Association of Erosion with Dietary Factors Among 5-year-old Children In India

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ABSTRACT

Purpose: The purpose of this study was to determine the association of dental erosion with dietary factors and oral hygiene practices among 5-year-old schoolchildren in Belgaum, Karnataka, India.

Methods: A random sample of 1,002 5-year-old children was drawn from Belgaum schools. Erosion was assessed using the modified Smith and Knight index. A self-designed questionnaire was used to probe into the details of the children's dietary practices.

Results: Frequency of consumption of beverages, canned juices, tamarind, and honey, a mixed diet, and frequency of teeth cleaning were significant predictors of dental erosion. Oral hygiene practices like timing of cleaning teeth and materials used did not show significant association with dental erosion.

Conclusion: Certain dietary factors like canned juice, raw mango, gooseberry, tamarind, honey, buttermilk, and beverages showed significant correlation with dental erosion. Dietary counseling must take this into consideration. (J Dent Child 2012;79(3):122-9)

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Currently, there is ample evidence indicating that dental attrition, abrasion, and erosion are showing a rising trend, the latter being implicated as a major contributor to the loss of tooth structure.[1] Research conducted in recent years has shown that there is already a trend for more pronounced dental erosion, even among younger age groups.[1] The prevalence of dental erosion ranges from 10% to 80%, reflecting the severity of the problem.[1, 2] It may lead to a number of problems, including tooth sensitivity, altered occlusion, pulp exposure, and, in severe cases, odontogenic abscess, thus affecting the oral health-related quality of life of an individual.[1]

Dental erosion has a multifactorial etiology, which can be categorized as intrinsic (eg, regurgitation/vomiting) and extrinsic acid sources (eg, acidic beverages).[3-5] It has also been suspected that diet plays a role in dental erosion. Dietary practices have changed drastically in the past few years. Consumption of beverages and processed foods has increased among adults as well as children.[5,6] Likewise, people who are health-conscious consume more citrus fruits, juices, and drinks as part of a balanced diet. The role of these dietary factors in dental erosion needs further investigation. Toothwear has also been reported in individuals with high levels of oral hygiene.[7,8] Intrinsic factors affecting dental erosion can be controlled by following appropriate medical advice and treatment, while appropriate lifestyle modification can help control extrinsic factors.[3,4]

Numerous studies have been conducted to assess the prevalence of dental erosion.[1-6] Studies assessing the role of diet in the dental erosion of the primary dentition, however, are scarce, even though the primary dentition is thought to be more susceptible to erosion than the permanent dentition due to morphological differences between the two.[9-11] Children with erosive lesions in the primary dentition are at increased risk of developing erosion in their permanent dentition.[1] Dietary practices develop during childhood and are difficult to

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change later. Thus, it is very important to examine the primary dentition for erosion, assess dietary practices, and provide timely dietary advice.

To date, no large scale study has been conducted on Indian diets and their association with dental erosion among 5-year-old schoolchildren. The purpose of the present study was to determine the association of dental erosion with dietary factors and oral hygiene practices among 5-year-old schoolchildren.

METHODS

This was a descriptive cross-sectional study. A part of this study has been published elsewhere.[12] The study was approved by the Institutional Ethics Review Board of KLE University, Belgaum. Written informed consent was obtained from parents of the children who also provided assent. A total of 1,002 randomly chosen 5-year-old children from the schools of Belgaum, India participated in the study. Stage random sampling method was used to select the children. In the first stage, 24 preschools were randomly chosen from north and south zones of Belgaum city. In the second stage, 500 children were randomly selected from each of these zones. Lottery method was used to randomly select the schools and children. Children with special health care needs and with orofacial defects were excluded. The study instrument consisted of a self-designed questionnaire containing a 3-day diet diary and 19 close-ended questions pertaining to sociodemographic factors, dietary factors, and oral hygiene practices. The frequency of consumption of acidic food substances was assessed using a food frequency questionnaire. A pilot study was conducted to determine sample size and to check comprehension of the questionnaire. The questionnaire was translated to 2 vernacular languages (Kannada and Marathi) with the help of language experts. The translated version of the questionnaire was retranslated into English by other language experts who were not aware of the original English version to assess whether the translated version conveyed the same meaning as the original one. The necessary modifications were completed and the final version of the questionnaire was prepared.

As a part of the pilot study, 100 children were examined and the erosion prevalence was estimated to be 28%.Based on this, the sample size was estimated using the following formula: $N=z^2pq/d^2$. The sample size was estimated and rounded off to 1,000. Permission to conduct the study was obtained from the deputy director of public instructions (**DDPI**), block education officer, child and women development officer, and respective school principals in Belgaum. A list of schools was obtained from the DDPI office. The city was divided into north and south zones and 12 schools were randomly chosen from each zone. A clinical examination using a mouth mirror and probe was done on the school premises.

Autoclaved instruments were used and spot sterilization was performed using Korsolex (Bode Chemie GmbH & Co. KG, Hamburg) during the survey when required. Cotton rolls were used to clean the tooth surfaces of any debris. Thirty children were examined per day. The modified Smith and Knight index was used to assess dental erosion.[13] The dental examination of the schoolchildren was done by a single examiner, who was trained and calibrated. The intraexaminer reliability was assessed, and the kappa coefficient was found to be 0.86.

Data were analyzed using SPSS for Windows 12 (SPSS Inc., Chicago, Ill.) and expressed in terms of frequencies and percentages. The chi-square test was used to determine the association of dental erosion with dietary factors and oral hygiene practices. Correlation was assessed using Spearman's rank correlation coefficient test. Multiple logistic regression was done to determine the interaction effects of the variables and which were significant predictors for dental erosion. For all the tests, the significance level was set at $P<.05$.

RESULTS

The study group consisted of 1,002 5 year-old participants (562 male and 440 female children), of which 292 (151 males, 141 females) presented dental erosion. Among those, 131 males and 134 females had erosion limited to the enamel, and the remainder had erosion involving the dentin.

DIETARY FACTORS AND DENTAL EROSION

- Frequency of consumption of curds, pickles, beverages, fruit juice, canned juice, gooseberry, raw mango, tamarind, honey, lemon juice and citrus fruits showed statistically significant association with dental erosion (Table 1).
- 393 children were vegetarian of whom 87 showed enamel erosion and 7 exhibited erosion involving dentin.

ORAL HYGIENE PRACTICES AND DENTAL EROSION

- 880 children cleaned their teeth using a toothbrush and toothpaste; 223 showed enamel erosion and 22 showed dentin erosion. The type of material used for cleaning teeth showed significant association with dental erosion.
- 268 children cleaned their teeth twice daily; 80 showed enamel erosion and 6 exhibited dentin erosion; No significant association was found between frequency of cleaning teeth and dental erosion.
- 664 children cleaned their teeth before meals; 174 demonstrated enamel erosion and 19 exhibited dentin erosion. The relation between brushing teeth before meals and dental erosion was not statistically significant.

Frequency of consumption of beverages, fruit juice, canned juice, gooseberries, raw mangos, tamarind, honey,

Table 1. Association Between Frequency of Consumption of Various Food Items and Severity of Dental Erosion

	Total Number of children consuming food item	Number of children with erosion consuming food item With every meal		Number of children with erosion consuming food item Once per day		Number of children with erosion consuming food item 2-3 times/day		Number of children with erosion consuming food item 1/week		Chi – Square value	*P* value
		Enamel erosion	Dentin erosion	Enamel erosion	Dentin erosion	Enamel erosion	Dentin erosion	Enamel erosion	Dentin erosion		
Curds	804	56	9	66	4	78	2	48	12	128.07	<.001
Pickles	732	69	10	86	12	51	1	41	2	177.63	<.001
Beverages	352	28	0	23	10	26	2	63	10	155.74	<.001
Fruit juice	576	33	2	24	5	48	3	81	3	44.60	<.001
Canned juice	178	11	0	10	2	14	2	53	0	73.11	<.001
Gooseberry	558	34	3	30	1	37	11	85	8	109.42	<.001
Raw mango	547	34	3	38	13	51	3	77	4	188.79	<.001
Tamarind	539	50	15	59	9	43	1	52	0	249.88	<.001
Honey	400	28	8	29	0	41	1	63	7	115.91	<.001
Buttermilk	568	43	4	61	3	57	0	48	6	126.99	<.001
Lemon juice	605	36	12	46	6	50	4	79	0	190.62	<.001
Citrus fruits	505	31	2	41	4	54	3	63	5	108.09	<.001

Table 2. Spearman's Rank Correlation Coefficient (SRRC) Between Dental Erosion and Various Variables

Variables	SRRC	*t* value	*P*-level
Curds	-0.01	-0.36	.71
Pickles	0.04	1.43	.15
Beverages	0.24	7.90	<.001
Fruit juice	0.07	2.24	.02
Canned juice	0.21	6.95	<.001
Gooseberry (seasonal)	0.11	3.47	<.001
Raw mango (seasonal)	0.15	4.95	<.001
Tamarind	0.16	5.19	<.001
Honey	0.23	7.42	<.001
Buttermilk	0.13	4.01	<.001
Lemon juice	0.10	3.19	.001
Citrus fruits	0.16	4.98	<.001
Diet	0.09	2.99	<.003
Illness	-0.06	-1.81	.07
Medications	0.00	--	--
Regurgitation	-0.11	-3.35	<.001
Cleaning teeth	0.05	1.58	.11
Materials used	0.08	2.38	.01
Frequency of cleaning	0.05	1.59	.11
Timing of cleaning	0.03	0.85	.39
Exposure type	0.52	19.02	<.001
Exposure time	0.51	18.72	<.001
Exposure duration	0.45	16.07	<.001

buttermilk, lemon juice, and citrus fruits showed a significant correlation with dental erosion (Table 2).

Frequency of consumption of beverages, canned juice, tamarind, honey, and mixed diets and frequency of cleaning teeth were significant predictors of dental erosion (Table 3).

DISCUSSION

The investigation of dental erosion involving a random sample of 5-year-old children was undertaken because this is when all the primary teeth have been exposed to the oral environment for a substantial period of time, and thus is a better representative age. It is the age group recommended by the World Health Organization for basic oral health surveys.[14] Identification of dental erosion and faulty dietary habits at an earlier age can help guide parents regarding healthy dietary habits so that these children do not develop dental erosion in the permanent dentition.

The overall prevalence rate of erosion was 29%. Similar results were reported by other researchers.[15-20] Few studies have reported higher prevalence of dental erosion among children.[9,10,13,21] Lifestyle changes could be a reason for the increase in the prevalence of erosion.

Consumption of curds in the present study was fairly high, with nearly 80% of the children consuming it. Frequency of consumption of curds was significantly associated with dental erosion (Chi-square value=128; *P*<.001) Similar findings were reported by Al Dlagian et al.[22] and Sujata.[23] However, curds did not appear to be a significant predictor of dental erosion (B value=0.8, *P*=.05). It has been reported that the odds of occurrence of dental erosion increases as yogurt consumption increases.[24] Contrary to this, other studies reported that yogurt hardly exerts any erosive effect.[25-30] Yogurt and other dairy products have been thought to have erosive potential because they have a low calcium and/or phosphate content and a low pH. Careful separation procedures of dairy products yields specific glycoprotein or proteose-peptone fractions that can play a part in protecting against demineralization.[31] The variation in the results could be attributed to the difference in the acidity of the curds, which may occur due to a difference in preparation methods and storage time. Approximately 56% of the children consumed buttermilk in the present study. A significant association and correlation between frequency of consumption of buttermilk and dental erosion was observed, with a high prevalence of dental erosion among children who consumed it with every meal (chi-square=126.9, *P*<.001; Spearman's rank correlation coefficient R=0.04, *P*<.05). Buttermilk consumption, however, was not a significant predictor of dental erosion (B=1.02, *P*=.73). No other studies have related consumption of buttermilk with dental erosion of primary teeth.

Pickling is the process of preserving food. Acids, spices, salt, sugar, oil, and moisture levels in the pickle help preserve it. The pH of pickles is as low as 4.6, thus could have an erosive potential. A significant association was observed between frequency of consumption of pickles and dental erosion (chi-square= 177.6, P<.001), although no significant correlation was observed (Spearman's rank correlation coefficient=.045, P=.15). It was also found to be a strong predictor of dental erosion, but was not statistically significant (B=1.09; P=.18). Frequent consumption of pickles has been reported to cause dental erosion in lactovegetarian diets.[32] To the best of our knowledge, no large scale studies have studied the association between pickles and dental erosion of the primary dentition.

Consumption of carbonated beverages has rapidly increased in recent years.[1,33] In the present study, however, only approximately 33% of the children consumed beverages. Frequency of consumption of beverages showed significant association and correlation with dental erosion, with a higher prevalence of dental erosion among children consuming beverages once a day (Chi-square=155.7, *P*<.001; Spearman's rank correlation coefficient R=.24, *P*<.001). Similar findings were reported by other studies.[9,34-38] It was a strong predictor of dental erosion (B=1.30; *P*<.001). This could be because of its pH, which can be as low as 4.0. Contrary to this, no relation was observed between consumption of acidic drinks and dental erosion.[37] Eccles and Jenkins[38] reported that soft drinks contain citric, phosphoric, carbonic, and other acids. It has been recommended that citric acid (most erosive component) be replaced by malic acid, which has lower erosive potential.[26,38] Prietsch et al[39] described an unusual pattern of erosion attributed to holding the beverage in the mouth until the carbonationhad dissipated. The variation may be due to a difference in the consumption pattern of the beverages.

Nearly 50% of the children consumed fruit juice, the frequency of which was significantly associated and correlated with dental erosion (chi-square=44.6, *P*>.02; Spearman's rank correlation co-efficient R=.07, *P*=.02). It was, however, not a strong predictor of dental erosion (B=0.90, *P*=.13). Studies have reported a positive association between consumption of fruit juice and dental erosion.[4,21,22,24,39,40] Contrary findings were reported by Milosevic.[41] The demineralizing effect of citric acid is more detrimental, as the chelating action of calcium continues even after the pH increases on the tooth surface.[42] The difference in the results of the studies could be due to the variation in the fruit used, the method of preparation, and variations in the sample size. Ascorbic acid added to a wide variety of drinks and candies has been identified as a possible cause for erosion.[43] Approximately 20% of the children consumed canned juice. The fact that relatively less consumption was observed could be attributed to the cost factor. Frequency of consumption of canned juice was significantly associated and also correlated with dental erosion (chi-square=7.11, *P*<.001; Spearman's rank

correlation coefficient R=0.21, *P*<.001), thus, it showed a significant predictive value for dental erosion (B=1.30, *P*=.002). Another study reported that canned lemon juice had high erosive potential.[44] Sixty percent of the children consumed lemon juice in the present study. A significant association and correlation was observed between frequency of consumption of lemon juice and dental erosion (chi-square=190.62, *P*<.001; Spearman's rank correlation coefficient R=0.10, *P*=.001). Consumption of lemon juice was a significant predictor of dental erosion (B=1.14, *P*=.03). Another study reported no association between consumption of lemon juice and dental erosion.[45] Stafne and Lovestedt[46] reported that individuals who drank lemon juice daily for therapeutic reasons showed a marked degree of dental erosion after only 3 months of use.

Gooseberries and raw mangoes are seasonal acidic fruits more commonly consumed by children. A statistically significant association and correlation was observed between frequency of consumption of gooseberries and dental erosion, with a high prevalence of dental erosion among children who consumed them at every meal (chi-square=109.4, *P*<.001; Spearman's rank correlation coefficient R=0.10, *P*<.001). Gooseberry consumption did not have a significant predictive value for dental erosion (B=0.90, *P*=.34). Frequency of consumption of raw mango showed a statistically significant association and correlation with dental erosion (chi square=188.7, *P*<.001; Spearman's rank correlation coefficient R=0.15, *P*<.001). This could be due to the fact that raw mango has oxalic, citric, malic, and succinic acids.[47] In addition to that, drying raw mango using sunlight could lead to concentration of the acids. In the current study, however, raw mango did not appear to be a significant predictor of dental erosion (B=1.10, *P*=.08). To the best of our knowledge, none of the other studies published to date have examined the association between raw mango and gooseberry consumption and dental erosion.

Tamarind is also an important part of the South Asian diet and is frequently consumed by children. Many organic acids like tartaric acid are reported to be present in tamarind, thus contributing to its erosive nature.[48] Frequency of consumption of tamarind was associated and correlated with dental erosion (chi-square=249.8, *P*<.001; Spearman's rank correlation coefficient R=0.16, *P*<.001). It was, however, not a significant predictor of dental erosion (B=1.10, *P*=.004). Another study also reported a significant association between tamarind consumption and dental erosion.[34]

Forty percent of the children consumed honey in the present study. A significant association and correlation was found between frequency of consumption of honey and dental erosion (chi-square=249.8; *P*<.001; Spearman's rank correlation coefficient R=0.22; *P*<.001). It was not, a significant predictor of dental erosion

Table 3. Results of Multiple Logistic Regression Analysis of Erosion (Without=0; With=1)

Variables	Coefficient±(SD)	Wald value	*P*-value	Odds ratio
Constant	-5.99±0.90	44.5021	<.001	
Curds	-0.14±0.07	3.7766	.05	0.87
Pickles	0.09±0.07	1.7911	.18	1.09
Beverages	0.30±0.06	24.9131	<.001	1.35
Fruit juice	-0.10±0.06	2.2889	.13	0.91
Canned juice	0.26±0.07	13.8693	<.001	1.30
Goose berry (seasonal)	-0.06±0.06	0.8794	.34	0.95
Raw mango (seasonal)	0.10±0.06	2.8956	.08	1.11
Tamarind	0.18±0.06	7.9107	.004	1.20
Honey	0.25±0.06	16.9461	<.001	1.29
Butter milk	0.02±0.06	0.1183	.73	1.02
Lemon juice	0.13±0.06	4.6305	.03	1.14
Citrus fruits	0.09±0.06	2.4815	.11	1.10
Diet	0.44±0.20	4.8411	.02	1.55
Illness	-4.00±7.69	0.2713	.60	0.02
Regurgitation	-0.56±0.25	4.8949	.02	0.57
Cleaning teeth	0.20±0.23	0.7306	.39	1.22
Materials used	0.13±0.12	1.1475	.28	1.14
Frequency of cleaning	0.91±0.43	4.4952	.03	2.48
Timing of cleaning	-0.36±0.23	2.4793	.11	0.70
-2 log likelihood=747.28				

****Significant at 5% level of significance (P<.05)***

(B=1.28; *P*<.001). An in vitro study reported that no erosive effect was found on enamel exposed to honey over a period of 30 minutes.[49]

Fruits like oranges and sweet limes contain high amounts of citric acid. The demineralizing effect of citric acid continues even after the pH increases; hence, it is more detrimental. Consumption of citrus fruits showed significant association and correlation with dental erosion (chi-square=108, *P*<.001; Spearman's rank correlation coefficient R=0.15, *P*<.001). However, it was not a significant predictor of dental erosion (B=1.09, *P*=.11). Jarvinen et al.[50] reported that when citrus fruits were eaten more than twice a day, there was considerable risk of dental erosion. Another study conducted among Cuban children also reported a positive association between consumption of oranges and dental erosion.[51] Contrary to this, no association was observed between consumption of citrus fruits and dental erosion by Dugmore et al.[52] The reason for variation in the results may be due to variation in the sample size and in the type of fruit consumed.

In the present study, 39% of the children were vegetarians and 61% consumed a mixed diet. A higher prevalence of dental erosion was observed among children consuming a mixed diet. The association and correlation between type of diet and dental erosion was statistically significant (Chi-square=9.03, *P*=.01; Spearman's rank correlation coefficient R=0.15, *P*=.002). Type of diet was a significant predictor of dental erosion (B=1.50, *P*=.27). In the present study, however, no differentiation was made between various types of vegetarian diet consumers. Contrary to the present study, other authors found no significant association between type of diet and dental erosion.[22] The disagreement could be due to a smaller sample size and differences in the age group of the children in the previous study.

Oral hygiene practices, such as brushing immediately after drinking beverages, have been reported to be associated with dental erosion. In the present study, the overall beverage consumption was less frequent than in other studies and none of the children brushed after consumption of beverages. Most of the subjects used a toothbrush and toothpaste. When the prevalence of dental erosion was compared with the materials used for cleaning the teeth, it was found that it was higher among the subjects who would clean their teeth with toothpaste and their finger. Although there was a significant association between the type of material used and dental erosion, the correlation and predictive value were not statistically significant. A higher prevalence of dental erosion was observed among subjects brushing their teeth twice or more daily. Similar findings were reported by Rios et al.[37] and Milosevic.[41] Dental erosion is found more often in individuals with higher levels of oral hygiene probably due to removal of the protective pellicle by the abrasives.[7,53] Frequency of tooth cleaning and dental erosion were not significantly associated in the present study as more than two thirds of the subjects brushed their teeth once daily. Another study found an association between erosion and brushing teeth before bedtime, brushing after meals, technique of brushing, type of toothbrush, and frequency of brushing.[54]

The present study had limitations. The responses were obtained from parents of the children. There might be also an exaggerated response from the parents regarding the food items provided to the child. Further studies are needed to assess the role of various components of diet as risk factors for dental erosion.

CONCLUSIONS

Consumption of acidic foods and products such as canned juice, raw mango, gooseberry, tamarind, honey, buttermilk, and beverages showed significant correlation with dental erosion. Strong and significant predictors of dental erosion were beverages, canned juice, honey and tamarind. Children should be encouraged to reduce the frequency of consumption of such diet and to consume neutralizing food along with acidic diet. Thus, appropriate dietary guidelines have to be formulated so that healthy dietary practices are instilled from childhood in order to decrease the chances of having dental erosion in the permanent dentition. Health professionals should not only bear in mind the beneficial effects of the dietary items discussed in this study on the general health but also their deleterious effects on dental health.

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