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Dental erosion among 12 year-old Libyan schoolchildren

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Objective: As there are limited data on dental erosion in Libya, the aim of this study was to assess the prevalence and severity of dental erosion in a sample of 12 year-old children in Benghazi, Libya. ***Basic research design****:* Cross-sectional observational study. ***Clinical setting****:* Elementary schools in Benghazi, Libya. ***Participants****:* A random sample of 791 12 year-old children (397 boys and 394 girls) attending 36 schools. ***Methods****:* Clinical dental examination for erosion using UK National Diet and Nutrition Survey (2000) criteria and self-completion questionnaire. ***Main outcome measures****:* The area and depth of dental erosion affecting the labial and palatal surfaces of the upper permanent incisors and occlusal surfaces of the first permanent molars. ***Results****:* Dental erosion was observed in 40.8% of subjects; into enamel affecting 32.5%, into dentine affecting 8.0% and into pulp affecting 0.3% of subjects. Based on area affected, 323 subjects (40.8%) exhibited dental erosion (code >0), with 32.6% of these subjects having erosion affecting more than two thirds of one or more surfaces examined. Mean total scores for dental erosion for all surfaces per mouth by area and by depth were both 2.69 (sd 3.81). Of the 9492 tooth surfaces examined, 2128 surfaces (22.4%) had dental erosion. Girls had more experience of erosion than boys at all levels of severity (p=0.001). ***Conclusions****:* In a cohort of 12 year-old Libyan schoolchildren, more than one third of children examined showed dental erosion, requiring clinical preventive counselling. Significantly more erosion occurred in girls than boys.

Key words: *dental erosion, children, Libya, prevalence*

Introduction

Dental erosion is a multifactorial condition influenced by the interaction of chemical, biological and behavioural factors which explains why some individuals exhibit more erosion than others (Lussi and Jaeggi, 2008), and it is often associated with other forms of tooth wear such as abrasion and attrition. The term 'tooth wear' is used as a reflection of all three conditions (erosion, abrasion and attrition). Tooth wear in childhood is predominantly due to dental erosion and there is concern regarding its prevalence since it is largely preventable (Al-Dlaigan *et al*., 2001; Chadwick and Pendry, 2004; Walker *et al*., 2000). The aetiology of dental erosion is usually extrinsic or intrinsic acids, according to the case history; the main source in most cases being extrinsic acids from soft drinks in the diet (Johansson *et al.*, 1996).

As dental caries prevalence has declined in many populations, dental erosion has become increasingly recognised as a public health concern amongst children and adolescents (McGuire *et al.*, 2009). The prevalence and severity of dental erosion varies widely between populations and ages; many cases are not identified until adulthood when they may be severe and difficult to treat, therefore, its early diagnosis and prevention are important.

A number of epidemiological observational studies have assessed the prevalence of dental erosion in children and adolescents and it has been the subject of recent systematic review (Kreulen *et al.,* 2010). The 2003 UK Child Dental Health Survey showed 12% of 12 year-olds had tooth surface loss (TSL) of buccal surfaces of permanent upper incisors; 30% having lingual surface loss on these teeth. The proportions of 12 year-olds showing TSL on the occlusal surface of first permanent molars was 19%. Only 2% of 12 year-olds and 4% of 15 year-olds had TSL into dentine (Chadwick and Pendry, 2004). In 5-14 year-old Australians the prevalence of erosion was 25% in subjects with permanent teeth, while a more recent study assessed the prevalence of tooth surface loss in 12-14 year-old Sudanese schoolchildren and found overall mouth prevalence was 74.1%, with mild and moderate tooth surface loss respectively in 61.8% and 22.9% of maxillary teeth examined (Kazoullis *et al.,* 2007; Sanhouri *et al.,* 2010). Also recently, a study of 12 year-old Iranians, reported that the prevalence of dental erosion for the labial and palatal surfaces of upper incisors was 38.1% (Talebi *et al.*, 2009). Similarly, a prevalence study carried out in 2003-4, of 13-19 year-old children and young adults in the United States, showed that 45.9% of subjects had erosive tooth wear in at least one tooth (McGuire *et al.*, 2009).

There are limited published epidemiological studies relating to the prevalence of dental erosion in Libya. Therefore, the aims of this study were to determine both the prevalence and severity of dental erosion and to examine gender differences in relation to the prevalence in a group of 12 year-olds in Benghazi, Libya. The relationship between dental erosion and parents' education levels, a proxy measure of socioeconomic status, was also considered.

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Materials and methods

Ethical approval and permissions were secured from the Libyan Health Ministry, the Education Ministry and local authorities. In addition, written informed consent was obtained from parents/guardians and written assent from children. The study was conducted in Benghazi, the second largest city in Libya with a population of 685,367, most (88%) living in urban areas (GAI, 2006). At the time of the study the number of 12 year-old schoolchildren in Benghazi was approximately 7682. These children were studying at 81 public elementary schools; 90% of all the schools in the city (GAI, 2006). In Libya, public schools are government-funded and do not require the payment of fees. In the absence of published data on the prevalence of dental erosion in Libya, the sample size calculation was based on the prevalence of dental erosion (52%) in 11-14 year-old British children (Walker *et al*., 2000), and in 13-14 year-old Brazilians (34%) (Auad *et al.*, 2007). A cluster sampling method, with schools as clusters, provided a random sample of 792. Having invited all 12 year-olds from 36 elementary schools across all 15 municipal districts in Benghazi to participate, the sample was selected from those returning consents. Each school was asked to provide 11 male and 11 female children for the sample (though one school could not provide this balance).

There is no governmental classification of areas based upon socioeconomic information in Libya, therefore, parents' education levels were taken as a proxy measure of socioeconomic status. These educational level data were collected through a questionnaire based on the one used in the UK National Diet and Nutrition Survey (Walker *et al*., 2000) and completed by the children in the schools. Instructions were given to subjects before they responded to the questionnaire.

Oral examinations were conducted in the schools by one examiner, calibrated previously by an experienced examiner. The dental examination was undertaken in any available space in the schools and conducted under artificial light, with additional lighting via a headlamp which was used throughout the dental examination as the diagnostic source of light. The subjects were seated in an ordinary chair, in front of the examiner. Pre-packed sterilised oral examination kits containing a plane mouth mirror and a probe were used for the dental examination. Packages of sterilised gauze were used to dry the tooth surfaces and the probe was used to remove food debris. Data were recorded by a trained assistant. The prevalence of dental erosion was determined by depth and area using a previously validated index for tooth surface loss from the oral health component of the UK National Diet and Nutrition Survey (NDNS) (Walker *et al.,* 2000) and UK Child Dental Health Survey (Chadwick and Pendry, 2004). This index was used to assess the labial and palatal surfaces of all permanent maxillary incisors and the occlusal surfaces of the first permanent molars. The depth and area of loss of tooth surface was assessed. Tooth surfaces were excluded if they had a large restoration, gross dental decay or orthodontic bands in place. Surfaces were coded according to the depth affected and the fraction of tooth surface involved: Code 0, normal; Code 1, enamel only, <1/3 of surface involved; Code 2, enamel and dentine, 1/3 to 2/3 of surface involved; Code 3, enamel, dentine and pulp, >2/3 of surface involved; Code 9, assessment cannot be made.

After completion of the dental examination, 9% of the total sample (70 subjects) were re-examined on the same day to ensure the reproducibility of the application of diagnostic criteria. To ensure the examiner was blind to those subjects, on the day of dental examination the assistant was instructed to randomly re-call 2 pupils during each dental examination session without informing the examiner, and another clinical examination was undertaken, allowing at least 2 hours before re-examinations.

The prevalence of erosion was calculated as the number and proportion of subjects affected and number and proportion of dental surfaces and groups of teeth affected, as well as severity based on depth and area. Dental erosion for area and for depth was cross-tabulated with gender. Since the data were not normally distributed, associations between dental erosion and socioeconomic variables were tested through a process of bivariate analysis, using the exact versions of the non-parametric test χ^2, Fisher's and Linear Association. Odds ratio (OR) and 95% Confidence Intervals (CI) were calculated for 2x2 tables. Only 2-sided statistical tests were used with the significance level set at 5%.

Results

Written consents were obtained from 2662 (88.3%) out of the 3014 12 year-olds in the selected schools with the reasons for non-response (n=338) being lack of signed parental consent (n=311, 10.8%) or absence (n=27, 0.9%). Of those consenting, 792 were selected randomly for dental examination and data collection took 5 months from September 2007. Overall 791 subjects were dentally examined, one child being absent on the day of dental examination. The mean age of the subjects was 11.7y (sd 0.31) (range 10.8-12.5).

The intra-examiner agreement for assessment of dental erosion, as measured by Cohen's Kappa statistic for Code 1 by depth (erosion into enamel only) was 89%, 91% and 77% for the labial and palatal surface of incisors and occlusal surface of molars respectively. This indicated a good level of agreement for diagnosis of erosion of labial and palatal surface of incisors and substantial agreement for occlusal surface of molars.

Of the 791 examined subjects, 323 (40.8%) exhibited dental erosion (Code >0) for depth in one or more upper permanent incisors, or upper and lower first permanent molars. Dental erosion into enamel only was the most common finding (32.5% of subjects); dentine erosion was relatively uncommon (8.0%), while erosion into pulp was rare (0.3%) (Table 1).

The pattern was similar for the tooth area affected by erosion; 323 subjects (40.8%) exhibited dental erosion (Code >0), with 32.6% of subjects having erosion affecting more than two thirds of one or more surfaces examined (Table 2). The mean total scores for dental erosion for all surfaces per mouth by area and by depth were both 2.69 (sd 3.81).

A higher prevalence of erosion was observed amongst girls (47%) than boys (35%) (Table 1). The distribution of girls and boys with experience of dental erosion by depth was also significantly different (Pearson χ^2; p=0.004)

Table 1. Mouth severity of erosion categorised by distribution of the highest codes scored for dental erosion for depth (all index teeth) by gender and by surface

	Code 0 *Normal*		*Code 1* *Enamel only*		*Code 2* *Enamel and dentine*		*Code 3* *Enamel, dentine and pulp*		*All*	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*Code >0*
a) By gender										
All	468	59.2	258	32.5	63	8.0	2	0.3	791	323
Boys	258	65.0	114	28.7	25	6.3	0	0	397	139
Girls	210	53.3	144	36.6	38	9.6	2	0.5	394	184
b) By tooth surface										
Upper incisors: Labial	593	75.0	195	24.6	2	0.3	1	0.1	791	198
Upper incisors: Palatal	589	74.5	199	25.1	2	0.3	1	0.1	791	202
First permanent molars: Occlusal	611	77.2	118	14.9	62	7.9	0	0	791	180

Table 2. Mouth prevalence of dental erosion categorised by distribution of the highest codes scored for area of tooth affected (all index teeth)

	Code 0 *Normal*	*Code 1* *<1/3 surface*	*Code 2* *1/3 < 2/3 surface*	*Code 3* *>2/3 surface*	*Total*	*Code >0*
No. of subjects	468	3	62	258	791	323
(%)	(59.2)	(0.4)	(7.8)	(32.6)	(100)	(40.8)

Table 3. Association between the mouth prevalence of dental erosion (for depth and/or Code >0) and gender

	Girls' experience of dental erosion			*Boys experience of dental erosion*			*All children's experience of dental erosion*		
	Yes	*No*	*Total*	*Yes*	*No*	*Total*	*Yes*	*No*	*Total*
n	184	210	394	139	258	397	323	468	791
(%)	(46.7)	(53.3)	(100)	(35.0)	(65.0)	(100)	(40.8)	(59.2)	(100)

Fisher's Exact Test; p=0.001 Odds Ratio = 1.63 (95% CI; 1.22, 2.16)

Table 4. Relationship between the number (n) and proportion (%) of children with and without erosion experience and parents' educational level

Parents' education	Number of children	With experience of erosion		No experience of erosion		p (Linear Association Exact test)
		n	(%)	n	(%)	
Mothers' education:						
Illiterate	51	17	(5.3)	34	(7.3)	0.130
Up to secondary school [1]	454	181	(56.0)	273	(58.3)	
Higher [2]	286	125	(38.7)	161	(34.4)	
Total	791	323		468		
Fathers' education:						
Illiterate	17	7	(2.2)	10	(2.1)	0.443
Up to secondary school [1]	367	144	(44.6)	223	(47.6)	
Higher [2]	407	172	(53.3)	235	(50.2)	
Total	791	323		468		

Notes: [1] Elementary school and intermediate school; [2] College/postgraduate

(Table 1). With regard to the extent of erosion by area, 153 girls (39%) and 105 boys (26%) had evidence of erosion involving more than 2/3 of the surface. This distribution was also significant (Pearson χ^2; p=0.001).

Of the 791 examined subjects, 198 (25.0%) had evidence of dental erosion (Code >0 for depth) on one or more labial surfaces of the incisors examined, 202 (25.5%) had evidence of erosion of palatal surfaces of incisors and 180 (22.8%) had evidence of erosion of occlusal surfaces of molars (Table 1).

In total, 6328 index teeth and 9492 index teeth surfaces were evaluated. The proportion of teeth affected by erosion ranged from 23.6% of the upper left lateral incisors to 24.2% of upper left central incisors examined. For the occlusal surfaces of molars, the proportion of surfaces affected ranged from 17.7% of mandibular first molars to 19.9% of maxillary left first molars.

There was no significant difference in children's erosion according to their parents' educational level (Table 4).

Discussion

Internationally, experience of dental erosion in children shows a wide range of prevalence (Al-Dlaigan *et al*., 2001; Al-Majed *et al*., 2002; van Rijkom *et al*., 2002). Most data are from European studies with only a few epidemiological studies being from developing countries (Al-Majed *et al.*, 2002; Al-Malik *et al*., 2001; Auad *et al.*, 2007; Johansson *et al*., 1996; Sanhouri *et al* 2010; Peres *et al*., 2005). Children aged 12 were selected for this study because at this age the index teeth have been present in the mouth for about 6 years and exposed to possible intrinsic and extrinsic aetiological factors which may cause dental erosion. This age group was also useful for comparison purposes since several published studies have focused on similar age groups ranging from 12-14 years. However, the use of different indices, criteria, age groups, sample size, gender and groups of teeth and tooth surfaces examined in other studies can make comparisons difficult. Some studies have assessed the prevalence of dental erosion while others have assessed the prevalence of tooth wear. The sample was felt to be sufficiently large to be representative of an urban community in Libya. Most Libyans (88%) live in cities, including the schoolchildren in the 36 schools drawn from the 15 districts with different socioeconomic groups and cultures. This made the study sample in Benghazi reasonably representative of other regions of Libya.

The results of the present study showed that the mouth prevalence of dental erosion was 40.8%. This figure was close to the value found in the UK NDNS for 11-14 year-olds, in which 42% of the children examined were affected (Walker *et al*., 2000). On the other hand, the prevalence in this study was higher than the 33% for 12 year-olds (Chadwick and Pendry, 2004) found in the 2003 UK CDH Survey. When comparing the present findings with other studies conducted in developing countries, the prevalence of erosion in this study was found to be higher than the 34% found in 13-14 year-old and 13% in 12 year-old Brazilians (Auad *et al*., 2007; Peres *et al*., 2005) but lower than the 74.1% in 12-14 year-old Sudanese (Sanhouri *et al*., 2010) and much less than the 95% prevalence in 12-14 year-old Saudi Arabian boys (Al-Majed *et al.*, 2002). Dental erosion into enamel only was the most common finding in the current study and this agrees with the findings of the majority of other studies documented previously (Al-Majed *et al*., 2002; Auad *et al.,* 2007; Caglar *et al.*, 2005; Chadwick and Pendry, 2004; Correr *et al*., 2009; Deery *et al*., 2000; Mungia *et al*., 2009; Peres *et al*., 2005; Walker *et al*., 2000).

Dental erosion into dentine was relatively uncommon, affecting only 63 subjects (8.0%) but it was higher than the 3% found in 11-14 year-olds in the UK's NDNS Survey (Walker *et al.*, 2000). However, it is difficult to make comparisons due to different methods and the reliability of scoring dentine is felt to be lower than scoring enamel erosion (Holbrook and Ganss 2008). Mouth prevalence of erosion for the upper permanent incisors in the present study was 25%. This figure was much less than that found in a Saudi Arabian study (72%) using the same diagnostic criteria (Al-Majed *et al.*, 2002), but closer to the 30% and 33% found in 12 and 15 year-olds in the UK 2003 CDH Survey (Chadwick and Pendry, 2004). Erosion into pulp was uncommon; only two maxillary incisors were pulpally involved in the present study. Similar findings were reported in 12-14 year-old Saudi Arabian boys (Al-Majed *et al.*, 2002).

A symmetrical distribution of dental erosion across the midline was observed in the present study, confirming the findings of others (Al-Majed *et al.*, 2002; Auad *et al.*, 2007; Dugmore and Rock, 2004). The prevalence of dental erosion for the occlusal surfaces of first permanent molars in the children studied was 22.8%; slightly higher than that reported for toothwear (19%) on these surfaces in UK (Chadwick and Pendry, 2004) and Brazilian children (5%) (Auad *et al*., 2007). Differences in times of exposure to risk factors, such as consumption of acidic drinks as snacks or at meal times or at bedtime, frequency of consumption of acidic drinks and foods and duration of drinks retained in the mouth may have exposed children to different degrees of risk.

In the present study, 9492 dental surfaces were evaluated; 75.4% were free of dental erosion, 22.4% had erosion and the remaining 2.2% could not be assessed. This is similar to the findings in 12 year-old Brazilian schoolchildren, in whom 73.1% of the total surfaces examined were free of erosion and 26.9% had erosion (Peres *et al.*, 2008). However, comparing the present study with the results of the Brazilian study requires caution due to the use of different methods; the Brazilian study examined the whole dentition and used a modified version of the Tooth Wear Index (TWI) (Smith and Knight, 1984). Interestingly, in the present study, upper and lower molars appeared to be similarly affected by erosion, while others have found that lower molars were more affected (Chadwick and Pendry 2004). However, different index teeth were included and subjects were examined at different ages, ranging from 12 to 14 years which may have influenced the results. Comparing dental erosion prevalence in subjects at different ages is unsafe because of the confounding generalized progression of tooth wear with age. The higher experience of erosion observed amongst girls than boys (46.7% vs. 35%, p=0.001). contrasts with several studies which have reported boys having the greater experience of dental erosion (Al-Dlaigan *et al*., 2001; Auad *et al.*, 2007;

Walker *et al*., 2000), while other studies have reported no gender differences (Caglar *et al*., 2005; Deery *et al*., 2000; Peres *et al*., 2005, 2008; Walker *et al.*, 2000). The differences seen between genders in the present study may be explained by different exposures to risk factors in the population such as dietary habits, frequency of acidic drinks intakes and the duration of drinks lasting in the mouth, or differing oral hygiene practices. In the present study, 6.3% of boys had exposed dentine compared with 9.6% of girls; fewer than in a UK study in which 56% of boys and 49% of girls showed exposed dentine (Al-Dlaigan *et al.*, 2001).

Results from UK, Chinese and Brazilian studies found children with more highly educated mothers had more experience of dental erosion than children whose mothers had lower educational levels (Auad *et al*., 2007; Luo *et al.*, 2005; Walker *et al*., 2000). The present study, however, found no association between parental education and experience of erosion.

In conclusion, in a cohort of 12 year-old Libyan schoolchildren, more than one third of the children examined showed dental erosion, requiring clinical preventive counselling. Statistically significantly more erosion occurred in girls than boys. Although comparisons with other populations are difficult, the prevalence and severity of dental erosion amongst the Libyan children was in agreement with data reported for the prevalence and severity of dental erosion in European children. In the present study, dental erosion into enamel only was the most common finding; this emphasises the importance of preventive measures to control the erosive process, before the need for invasive treatment to restore eroded teeth occurs.

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