erosion on their maxillary incisor teeth. Caries were seen in 720 (73%) and rampant caries was diagnosed in 336 children (34%).

#### Social factors

**Erosion and social factors** The social class of each child was measured in terms of the father's occupation, the mother's education and the type of school attended. Sixty (28%) of the 211 children whose fathers were from higher professions had

erosion, as had 45 (36%) of those whose fathers held other professional occupations. One hundred and forty-nine (32%) of those from the middle class and 54 (28%) of those whose fathers held unskilled or other occupations also showed erosion.

In relation to the mother's education, erosion was seen in 31% of those whose mothers had been educated to college level or beyond and 33% of those educated to secondary and high-school level. Erosion appeared least prevalent (27%) among children whose mother's education was limited to primary level or who had no education, but numbers in this group were very small (only 11 children).

Prevalence of erosion in relation to school type suggested that there was little difference in prevalence between the two school types. Two hundred and three (32%) of the children in private schools were affected compared with 106 (31%) of those attending public schools. Age distribution differed in the two types of schools, equivalent age-adjusted estimates were 32% and 33% for private and public types respectively. None of the differences seen in relation to social factors proved statistically significant using single-variate analysis. (Table 1)

**Caries and social factors** The lowest prevalence of caries was seen in children from higher professional families. Prevalence in children from other social classes was little different. A similar pattern was seen in relation to rampant caries, with fewer children from higher professional families showing any evidence. Differences in relation to social class were statistically significant for caries but not for rampant caries when tested using single-variate analysis.

**Table 1.** Social class based on father's occupation and mother's education in relation to prevalence of erosion, caries and rampant caries.

Social class	No. of children	Erosion		Caries		Rampant caries	
		No.	(%)	No.	(%)	No.	(%)
<b>Father's occupation</b>							
High professional	211	60	(28.4)	138	(65.4)	59	(28.0)
Professional	125	45	(36.0)	95	(76.0)	44	(35.2)
Middle class	461	149	(32.3)	341	(74.0)	166	(36.0)
Unskilled and others	190	54	(28.4)	146	(76.8)	67	(35.3)
<b>Mother's education</b>							
College and postgraduate	629	192	(30.5)	441	(70.1)	191	(30.4)
Secondary and high school	258	84	(32.6)	209	(81.0)	111	(43.0)
Primary and no education	11	3	(27.3)	10	(90.9)	7	(63.6)

$\chi^2$  for difference between father's occupation and prevalence of caries = 8.38,  $P < 0.05$ .  $\chi^2$  for difference between level of mother's education and prevalence of caries = 12.89,  $P < 0.01$ .  $\chi^2$  for difference between level of mother's education and prevalence of rampant caries = 17.20,  $P < 0.001$ .

**Table 2.** Prevalence of erosion, caries and rampant caries in relation to dietary and oral hygiene practices in 987 children aged 2–5 in Saudi Arabia.

Factors	Erosion		Caries		Rampant caries	
	No.	(%)	No.	(%)	No.	(%)
Type of infant feeding						
Bottle-fed ( <i>n</i> = 173)	54	31	113	65	46	27
Breast-fed ( <i>n</i> = 260)	84	32	199	77* <sup>3</sup>	105	40* <sup>2</sup>
Drinks from a feeding bottle as a baby						
Fruit syrup ( <i>n</i> = 56)	25	45* <sup>3</sup>	46	82	21	38
Herbal drinks ( <i>n</i> = 580)	167	29* <sup>3</sup>	421	73	187	32
Bedtime drinks from a feeding bottle as a baby						
Fruit syrup ( <i>n</i> = 35)	18	51* <sup>2</sup>	28	80	11	31
Packed fruit juice ( <i>n</i> = 74)	30	41	60	81	33	45* <sup>3</sup>
Bedtime drinks at the time of the study						
Pure fruit juice ( <i>n</i> = 144)	50	35	116	81* <sup>3</sup>	54	38
Packed fruit juice ( <i>n</i> = 108)	39	36	91	84* <sup>2</sup>	47	44* <sup>3</sup>
Fruit syrup ( <i>n</i> = 65)	29	45* <sup>3</sup>	54	83* <sup>1</sup>	26	40
Fizzy drinks ( <i>n</i> = 90)	30	33	75	83* <sup>3</sup>	41	46* <sup>3</sup>
Frequency of drinks						
≥ once/day having fizzy drinks ( <i>n</i> = 397)	145	37* <sup>2</sup>	300	76* <sup>3</sup>	159	40* <sup>1</sup>
≥ once/day having fruit syrup ( <i>n</i> = 154)	59	38* <sup>3</sup>	126	82* <sup>2</sup>	60	39
Method of drinking						
Feeder cup ( <i>n</i> = 73)	22	30	50	69	31	43
Cup with straw ( <i>n</i> = 79)	27	34	56	71	25	32
Cup without straw ( <i>n</i> = 519)	163	31	376	72	182	35
Both ( <i>n</i> = 301)	95	31	224	74	91	30
Fruits						
≥ once/day having dates ( <i>n</i> = 426)	132	31	336	79* <sup>1</sup>	163	38* <sup>2</sup>
Vitamin C supplements ( <i>n</i> = 54)	28	52* <sup>1</sup>	34	63	12	22
Use of dummies ( <i>n</i> = 215)	64	30	190	88* <sup>1</sup>	125	58* <sup>1</sup>
Oral hygiene habits						
Frequency of brushing: Daily ( <i>n</i> = 768)	238	31	544	71	248	32
Occasionally ( <i>n</i> = 181)	59	33	148	82* <sup>2</sup>	73	40* <sup>3</sup>
Age started brushing: ≤ 12 months ( <i>n</i> = 257)	79	31	166	65	70	27
> 12 months ( <i>n</i> = 693)	218	32	527	76* <sup>1</sup>	251	36* <sup>2</sup>
With/Without help: With ( <i>n</i> = 540)	166	31	378	70	190	35
Without ( <i>n</i> = 409)	131	32	314	77* <sup>3</sup>	131	32

\*<sup>1</sup>*P* ≤ 0.001; \*<sup>2</sup>*P* ≤ 0.01; \*<sup>3</sup>*P* ≤ 0.05.

Relationships between caries, rampant caries and the mother's education appeared stronger than those based on the father's occupation. The lowest levels of disease were seen in the children of mothers educated to college level or beyond with trends being consistent in showing lower prevalence of caries and rampant caries with progressively higher levels of educational achievement (Table 1).

In relation to school type, slightly fewer (71%) children from private schools than from public schools (77%) had some caries experience. The difference between them, 6%, was just statistically significant. One hundred and ninety-nine children (31%) from private schools and 137 (40%) from public schools had rampant caries. The difference of 9% in rampant caries between schools was also significant. There was also a difference between school

types in dmft and dmfs (1.11 in dmft and 2.96 in dmfs) with lower values for children in private schools. Differences in dmft and dmfs were confirmed as statistically significant (*P* = 0.002 and *P* = 0.009).

#### Dietary practices

The prevalence of erosion, caries and rampant caries are shown in relation to information regarding diet drawn from the study, are shown in Table 2.

There was little difference in prevalence of erosion in relation to feeding practices, but both caries and rampant caries were least prevalent amongst children who had been wholly bottle-fed (65% were affected by caries and 27% by rampant caries) and highest in those who had been wholly breast-fed

(77% had caries and 40% had rampant caries) ( $P < 0.05$ ;  $P = 0.01$ ).

There were some evident differences relating to drinks and foods. The prevalence of erosion amongst children who had been given fruit syrup in a feeding bottle was 45% compared to 31% amongst those who had not had such drinks. Amongst those who had herbal drinks only 29% had erosion (compared to 35% amongst those who did not). Similar prevalences of caries and rampant caries were seen in relation to consumption of other drinks. Only fruit syrup given in a bottle at bedtime during babyhood showed a significant relationship to erosion. The prevalence of rampant caries was higher (45%) in children having fruit juice (of the type in cartons) ( $P < 0.05$ ) at this time of day when they were babies. Amongst drinks given at bedtime at the time of the survey, the highest prevalence of erosion was seen when fruit-syrup drinks were given ( $P < 0.05$ ). In relation to caries, prevalence was significantly increased but similar when any of these types of drinks were given at bedtime (Table 2).

The highest prevalence of rampant caries was seen in children who consumed carbonated (fizzy) drinks at bedtime (46%,  $P < 0.05$ ). It was also increased in those who had packed fruit juice (44%,  $P < 0.05$ ).

Differences in prevalence of erosion in relation to the reported frequency of fizzy drink consumption were also especially significant. One hundred and thirty-eight of the children (28%) having fizzy drinks once or twice a week, or less, showed evidence of erosion compared to 145 (37%) of those who had fizzy drinks at least once a day, or more often. Differences in fizzy drinks and fruit syrups were also apparent in relation to caries; of children having fizzy drinks once or twice per week or less, 69% had evidence of caries and 28% had rampant caries. Amongst those having fizzy drinks at least daily, 76% had evidence of caries and 40% had rampant caries ( $P < 0.05$ ;  $P < 0.001$ ). Children who drank diluted fruit syrup once or twice per week or less, also had less evidence of erosion (30%) than children who had these once or more per day (38%). These children also showed less evidence of caries (70%) compared to children who had them more often (82%) ( $P < 0.01$ ).

There appeared to be little difference in the prevalence of erosion, caries or rampant caries and the way the drink was consumed. There also appeared to be little difference in prevalence of erosion in

relation to specific fruits or foods. Caries were related to consumption of dates, being highest (79%) amongst those who ate dates once daily or more often, than amongst those eating them less often or who ate other fruits ( $P < 0.001$ ). The prevalence of rampant caries was also higher amongst these children (38%) ( $P < 0.01$ ). Vitamin C supplements were related to erosion. Just under half (28 of 54) of the children having regular vitamin C supplements had erosion and half of these (14) had erosion of the severe form extending into dentine and/or the pulp ( $P < 0.001$ ). Erosion appeared to be unaffected by the use of a dummy dipped in honey or sugar but this habit was strongly related to caries; of the children who had been given one, 88% had caries and 58% had rampant caries.

#### *Oral hygiene practices*

Little difference was seen in prevalence of erosion in relation to brushing frequency, when brushing was begun or whether the child brushed with assistance, but some consistent differences could be seen in relation to caries. Amongst those who brushed daily, 71% had caries and 32% had rampant caries. These values were compared to 82% of those whose teeth were brushed occasionally who had caries and 40% who had rampant caries. A higher prevalence of caries (76%) and rampant caries (36%) was seen when the brushing habit started later compared to when it was started earlier (65% and 27% respectively). Higher caries levels were also seen when the child brushed alone without assistance (77% compared to 70%).

#### *Multivariate analysis*

Multivariate analysis was carried out using a stepwise multiple logistic regression to determine the factors that were independently related to the aetiology of erosion when others were held constant. All variables were included at the start and those failing to show a significant relationship to erosion were subsequently removed in a stepwise fashion. The final model summarized in Table 3 shows that factors remaining statistically significant were: use of vitamin C supplements (OR = 2.6), the consumption of fruit syrup at bed/nap time when the child was a baby (odds ratio (OR) = 2.3) and frequent use of fizzy drinks at the time of the study (1–2 or more per day compared to 1–2/week) (OR = 1.4). Confidence

**Table 3.** Results of logistic regression for erosion when all children were included: regression coefficient (B), standard error (SE), significance (P), odds ratio (OR) with 95% CI for OR.

Variables	B	SE	P	OR	95% CI for OR	
					Lower	Upper
Use of Vitamin C <sup>1</sup>	0.9638	0.2958	0.001	2.6215	1.4681	4.6811
Fruit syrup at bedtime as a baby <sup>2</sup>	0.8577	0.3555	0.0158	2.3577	1.1746	4.7326
Frequency of fizzy drinks <sup>3</sup>	0.3526	0.1468	0.0163	1.4227	1.0671	1.8969

<sup>1</sup>Use of vitamin C: 1, not having vitamin C; 2, having vitamin C. <sup>2</sup>Diluted fruit syrup at bed time as a baby: 1, not having diluted fruit syrup at bed time; 2, having diluted fruit syrup at bed time. <sup>3</sup>Frequency of fizzy drinks at the time of the study: 1, once/twice week; 2, once a day or more.

**Table 4.** Results of logistic regression for erosion when children with rampant caries were excluded: regression coefficient (B), standard error (SE), significance (P), odds ratio (OR) with 95% CI for OR.

Variables	B	SE	P	OR	95% CI for OR	
					Lower	Upper
Use of Vitamin C <sup>1</sup>	0.9676	0.2977	0.001	2.6317	1.4684	4.7168
Fruit syrup at bedtime as a baby <sup>2</sup>	0.8266	0.3575	0.021	2.2855	1.1342	4.6053
Caries excluding rampant caries <sup>4</sup>	0.4273	0.1496	0.004	1.5332	1.1435	2.0556
Frequency of fizzy drinks <sup>3</sup>	0.3805	0.1479	0.010	1.4629	1.0949	1.9548

<sup>1</sup>Use of vitamin C: 1, not having vitamin C; 2, having vitamin C. <sup>2</sup>Diluted fruit syrup at bed time as a baby: 1, not having diluted fruit syrup at bed time; 2, having diluted fruit syrup at bed time. <sup>3</sup>Frequency of fizzy drinks at the time of the study: 1, once/twice week; 2, once a day or more. <sup>4</sup>Caries: 1, no caries; 2, caries excluding rampant caries.

intervals showed that in the case of vitamin C and bedtime fruit syrup, the OR in the population may have been as high as 4.6 and for fizzy drinks as high as 1.8. The presence of caries did not relate to erosion in the first analysis but the procedure was repeated for the outcome of erosion, excluding children with rampant caries, Table 4 summarizes the findings. In this case, caries proved to be a significant risk factor. In these circumstances the odds of having some erosion in children with caries excluding rampant caries was 1.5 and confidence intervals suggested the risk may have been as great as 2.1. Risk factors seen in the analysis for all children again emerged as significant when those with rampant caries were excluded.

Multivariate analysis was carried out using the same method to determine the strongest factors related to the outcomes of caries and rampant caries (Tables 5 and 6). More factors related to caries than erosion. The final model showed that factors most clearly related to caries were: using a dummy dipped in honey or a sugary syrup (OR = 3.1); the consumption of diluted fruit syrup when the child was a baby (OR = 3.1); the frequency of use of diluted fruit syrup drinks at the current time (OR = 2.0); school type (OR = 1.9); the age at which the child started to brush his/her teeth (OR = 1.7);

the consumption of pure fruit juices at the time of the survey (OR = 1.7); the mother’s educational level (OR = 1.6); whether the child brushed his/her teeth with help or without (OR = 1.5); and the age of the child (OR = 1.5).

The final model related to the aetiology of rampant caries showed the importance of using a dummy dipped in sugary syrup (4.2), the use of vitamin C (OR = 2.2); school type (OR = 2.0); mother’s education (OR = 1.7); frequent of use of fizzy drinks at current time (OR = 1.6); the time the child started to brush their teeth (OR = 1.5); feeding type (OR = 1.5); and the age of the child (OR = 1.3).

**Discussion**

The aim of the study was to investigate the possible association between the prevalence of erosion and caries, and socio-economic, dietary and oral hygiene factors in 2–5 years-old preschool children in Jeddah, Saudi Arabia.

The sampling procedure used was designed to provide a group that was representative of children in the city but would also allow consideration of the effects of school type. The difference in proportion consenting, with fewer of the children in publicly funded schools returning their forms, suggests an

**Table 5.** Results of logistic regression for caries: regression coefficient (B), standard error (SE), significance (P), odds ratio (OR) with 95% CI OR

Variables	B	SE	P	OR	95% CI for OR	
					Lower	Upper
Use of dummy <sup>1</sup>	1.1537	0.2582	0.000	3.1700	1.9112	5.2578
Fruit syrup as a baby <sup>2</sup>	1.1410	0.5473	0.037	3.1300	1.0707	9.1501
Frequency of fruit syrup <sup>3</sup>	0.7258	0.2683	0.007	2.0664	1.2213	3.4964
School type <sup>4</sup>	0.6547	0.1979	0.001	1.9246	1.3058	2.8367
Start brushing <sup>5</sup>	0.5727	0.1835	0.002	1.7730	1.2373	2.5406
Current use of Pure juice at bedtime <sup>6</sup>	0.5469	0.2654	0.039	1.7278	1.0271	2.9065
Mothers educational level <sup>7</sup>	0.4896	0.1977	0.013	1.6317	1.1075	2.4041
Brushing with help <sup>8</sup>	0.4438	0.1763	0.012	1.5586	1.1034	2.2017
Age <sup>9</sup>	0.4092	0.1340	0.002	1.5056	1.1579	1.9577

<sup>1</sup>Use of sweetened dummy: 1, not using sweetened dummy; 2, using sweetened dummy. <sup>2</sup>Dilute fruit syrup as a baby: 1, not having diluted fruit syrup as a baby; 2, having diluted fruit syrup as a baby. <sup>3</sup>Frequency of fruit syrup at the time of the study: 1, once or twice/week; 2, once a day or more. <sup>4</sup>School type: 1, private; 2, public. <sup>5</sup>Start brushing: 1, 0–1 years; 2, 1–2 years. <sup>6</sup>Currently use of pure juice drink at bed-time: 1, not having pure fruit juice at bed time; 2, having pure juice at bed-time. <sup>7</sup>Mothers educational level: 1, college and beyond; 2 others. <sup>8</sup>Brushing with help: 1, with help; 2, without help. <sup>9</sup>Age: 1, 3-years-old; 2, 4-years-old; 3, 5-years-old.

**Table 6.** Results of logistic regression for rampant caries: regression coefficient (B), standard error (SE), significance (P), odds ratio (OR) with 95% CI.

Variables	B	SE	P	OR	95% CI for OR	
					Lower	Upper
Use of dummy <sup>1</sup>	1.4550	0.1899	0.000	4.2843	2.9529	6.2159
Use of vitamin C <sup>2</sup>	0.8180	0.4002	0.041	2.2659	1.0341	4.9648
School type <sup>3</sup>	0.7344	0.1846	0.000	2.0842	1.4514	2.9930
Mothers educational level <sup>4</sup>	0.5539	0.1731	0.001	1.7400	1.2393	2.4430
Frequency of fizzy drinks <sup>5</sup>	0.5160	0.1626	0.002	1.6754	1.2182	2.3043
Start brushing <sup>6</sup>	0.4570	0.1915	0.017	1.5793	1.0852	2.2985
Feeding type <sup>7</sup>	0.4158	0.1816	0.022	1.5156	1.0617	2.1636
Age <sup>8</sup>	0.3018	0.1354	0.026	1.3522	1.0371	1.7631

<sup>1</sup>Use of sweetened dummy: 1, not using sweetened dummy; 2, using sweetened dummy. <sup>2</sup>Use of vitamin C: 1, not having vitamin C; 2, having vitamin C. <sup>3</sup>School type: 1, private; 2, public. <sup>4</sup>Mothers educational level: 1, college and beyond; 2 others. <sup>5</sup>Frequency of fizzy drinks at the time of the study: 1, once or twice/week; 2, once a day or more. <sup>6</sup>Start brushing: 1, 0–1 years; 2, 1–2 years. <sup>7</sup>Feeding type: 1, no breast-feeding or both breast and bottle; 2, breast-feeding only. <sup>8</sup>Age: 1, 3-years-old; 2, 4-years-old; 3, 5-years-old.

element of bias. Nevertheless, the group included children from a spectrum of social classes. The importance of including school type as a variable was demonstrated when it emerged as having a significant independent relationship to caries and rampant caries.

At least three previous studies have suggested that erosion is related to social class [15–17]. In contrast, no relationship was seen in a fourth large study [8] and none was seen in the present investigation. Indicators of social class included school type, father's occupation and mother's educational level. In none did relationships with erosion reach significant levels in either single or multivariate analysis.

In contrast to findings for erosion, caries and rampant caries were found to relate consistently

to social variables. Caries has been related to social factors in many studies, with levels of disease most often being higher amongst children in the lowest socio-economic classes [8,18,19]. The same trend has been reported in Saudi Arabia [20] and was also apparent here. Thus, caries were more prevalent and dmft and dmfs were higher in children from lower social classes, those whose mothers had been less highly educated and those who attended publicly funded schools.

The questionnaires covered a number of dietary items reported to be related to erosion and/or to caries. Analysis included not only single but also multivariate analysis, allowing for the fact that determinants are unlikely to have had wholly independent effects.

Three dietary factors emerged as significant in relation to erosion. These were use of vitamin C supplements, frequency of use of fizzy drinks at the time of the study, and consumption of fruit syrup from a feeding bottle at bed/nap time when the child was a baby. For all three, relationships to caries and/or rampant caries were also apparent. The results appear to be in contrast to findings in the survey of 1.5–4.5-year-olds in the UK, where no statistically significant relationship was seen between erosion and dietary behaviour, but closer examination of UK data provides some evidence of similar trends. For example, of the 3.5–4.5-year-olds who drank carbonated drinks most days, 22% had erosion, compared to only 8% amongst children who had this type of drink less [8].

Children who were given vitamin C supplements may have up to 4.7 times the risk of erosion and may also be at a potentially higher risk of having rampant caries. If these associations are real, it might be speculated that ascorbic acid not only affects enamel directly but also indirectly potentiates or contributes to the process of rampant caries. The number of children given vitamin C supplements was small, only 54 children, so some caution is needed in considering these apparent associations.

The role of carbonated drinks in the aetiology of erosion is well known [4,6,7]. These drinks have a high sugar content and are also potentially cariogenic [9]. In the current study, the frequency of giving carbonated drinks was a risk factor common to both erosion and rampant caries.

Drinks given at night or at naptime may carry particular erosive potential and the consumption of diluted fruit-syrup drinks from a feeding bottle at bedtime during babyhood was related to erosion. Other relationships were seen to be consistent with this finding. For example, the use of fruit-syrup drinks at bedtime and frequency of use at the time of the study were both significantly related to erosion in single-variate analysis.

Diluted fruit syrup drinks also emerged as important in relation to caries, where both the use of these drinks in a bottle during babyhood and the frequency of use at the time of the survey emerged as significant in multivariate analysis. Diluted fruit syrups given during babyhood represented up to nine times the risk for caries in the population from which the children were drawn.

Results of the questionnaire therefore provided evidence to support the role of dietary factors common

to both erosion and caries but not all relationships were consistent. One obvious example lies in the fact that there was little clear evidence to link diluted fruit syrups given in a feeding bottle to rampant caries. This was unexpected as drinks of this type, given at night or naptime, have been associated with the disease [14]. It may be that other aetiological agents have assumed greater importance in the sample of children from Jeddah, overwhelming the effect of drinks. In the study, dummies dipped in syrup, sugar or other sweet agents, which had been given to 215 of the 987 children and which have been clearly related to caries in the past [21], proved to be the strongest determinant of disease to emerge for both caries and rampant caries.

None of the three aspects of oral hygiene habits considered in the questionnaire proved to be related to the prevalence of erosion in this sample of children but two out of three were related to caries. Children for whom tooth brushing began after 1 year of age proved to be at significantly higher risk of both caries and rampant caries, and children who had no help in brushing were also at higher risk of caries.

The study highlighted the role of feeding methods used in infancy but the relationship between caries and feeding method seen was the reverse of that reported elsewhere. Children who were wholly breast-fed had more rampant caries (and a higher caries prevalence) than did those who had been wholly or partly bottle-fed. Rampant caries was also more common in children breast-fed beyond the age of 1 year. These apparent relationships may well have been confounded by social class as breast-feeding (and more prolonged breast-feeding) was more common for children in lower social classes. Children in these classes may have been more likely to have been given sweetened dummies and less likely to have had their teeth brushed at an early age.

Fruit juices were given at bedtime to 144 of the children and dates were eaten at least once a day by 426 of the group. The former was seen as a risk factor for caries in multivariate analysis and the latter was seen to relate to both caries and rampant caries in single-variate analysis. Fruit juices contain high levels of non-milk extrinsic sugars but there has been little clear evidence of their relationship to caries in past studies and this finding may simply be a chance result. The same is true of the consumption of dates. No previous clinical studies appear to have investigated the relationship between dates and caries,



but dates contain approximately 80% carbohydrates, most of which take the form of sugars that are readily fermented by the oral flora. Their acidogenic potential has proved to be similar to glucose and sucrose in at least one *in vitro* study [22].

It may be concluded that this study provides evidence of associations that may be important in the aetiology of both erosion and caries. There was no clear relationship between erosion and social class but the reverse was true for caries. The dietary factors identified as being related to erosion may also have contributed to caries and/or rampant caries in this group of children. The importance of dietary factors in caries in children in Saudi Arabia has been stressed in the past [23,24]. Findings here would lend emphasis to this concept.

### Acknowledgements

The authors would like to thank the Ministry of Higher Education and the President General for Girls Education office in Jeddah for the approval of the study and the schools, the children and their parents for their co-operation.

**Résumé. Objectifs.** Cette étude a eu pour objectif d'étudier l'association possible entre érosion et caries, et des variables comprenant le statut socio-économique, les pratiques d'hygiène rapportées et l'hygiène buccale dans un groupe d'enfants de Jeddah, Arabie Saoudite. **Protocole.** Etude transversale incluant l'examen dentaire et une enquête par questionnaire.

**Mise en place.** Jardins d'enfants à Jeddah, Arabie Saoudite.

**Echantillon et méthodes.** Un échantillon de 987 enfants (2–5 ans) a été recruté au sein de 17 jardins d'enfants. Les examens cliniques ont été réalisés de façon standardisée par un examinateur entraîné et étalonné (MAM).

Les renseignements sur le régime et les facteurs socio-économiques ont été tirés de questionnaires distribués aux parents par les écoles. Ils ont été remplis avant l'examen clinique.

**Résultats.** Sur les 987 enfants, 309 (31%) présentaient des érosions. Des caries ont été détectées chez 720 (73%) des enfants, et des caries rampantes chez 336 (34%). Des suppléments en vitamine C, l'utilisation fréquente de boissons sucrées, la consommation de sirop de fruit dans un biberon au lit ou lors de la sieste lorsqu'il s'agissait de très jeunes enfants étaient tous reliés aux érosions. L'utilisation de ces boissons

était aussi liée aux caries, mais faisait partie d'un éventail plus élargi de facteurs significatifs comprenant des données socio-démographiques et des pratiques d'hygiène buccale.

**Conclusions.** Il n'y avait pas de relation claire entre les érosions et la classe sociale ou entre les érosions et les pratiques d'hygiène buccale, l'inverse étant avéré pour les caries. Des facteurs diététiques liés à la fois aux érosions et aux caries et/ou aux caries rampantes ont été retrouvés dans cet échantillon d'enfants.

**Zusammenfassung. Ziele.** Ziel der Studie war es, einen möglichen Zusammenhang zwischen Erosion und Karies unter Einbeziehung von den Faktoren sozioökonomischer Status, Ernährungsgewohnheiten und Mundgesundheitsverhalten bei einer Stichprobe von Kindern aus Jeddah, Saudi-Arabien zu untersuchen.

**Design.** Querschnittstudie mit einer zahnärztlichen Untersuchung und einer Befragung mit einem Fragebogen.

**Untersuchungsort.** Kindergärten in Jeddah, Saudi Arabien.

**Stichprobe und Methoden.** Es wurde eine Stichprobe von 987 Kindern (Alter 2–5 Jahre) aus 17 Kindergärten gezogen. Unter standardisierten Bedingungen wurde eine klinische Untersuchung durchgeführt durch einen ausgebildeten und kalibrierten Untersucher. Informationen zu Ernährung und sozioökonomischen Faktoren wurde gewonnen anhand eines Fragebogens, welcher an die Eltern verteilt worden war. Der Fragebogen wurde vor der Untersuchung komplettiert.

**Ergebnisse.** Von den 987 Kindern zeigten 309 (31%) Erosionen. Karies wurde bei 720 Kindern (73%) festgestellt und umfangreiche Gebißzerstörungen bei 336 Kindern (34%). Die Gabe von Vitamin C Supplementen, der häufige Genuß von Brausegetränken und die Zufuhr von Fruchtsaftgetränken mittels Saugerflasche vor dem Einschlafen waren alle korreliert mit dem Auftreten von Erosionen. Der Gebrauch der genannten Getränke war ebenso mit Karies assoziiert, dort spielten aber auch andere Faktoren eine wichtige Rolle, insbesondere sozioökonomische Faktoren und Mundhygieneverhalten.

**Schlussfolgerungen.** Es zeigte sich keine eindeutige Korrelation zwischen Erosion und Sozialstatus oder zwischen Erosion und Mundhygieneverhalten, im Gegensatz zu Karies. Ernährungsfaktoren waren in der untersuchten Stichprobe gleichermaßen mit Erosion sowie Karies/umfangreichen kariösen Gebißzerstörungen assoziiert.

**Resumen. Objetivos.** El objetivo de este estudio fue investigar la posible asociación entre erosión, caries y variables que incluyen estado socio-económico, información sobre la dieta y comportamiento de higiene bucal en una muestra de niños en Jeddah, Arabia Saudí. **Diseño.** Estudio transversal que incluye el examen dental y un cuestionario.

**Lugar.** Guarderías en Jeddah, Arabia Saudí.

**Muestra y métodos.** A partir de 17 guarderías se escogió una muestra de 987 niños (2–5 años). Los exámenes clínicos se llevaron a cabo bajo condiciones estandarizadas por un examinador calibrado y entrenado. La información sobre la dieta y los factores socio-económicos se realizó mediante cuestionarios distribuidos a los padres a través de las escuelas. Los cuales fueron completados antes del examen dental. **Resultados.** De los 987 niños, 309 (31%) tenían erosión. La caries se diagnosticó en 720 (73%) de los niños y la caries rampante en 336 (34%). Los suplementos de vitamina C, la ingesta frecuente de bebidas carbonatadas y el consumo de zumos de fruta mediante biberón durante la noche o en la siesta cuando el niño era un bebé, se relacionaron con la erosión. El uso de estas bebidas también se relacionó con caries formaban parte de un mayor número de factores significativos incluyendo medidas socio-demográficas y prácticas de higiene oral.

**Conclusiones.** No hubo una relación clara entre erosión y clase social o entre erosión y prácticas de higiene oral, lo contrario fue cierto para la caries. En esta muestra de niños se encontraron factores dietéticos relacionados tanto a la erosión como a la caries y/o caries rampante.

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