Distribution and Severity of Erosion Among 5–year–old Children in a City in India

Sushma Shankar Nayak, MDS B.R. Ashokkumar, MDS
Anil V. Ankola, MDS Mamata I. Hebbal, MDS

ABSTRACT

Purpose: The purpose of this descriptive, cross-sectional study was to determine the prevalence and distribution of dental erosion among 5-year-old schoolchildren in Belgaum, North Karnataka, India.
Methods: A random sample of 1,100 5-year-old schoolchildren who met the inclusion criteria were included in the study, of whom 1,002 actively participated. The question naire given to parents pertained to sociodemographic factors, and the parents were instructed to maintain their child's 3-day diary to assess his/her existing dietary habits. Later, the questionnaire was collected and a clinical examination for dental erosion was performed. A modified Smith and Knight index was used to assess the extent of dental erosion. The child's socioeconomic status was assessed using Kuppuswamy's classification. Statistical analysis was performed using the chi-square test, Spearman's rank correlation coefficient tests and multiple logistic regression analysis.
Results: The prevalence of dental erosion was approximately 29% (with a higher prevalence observed in females).
Conclusion: A statistically significant association was found between diet type, type and time of exposure to acidic diet and dental erosion.
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Recently, tooth wear has emerged as a major dental concern throughout the world. Although loss of tooth structure results from a combination of erosion, attrition, and abrasion, dental erosion plays a predominant role.[1] The upward trend noted in the recent years is attributed to changing lifestyles, including the increase in beverage consumption.

The term "erosion" is derived from the Latin word "erosum," meaning to corrode, which describes the process of gradual destruction of a surface, usually by a chemical or electrolytic process.[2] Dental erosion (perimylolysis) has been defined as the irreversible loss of dental hard tissue by a chemical process not involving bacteria and not directly associated with mechanical or traumatic factors or with dental caries.[2] It is solely a surface phenomenon, unlike caries, which has been established as a destructive effect involving both the surface and subsurface regions.

Although removal and softening of the tooth surface occurs, dissolution of mineral below the surface also may occur. This multifactorial phenomenon can be initiated either by intrinsic or extrinsic acidic sources or both. Erosion softens the enamel, which in turn renders the tooth surface more susceptible to wear by abrasive mechanical agents. Tooth changes observed after dental erosion range from mild modification of surface characteristics to severe loss of tooth structure.[3]

Numerous epidemiological studies have reported that the prevalence of dental erosion is high in young people and adolescents, whereas studies on dental erosion in the primary dentition are sparse. Deshpande and Hugar

Dr. Nayak is lecturer, Dr. Ashokkumar is professor, Dr. Ankola is professor and head, and Dr. Hebbal is reader, all in the Department of Community Dentistry, KLE VK Institute of Dental Sciences, KLE University, Belgaum, Karnataka, India.
Correspond with Dr. Nayak at dr_sushmanayak@yahoo.co.in

reported a prevalence of approximately 29%;[2] Weigand et al reported a prevalence of approximately 30% in 2- to 7-year-olds[4]; and Ayers et al reported a prevalence of 82% among 5- to 8-year-olds.[5] There is a lack of information, however, about the distribution of dental erosion in 5-year-old children. No extensive studies conducted so far have reported the distribution of dental erosion while also considering the entire primary dentition. There also is a paucity of information on dental erosion in Indian children.

Hence, the purposes of the present study were to determine the: prevalence of dental erosion among 5-year-old schoolchildren in Belgaum, North Karnataka, India; distribution of dental erosion according to the surfaces involved; and relation between dental erosion and existing dietary habits/exposure.

METHODS

This was a cross-sectional, descriptive type of study. Prior to the commencement of the study, ethical clearance was obtained from the Institutional Review Board of KLE VK Institute of Dental Sciences located in Belgaum, India. A pilot study was conducted among 100 children with the objective of determining sample size and feasibility of the study. It was conducted in 2 stages.

In the first stage, a questionnaire—created in English, Kannada, and Marathi versions—was distributed to 20 mothers of children, randomly chosen from a school in Belgaum city, to gauge comprehension of mothers, regarding the questions in the questionnaire. Consequently, it was found that few questions were not comprehensible. Only these questions were modified to make them easily understandable.

In the second stage, the finalized questionnaire was distributed to 100 mothers and subjects were examined to determine the sample size. After a month, the questionnaire was redistributed to the mothers to check its reliability, which was found to be 0.8.

The finalized questionnaire consisted of 2 parts: the first pertained to the child's sociodemographic information; the second consisted of a 3-day diet diary, with a model example and instructions to help the parents complete it. The parents were asked to write in detail the child's pattern of dietary consumption (eg, sucking, sipping, chewing for prolonged periods, etc) and the time and frequency of consumption.

Based on the pilot study, sample size was estimated to be 950, which was approximated to 1,000. A simple, random sampling technique was used to select the study's sample. Belgaum was divided into 2 zones: north and south, from which 12 schools were selected. Permissions from concerned authorities, such as Deputy Director of Public Instructions and Head Master/Head Mistress of the respective schools, were sought prior to study commencement. Clinical examination was conducted on school premises under natural light using a mouth mirror and probe (Type III examination). Cotton rolls were used to clean the teeth of food debris and to dry them. Children's dental erosion status was assessed using a modified Smith and Knight index.[2] A self-designed format was used to record the dental erosion scores for the entire dentition. The clinical examination of all preschool children participating in the study was done by a single examiner, who was calibrated. Before conducting the survey, the Kappa coefficient value for intraexaminer reliability was found to be 0.86, reflecting a high degree of conformity in observations.

To assess the socioeconomic status, the necessary information regarding education, occupation, and family income was obtained using the questionnaire and subjects were divided accordingly into 5 classes using modified family income group in Kuppuswamy's socioeconomic status scale.[6]

Dietary assessment included all food items consumed by the children in a 3-day period, including the snacks consumed between meals. The total number of meals was restricted to 4, whereas the number of in-between meals was unrestricted. Food items were categorized as acidic and nonacidic. The type of acidic foods consumed and the frequency of eating them was calculated. All acidic food items recorded in the 3-day diet diary were circled in red.

The dietary chart was analyzed for frequency, time, type, and approximate duration of acidic exposure. Due to the nonavailability of a universally accepted system of diet analysis for acidic exposure, an ad hoc format was devised. Depending upon the time of exposure to acidic diet, "with meals exposure" was coded as 0 and "between meals exposure" was coded as 1. Single exposure to acidic diet was coded as 0; combined acidic exposure was coded as 1; one-time acidic exposure was coded as 0; and prolonged acidic exposure, such as sucking, sipping, and chewing, was coded as 1.

Statistical analysis was conducted using SPSS for Windows 12 (SPSS Inc, Chicago, Ill). Qualitative data was expressed in terms of frequency and percentages. Spearman's rank correlation coefficient test was used to determine the type of association between various risk factors with dental erosion. Multiple logistic regression analysis was performed to know the interaction effects of various variables on dental erosion. For all tests, the significance level was set at $P \leq .05$.

Table 1. Distribution of Subjects according to Gender and Dental Erosion*

Gender	No Erosion	Enamel Erosion	Dentin Erosion	Total
Males	411	131	20	562
Females	299	134	7	440
Total	710	265	27	1,002

** Chi-square=9.2440; df (degree of freedom) =2; P=.01 (statistically significant).*

RESULTS

This study examined a total of 1,002, 5-year-old schoolchildren. The prevalence of dental erosion was estimated to be approximately 29% (32% for females). A slightly higher prevalence of dental erosion was observed in the upper lower socio-economic class (classified according to Kuppuswamy's Socio-Economic Scale) (30%), but the difference was not considered to be statistically significant (Tables 1 and 2).

Table 2. Distribution of Study Subjects according to Socioeconomic Status (SES) and Dental Erosion*

SES	No Erosion	Enamel Erosion	Dentin Erosion	Total
Upper class	25	7	2	**34**
Upper middle class	175	69	4	**248**
Lower middle class	318	114	13	**445**
Upper lower class	187	74	7	**268**
Lower class	5	1	1	7
Total	**710**	**265**	**27**	**1,002**

** Chi–square=7.3090; df (degree of freedom) =8; P=.50 (not statistically significant).*

Table 3. Distribution of Tooth Surfaces according to Severity of Dental Erosion*

Maxilla	Erosion involving enamel	Erosion involving dentin
Incisors		
• Buccal surfaces	115	14
• Incisal surfaces	130	4
• Lingual surfaces	60	2
Canines		
• Buccal Surfaces	39	0
• Incisal Surfaces	18	0
• Lingual Surfaces	9	0
Molars		
• Buccal surfaces	66	0
• Occlusal surfaces	19	2
• Lingual surfaces	5	1
Mandible		
Incisors		
• Buccal surfaces	45	4
• Incisal surfaces	22	0
• Lingual surfaces	32	5
Canines		
• Buccal surfaces	16	1
• Incisal surfaces	5	0
• Lingual surfaces	14	0
Molars		
• Buccal surfaces	32	2
• Occlusal surfaces	58	0
• Lingual surfaces	2	0

** None of the subjects exhibited dental erosion extending into pulp.*

DISTRIBUTION OF DENTAL EROSION ON TOOTH SURFACES

Of the 60,120 total tooth surfaces examined, 335 labial/buccal, 129 lingual, and 258 incisal/occlusal surfaces were affected by dental erosion. Additionally, 484 maxillary and 238 mandibular surfaces were affected by dental erosion (Table 3). Erosion involving dentin was observed in 35 (23 maxillary and 12 mandibular) surfaces. No tooth surfaces showed dental erosion involving the pulp (Table 1).

Dietary analysis revealed the following findings: 407 children had single exposure to an acidic diet, of whom 82 (20%) exhibited dental erosion; 237 children had combined exposure, of whom 178 (75%) exhibited dental erosion. A significantly higher prevalence of dental erosion was observed in children with combined exposure ($P<.05$; Table 4).

According to the timing of acidic exposure, 445 children were exposed to an acidic diet with meals, of whom 102 (23%) exhibited dental erosion; 199 were exposed to an acidic diet between meals, of whom 158 (79%) exhibited dental erosion. A significantly higher prevalence of dental erosion was observed in children with acidic exposure between meals ($P<.05$; Table 5).

According to the duration of exposure, 544 children had one-time exposure to an acidic diet, of whom 170 (31%) exhibited dental erosion; 100 children had prolonged exposure to an acidic diet, of whom 90 (90%) had dental erosion. A significantly higher prevalence of dental erosion was noted in children with prolonged exposure to acidic diet ($P<.05$; Table 6).

Spearman's rank correlation coefficient analysis revealed a significant relation between type, time, and duration of acidic exposure with dental erosion. Multiple logistic regression analysis revealed significant relation between gender, type, and time of acidic exposure with dental erosion (Tables 7-9).

DISCUSSION

Black stated: "Though erosion is rare compared to caries, once a practitioner is aware of dental erosion he will actually see it in many more patients."[7] This philosophy is not out of place today.

Changing lifestyle and dietary patterns have played a major role in the increase in dental erosion in recent years. Children with dental erosion have established patterns of eating and drinking, which place them in a high-risk group for damage to the permanent dentition.[7,8] Therefore, it is necessary to diagnose tooth wear processes in the primary dentition as early as possible to adopt effective preventive measures. Adoption of such measures, however, requires a detailed insight into the prevalence and distribution of dental erosion. Hence, thepresent study was conducted. Five-year-old

school-children were selected for this study because this is an age group recommended by the World Health Organization for oral health surveys.[9]

Among the various indices available to measure dental erosion. Smith and Knight's tooth wear index is the most widely used, but its primary disadvantage is that it measures tooth wear and not erosion. This necessitated the use of a modified version of the index (used in the National Health and Nutrition Examination Survey).[2,10]

Table 4. Distribution of Subjects according to Acidic Dietary Exposure Type and Dental Erosion*

Exposure type	No erosion	Enamel erosion	Dentin erosion	Total
Nil	326	32	0	**358**
Single	325	79	3	**407**
Combined	59	154	24	**237**
Total	**710**	**265**	**27**	**1,002**

** Chi-square=342.1100; df (degree of freedom) =4; P=.00 (statistically significant).*

Table 5. Distribution of Study Subjects according to Timing of Acidic Dietary Exposure and Dental Erosion*

Time of exposure	No erosion	Enamel erosion	Dentin erosion	Total
Nil	326	32	0	**358**
With meals	343	99	3	**445**
Between meals	41	134	24	**199**
Total	**710**	**265**	**27**	**1,002**

** Chi-square=345.418; df (degree of freedom) =4; P=.00 (statistically significant).*

Table 6. Distribution of Study Subjects according to Duration of Acidic Dietary Exposure and Dental Erosion*

Exposure duration	No erosion	Enamel erosion	Dentin erosion	Total
Nil	326	32	0	**358**
One time	374	160	10	**544**
Prolonged exposure	10	73	17	**100**
Total	**710**	**265**	**27**	**1,002**

** Chi-square=285.5530; df (degree of freedom) =4; P=.00 (statistically significant).*

Table 7. Results of Spearman's Rank Correlation Coefficient (RCO) between Dental Erosion Status and Various Other Variables*

Variables	Erosion status			
	Spearman's RCO	*t*-value	*P*-value	Statistically significant
Sex	0.05	1.54	>.12	No
Socioeconomic status	0.01	0.35	>.72	No
Acidic exposure type	0.52	19.02	.00	Yes
Acidic exposure time	0.51	18.71	.00	Yes
Acidic exposure duration	0.45	16.07	.00	Yes

The present study revealed that approximately 29% children had dental erosion. Similar results were obtained by: Cagalar (28% among 11-year-olds)[11]; Deshpande and Hugar (29% among 5-year-olds)[2]; Jones and Nunn (29% among 3-year-olds)[12]; Millward (30% among 4- to 16-year-olds)[13]; and Milsoveic et al (30% among 14-year-olds).[14]

A higher prevalence of dental erosion vs the present study was reported by: Malik et al (31%)[15]; Al-Majed et al (34%)[16]; the National Diet and Nutrition Survey (NDNS, 42% among 14-year-olds)[10]; and Harding et al (47% among 5-year-olds).[17]

A lower prevalence of dental erosion vs the present study was reported by: Peres et al (13% among 12-year-olds)[18]; the UK Child Dental Health Survey (25%)[10]; and Al-Maejed et al (26% among 14-year-olds).[16] The reasons for these differences may be attributed to variations in: sample size; diagnostic criterias; indices used to measure tooth wear; lifestyles and dietary habits of the children; and the dentition assessed.

The dental literature is varied regarding the prevalence of dental erosion among males and females.

In the present study, 56% of the children were males and 44% were females. Chi-square analysis revealed a significantly higher prevalence of dental erosion in females (chi-square value=9.24; $P<.01$). Results of logistic regression analysis revealed a significant association between gender and dental erosion. Al-Dlaigan et al,[19] El Aidi,[20] Dugmore and Rock,[21] and Bartlett et al[22] observed a higher prevalence of dental erosion among males. Peres et al found no significant difference in the prevalence of dental erosion among males and females.[18] Milsoveic et al reported a higher prevalence of dental erosion among females.[14] These variations could be due to differing lifestyles and variations in sample size.

A statistically significant association between socioeconomic status and dental erosion, with a higher prevalence of dental erosion in lower socioeconomic status, was noted by Nunn,[10] Jones et al,[12] Millward et al,[13] Milsoveic et al,[14] Harding et al,[17] and Al-Dlaigan et al.[19] Dugmore and Rock also noted a significantly lower level of dental erosion in socioeconomically advantaged children.[21] The NDNS for 1½- to 4½-year-olds did not report any significant association between socioeconomic status and dental erosion.[10] El Karim reported a higher prevalence of dental erosion among children of higher socioeconomic status.[23] The present study, however, failed to show a statistically significant difference in the prevalence of dental erosion with social classes (chi-square value=7.3; $P=.50$). There is a possibility that a relation of this type does not exist in the selected group. Also, it is possible that there may be an unequal distribution of children among different socioeconomic classes.

One of this study's vital findings is a higher prevalence of dental erosion on the buccal/labial surfaces

followed by incisal and lingual surfaces. Similar results were obtained by Peres et al,[18] William et al,[24] Al Majed et al,[16] and Lussi et al.[25] The anterior teeth's labial surfaces have most often been reported to be affected when erosion has been associated with diet. Jarvinen et al, however, concluded that the cause of dental erosion could not be identified by location of the illness.[26] UK surveys revealed a higher prevalence of dental erosion on the incisal surfaces.[10] Similar findings were reported by Al Malik et al.[15] Hugar reported a higher prevalence of dental erosion on the palatal and buccal surfaces of maxillary central incisors and on the occlusal surfaces of primary mandibular first molars.[2]

Comparing the jaws indicated a higher prevalence of dental erosion in maxillary vs mandibular teeth. According to the extent of tooth surface involvement, most tooth surfaces showed erosion involving enamel, followed by dentinal involvement. No tooth surfaces showed erosion involving pulp. Similar findings were reported by Hugar and Deshpande.[2] Harding et al noted that erosion involving enamel was seen in almost half of the population and involving dentin and pulp in 20% of the population.[17] The UK child dental survey and NDNS reported a higher prevalence of dental erosion on the palatal surfaces of primary incisors.[10] No studies conducted so far have extensively compared dental erosion involving the entire dentition in a large population.

Dietary analysis revealed a significant association of dental erosion with prolonged exposure, combined exposure, and between-meals exposure to an acidic diet. A wide range of studies have been conducted to investigate the relationship between diet and dental erosion. Linkosalo reported a significant relationship between dental erosion and consumption of acidic foods.[27] Al Majed et al reported a significant relationship between dental erosion and consumption of carbonated beverages.[16] Similar findings were obtained by El Karim et al,[23] Jensdottir et al,[28] and Waterhouse et al.[29] Rios, however, found no relationship between consumption of carbonated or acidic drinks and tooth wear.[30] The differences may result from variations in patterns of beverage consumption as it influences the rate of acid clearance. Lussi et al reported that the consumption of fruit juices with pH 3.2 and 3.9 are capable of softening enamel and dentin.[25] Al-Dlaigan et al[31] and Lussi et al[25] also noted a significant association between citrus fruit and dental erosion. Jarvinen et al found a strong association with dental erosion in patients who consumed citrus fruits more than twice a day.[26]

Linksalo reported that frequent consumption of pickles causes erosion in lactovegetarian diets.[27] El Karim reported a significant correlation between consumption of tamarind and dental erosion.[23] Hence, it has been in-creasingly evident that diet plays a role in dental erosion. None of the studies so far, however, have examined dental erosion in terms of the form, frequency, and type of acidic exposure.

Table 8. 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	44.50	.00*	For constant OR cannot be calculated
Acidic exposure type	0.97±0.29	11.30	<.001*	2.63
Acidic exposure time	1.02±0.27	13.75	<.001*	2.76
Acidic exposure duration	0.45±0.32	2.04	>.15	1.57
-2 log likelihood 747.284 – It indicates the model fitting performance				

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

Table 9. Results of Logistic Regression Analysis of Dental Erosion (without=0; with=1)

Variables	Coefficient±(SD)	Wald-value	*P*-value	Odds ratio Exponential of (Coefficient)
Constant	-0.94±0.51	3.36	<.07*	For constant OR cannot be calculated
Sex	0.26±0.14	3.56	<.06*	1.30
Socioeconomic status	0.02±0.37	0.01	<.95	1.02
-2 log likelihood 1202.464 – It indicates the model fitting performance				

**** Significant at 10% level of significance (P<.10).***

The present study has certain limitations. Though dental erosion is primarily influenced by dietary factors, it also may be influenced by other factors like salivary buffering capacity, calcium and phosphate content of saliva, and pH of saliva. Those that have not been mentioned can indirectly promote dental erosion either by influencing saliva composition or tooth morphology and composition. Any study of a diet/erosion relationship has some inherent difficulties. There is no consensus on the most valid method of measuring dietary intake.

The diet diary used in this study revealed the current diet pattern followed by the child, whereas dental erosion is a cumulative effect of past dietary habits. An exact correlation may not be possible using the diet diary.

CONCLUSIONS

The present study's findings highlight the surfaces of the tooth most prone for dental erosion. Dietary factors like frequency, duration, and time of acidic exposure play an important role in the development of dental erosion. Further studies are needed with detailed insight into dietary pattern and salivary parameters affecting dental erosion.

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