

Dental Erosion in 8 and 15-year-old School Children and Associated Factors

Miriam Schembri* and Nikolai Attard

Department of Oral Rehabilitation and Community Care, Faculty of Dental Surgery, University of Malta Medical School, Mater Dei Hospital, Block A, Level O, B'Kara Bypass, Msida MSD2090, Malta

Abstract

Aim: The aim of this cross-sectional study was to establish the prevalence and severity of tooth erosion in 8-year and 15-year old children and to determine the predisposing factors leading to tooth erosion.

Methods: Ten per cent of the current 8-year and 15-year olds of the Maltese population were randomly selected. The sample was representative of geographical regions, gender and type of school attended (state, church and independent schools). Four hundred thirty nine (439) subjects of 8-year-olds and 555 subjects of 15-year olds were examined in a standardized fashion. The subjects were asked to fill in a questionnaire to give an indication of their social, oral hygiene, dietary and medical history. The Basic Erosive Wear Examination Index (BEWE) was used to measure the erosion scores and the calculated cumulative score values were later divided into four risk categories in accordance with the risk level guide to clinical management.

Results: The prevalence of erosion in 8-year olds was 69.7% whilst that in 15-year olds was 76.3%. The BEWE mean score for 8-year olds was 4.63 whereas the mean score for 15-year olds was 3.5. The difference in erosion between the two age groups was statistically significant with a higher incidence of tooth erosion reported for the 8-year olds (Unpaired t-test: $p=0.0001$). The severity of tooth erosion between the two age groups was also significantly different with 8-year olds having higher BEWE scores (Chi-square test: $p=0.022$). Various contributing factors such as gender, BMI and medical conditions were observed to have a correlation to the incidence of the subjects' tooth erosion (Various tests: $p<0.05$).

Conclusions: This study indicates that dental erosion is indeed a problem in the younger segment of the populations and underscores the need for appropriate preventive strategies.

Keywords: Dental erosion; Oral hygiene; Dental caries; Incisal edges; Tooth erosion

Introduction

Tooth wear has been observed in archaeological specimens from various parts of the world and clearly pre-dates the first appearance of dental caries [1]. This non-carious destruction of teeth is recognized as a common condition in Europeans and can be present in individuals of all ages [2,3]. It is more worrying when this condition is found in an alarming proportion among children [4]. Studies carried out in the United Kingdom suggest that not only is the younger population at risk but the incidence in this age group is increasing [5]. Over the past 10-15 years, there has been a steady increase in reports of erosion seen especially in young adolescents [6] and young children [7]. Also the trend from UK prevalence data indicates an increase in the proportion of children with tooth wear [Milosevic, 2010], the percentage of teeth with exposed dentine in 14-year olds being 30% in 1994 [8] and 53% in 2004 [9]. UK National Child Dental Health Surveys show an increase of 3% exposed dentine excluding incisal edges in 15-year olds in 2003 as compared to 1993 [10]. It was also found that there were over 50 per cent of five year old children with erosion in their primary incisors and 25 per cent of 12 and 14 year old children had their permanent dentition affected [11]. In a study carried out on 12-year old school children at Lucknow city, a prevalence of erosion was found to be 34.12% [12].

Another consistent finding from epidemiological surveys is that males have more tooth wear than females. An early prevalence study in Liverpool on 14-year old school children found significantly more males had tooth wear into dentine (35%) than females (24%), [8]. This may be due to the fact that teenage boys consume more alcoholic

drinks and carbonated beverages than females [9], although on the other hand boys tend to eat less fruit than girls. Adult males were also found to suffer from tooth wear more than females. A cross sectional survey of 1,007 adult dental patients found males had more wear than females, with the most severe wear on incisal edges and being positively correlated with age [13]. Similarly, 42.1% of 5-year old children at South Bangalore suffer erosion lesions, with incidence being higher in males (25.17%) than in females (24.9%) [14].

It is generally accepted that the prevalence of tooth surface loss increases with age, however, the exact prevalence is unclear mostly because of different assessment criteria. In a study carried out by Lussi et al. a total of 391 randomly selected Swiss individuals of two different age groups; 26-30 year olds and 46-50 year olds were examined and questioned regarding dietary habits, lifestyle, oral hygiene, general illnesses related to erosion, ingestion of medication and tooth sensitivity. Thirteen per cent (13%) of the older age group had at least one tooth affected with facial erosion with involvement

***Corresponding author:** Schembri M, Research Associate, Department of Oral Rehabilitation and Community Care, Faculty of Dental Surgery, University of Malta Medical School, Mater Dei Hospital, Block A, Level O, B'Kara Bypass, Msida MSD2090, Malta; Tel: (00356) 23401875; E-mail: miriamschem@gmail.com

Received February 10, 2017; **Accepted** March 20, 2017; **Published** March 28, 2017

Citation: Schembri M, Attard N (2017) Dental Erosion in 8 and 15-year-old School Children and Associated Factors. *Pediatr Dent Care* 2: 134. doi: [10.4172/2573-444X.1000134](https://doi.org/10.4172/2573-444X.1000134)

Copyright: © 2017 Schembri M, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

of dentine as compared to 8% in the younger age group. Also 43% of the older age group had severe erosion occlusally whereas 30% of the younger age group were affected occlusally, and only 2% of the older subjects showed severe lingual erosions [6]. Regression meta-analysis performed to study the relationship between tooth wear and age showed a linear increase in tooth wear into dentine of deciduous teeth with increasing age, however, this relationship was not established for permanent teeth [15].

In a systematic review of the prevalence of tooth wear in children and adolescents it was concluded that tooth wear into dentine in deciduous teeth ranged from 0 to 82 per cent while in permanent teeth it ranged from 0 to 54 per cent. Additionally, wear into dentine of primary teeth was reported to range from 10 to 30 per cent in 11 of 19 included studies. On the other hand wear into dentine of permanent teeth was reported to be less than 10 per cent in 25 out of 29 studies [15]. The age of children in the studies ranged from 1.5 to 18 years. Therefore there is a difference in the prevalence of tooth wear in primary and permanent teeth of children.

In conclusion in a study carried out by Dugmore and Rock it was found that males, white children and social deprivation were significantly associated with erosion experience [16]. This agrees with the results found by Al-Daigan et al. [17], and Milosevic et al. [8]. Contrasting this study was the conclusion given by Bardsley et al. in their study stating that the risk of tooth wear is greater with increasing affluence [9]. This is due to the higher availability of erosive foods.

Tooth wear indices remain the only reliable method of assessing wear over long periods of time and have proved to be effective in measuring the prevalence of wear in populations [18]. The earliest indices introduced to measure dental erosion were those by Restarske et al. [19], Eccles [20], Xhonga and Valdmanis [21] and Bardsley [22]. The Smith and Knight tooth wear index involves recording of wear on all four visible tooth surfaces. This index although widely used does not discriminate wear particularly well once dentine is exposed. Thus sensitivity is sacrificed for reproducibility [23]. Many other indices have been proposed for measuring erosive tooth wear. These are derived from the indices of Eccles [20] and Smith and Knight [24]. No single index is simple enough and meets all the requirements of clinical and research teams [22].

The Basic Erosive Wear Examination (BEWE) Index [25] was used to measure the erosion scores and the calculated cumulative score values were later divided into four risk categories in accordance with the risk level guide to clinical management as outlined by Bartlett et al. [25] leading to a strategy for treatment for each scoring level. This index is simple, reproducible and transferable for recording findings and for assisting in the decision making process for the management of erosive tooth wear.

In the absence of epidemiological studies on tooth wear in young children, that is in a small island community, it was deemed important to review the prevalence of and contributing factors to tooth wear in children and adolescents because of the cumulative nature of tooth wear over an individual's lifetime and to understand whether contemporary diet and habits contribute to tooth wear in children.

The objectives of this study were to establish the prevalence and severity of tooth erosion in a sample of 8-year and 15-year old children and identify the predisposing factors leading to tooth erosion.

Materials and Methods

The study was carried in 2015. Ethical approval was obtained from

the University of Malta. The consent to examine the selected children was obtained from the respective legal guardians and respective school authorities. The authors underwent the necessary training and calibration prior to embarking the clinical survey.

Patient groups and selection

Two age groups, of 8-year and 15-year olds, were selected for examination. A mixed dentition was present in the 8-year old group. The deciduous teeth were exposed to acidic food for a minimum of 6 years whilst the permanent incisors and first molars would have been in the mouth for just two years. On the other hand, in the 15-year old group the subjects would have attained the permanent dentition except for the third molars.

At the time of the study, the Maltese population of 8-year and 15-year olds was 4,393 and 5,031 respectively, of which 10% were randomly examined. Randomisation was carried out with the help of a statistician and was based on gender, geographical region and school type attended (State, Church and Independent Schools). The subjects were also asked to fill in a questionnaire on their demographic, behavioural, medical and dental history.

Data collection

The study involved data collection by means of questionnaires and the clinical oral examination of the subjects.

The questionnaires prepared for the respective age groups were designed to obtain information regarding the subjects' social status; oral hygiene practices such as frequency and timing of teeth brushing, brushing techniques and dental hygiene products used; and medical history including medical conditions and treatments followed, frequency of visits to a dentist and reason for such dental visits. A substantial part of the questionnaires included detailed questions relating to study subjects' dietary habits.

The next phase of the study was the clinical examination in the subjects' respective schools. The examination by a team of standardised dentists involved the use of a portable dental chair, a mobile dental unit and a Daray lamp (Daray X200LED examination light on a mobile mount with a 5-castor base. Light intensity was 8,000 lux at 1 m and 32000 lux at 0.5 m). The lamp was a calibrated one and was used in prior studies.

Height was measured using a portable stadiometer-SECA 214 Portable Stadiometer, whilst weight was recorded using a portable SECA digital scales, both instruments consistently used throughout the study.

The height and weight were measured to calculate the Body Mass Index (BMI) for each study subject and the resulting BMI values measured in kg/m² were classified into 4 categories as identified by the World Health Organisation (WHO), namely, an underweight group, 2 average weight groups and an overweight group. Table 1 summarises the 4 categories and the respective BMI values relevant to female or male subjects [World Health Organization Geneva, 2007].

Statistical analysis

Data analysis was carried out using SPSS 20 system for Windows (SPSS 20, SPSS Inc. Chicago, IL, USA) as follows:

Univariate analysis

Descriptive statistics were carried out to investigate the population that was studied.

Gender	Body Mass Index (BMI) category			
	Underweight	Average group 1	Average group 2	Overweight
Females	≤ 14.12 kg/m ²	14.13–18.63 kg/m ²	18.64–22.04 kg/m ²	≥ 22.05 kg/m ²
Males	≤ 14.24 kg/m ²	14.25–18.73 kg/m ²	18.74–22.11 kg/m ²	≥ 22.12 kg/m ²

Table 1: Body Mass Index grouping classification.

Bivariate analysis

Pearson chi-square test or Fisher’s exact test was used to analyse the association between two categorical variables such as type of school attended by study subjects and the BEWE score.

Unpaired *t*-tests were carried out to calculate the association between the mean BEWE cumulative scores of the two age groups and also between the mean BEWE cumulative scores and continuous variables.

Sextant BEWE scores 3 were correlated to dietary variables by Spearman’s rank correlation coefficient ($r_s < 0.05$). In all tests carried out, statistical significance was set at a *p*-value < 0.05 .

Results

Patients overview

A balanced gender sample was observed for this study, where the 8-year olds group was composed of 231 female subjects (49%) and 238 male subjects (51%) while in the 15-year olds group, 260 subjects (47%) were females and 295 subjects (53%) were males.

The subjects for this study were selected randomly and the turnout of participants suffering from physical limitations or medical conditions was very low. This is in line with expectations considering the young age of the study subjects. The number of respondents suffering from a medical condition is presented in Table 2.

Incidence of tooth erosion

The prevalence of erosion in 8-year olds was 69.7% whilst that in 15-year olds was 76.3%.

Figures 1 and 2 present the cumulative BEWE scores for the two age groups. There were 439 statistically valid BEWE cumulative score results for 8-year old subjects of whom the majority (42.4%) had a BEWE cumulative score of 0-2, whilst 6.4% had a score of 14 and over.

The number of 15-year old subjects examined and statistically valid amounted to 555. Once again the majority of those observed were in the category with a BEWE cumulative score of 0-2 (55.9%) whilst only 0.9% had a score of 14 and over.

Sextant examination and observed BEWE index score

The most severely affected surface in each sextant was recorded into the four level BEWE score grades. These findings of the sextant examination are presented in Figures 3 and 4.

In both age groups, the upper anterior sextant, that is 53-63 in 8-year olds and 13-23 in 15-year olds, is the most severely affected with 16.0% of 8-year olds and 13.1% of 15-year olds having a BEWE score of 3 representing the highest level of tooth erosion.

The sextant with the highest reporting of no erosion in the 8-year olds group is the 73-83 with 72.4% having a BEWE score of 0. Meanwhile, within the 15-year olds group the least affected sextants were 37-34 and 44-47, both having over 80% of subjects scoring a BEWE value of 0.

Reported Medical condition	8-year olds		15-year olds	
	N	%	N	%
Heartburn	12	6.00%	197	25.10%
Regurgitation	9	4.50%	83	10.60%
Vomit often	6	3.00%	14	1.80%
Vomiting over a period	2	1.00%	36	4.60%
Use of medications	36	17.90%	107	13.60%
History of Hospitalization	12	6.00%	54	6.90%
Diabetes	-	0.00%	12	1.50%
Epilepsy	-	0.00%	8	1.00%
Asthma - Suffered in the past	51	25.40%	120	15.30%
Asthma - Still suffering	5	2.50%	12	1.50%
Asthma – Hospitalized	21	10.40%	45	5.70%
Asthma - Take medication	22	10.90%	46	5.90%
Asthma - Use inhaler	25	12.40%	51	6.50%

Table 2: Medical history.

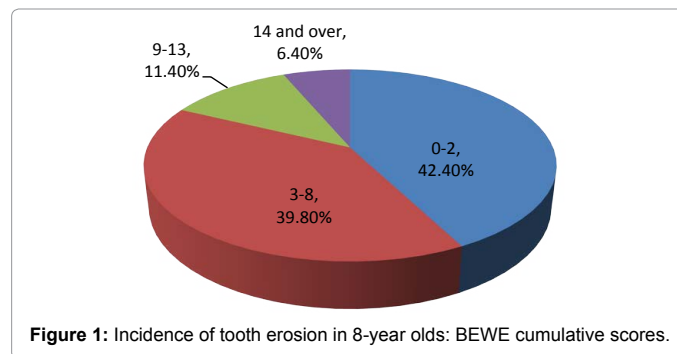


Figure 1: Incidence of tooth erosion in 8-year olds: BEWE cumulative scores.

Analysis and reporting of BEWE cumulative score

The data collected from the examination of the sextant and the resulting BEWE Index scores were further analysed to assess the BEWE cumulative scores of the two age groups.

An unpaired *t*-test was carried out to compare incidence of erosion in 8-year and 15-year olds and the difference was found to be statistically significant (Unpaired *t*-test: *p*-value 0.0001) with more 8-year olds suffer erosion compared to 15-year olds as presented in Figure 5. The severity of tooth erosion between the two age groups was also significantly different with 8-year olds having higher BEWE scores compared to 15-year olds (Chi-square test: *p*=0.022).

Gender predisposition to tooth wear

Unpaired *t*-tests were carried out to compare the mean BEWE cumulative scores of females and males. In the 8-year olds group, there was a statistically significant difference between the gender group;

the incidence of erosion being higher in males compares to females (Unpaired *t*-test: $p=0.0147$).

Body Mass Index (BMI)

Eight-year old children whose BMI value is within the range of 18.64 to 22.04 kg/m² for male candidates and 18.74 to 22.11 kg/m² for the female counterparts are reportedly at a higher risk of tooth erosion compared to children identified in the other predefined categories since they represent the lowest percentage of participants at the no risk category (Chi-square test: $p=0.003$).

Medical conditions

The only medical condition that was statistically related to the incidence of erosion was a history of vomiting for the 15-year old subjects (Figure 6; Fisher's Exact test: $p=0.010$). There is a distinctive variance between the identified subjects predisposed to this condition and whilst only 37.8% of identified subjects are at no risk of tooth erosion compared to the 58.1% unaffected subjects at no risk of tooth erosion, the percentages turn around significantly as the level of tooth erosion increases as can be observed in Figure 6.

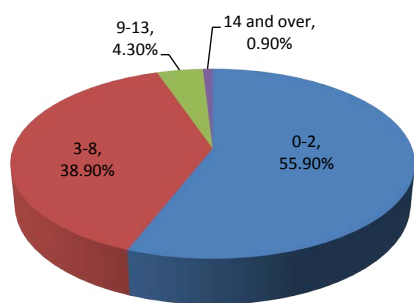


Figure 2: Incidence of tooth erosion in 15-year olds: BEWE cumulative scores.

Figure 7 presents the association between the incidence of tooth erosion and reported masticatory problems by the subjects observed in this study. Though relatively few of the 15-year old patients experience difficulty in chewing, they were reportedly at higher risk of tooth erosion. A statistically relevant finding has been reported which highlights the increased incidence of severe tooth erosion, as measured and classified in accordance with the BEWE, in subjects having difficulty in chewing compared to their counterparts. According to the results, 3.6% of subjects that have difficulty in chewing have a BEWE cumulative score of 14 and over whilst 17.9% of subjects have a score of 9-13. These percentages are significantly higher than the 0.6% and 3.5% reported in the same BEWE cumulative scores respectively for subjects with no masticatory problems. It is also noted that a higher percentage of subjects with no masticatory difficulties are at no risk of tooth erosion.

Discussion

The study's reporting on incidence of erosion for the older sample group (15-year olds) is similar to figures resulting from studies carried out in other countries such as a national study carried out in Iceland in 2010 on 15 year-olds which has concluded that 30% of examined subjects suffered tooth erosion to some degree [26] whilst in a study carried out in the Netherlands in 2009, 44.2% of 15-year old students suffered erosion [27].

The findings highlight a significant difference in incidence of erosion between the two age groups, whereby higher levels of erosion were noted in the 8-year old subjects compared to the 15-year old subjects. The 8-year olds group also scored a higher mean BEWE at 4.6 suggesting a higher risk of tooth wear as opposed to the lower 3.2 mean BEWE scored by the 15-year old subjects. The difference is partially attributable to the examination of the deciduous teeth for the 8 year old group which would have been exposed to acidic threats for a longer period of time compared to the permanent dentition examined in the 15-year olds subjects and to the difference in tooth structure. This

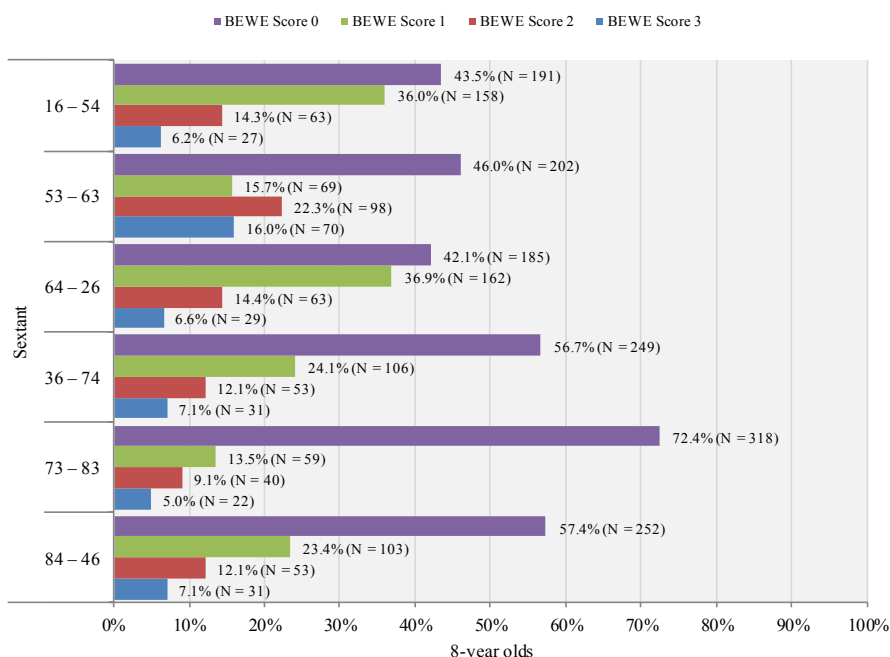


Figure 3: Sextant BEWE scores for 8-year olds.

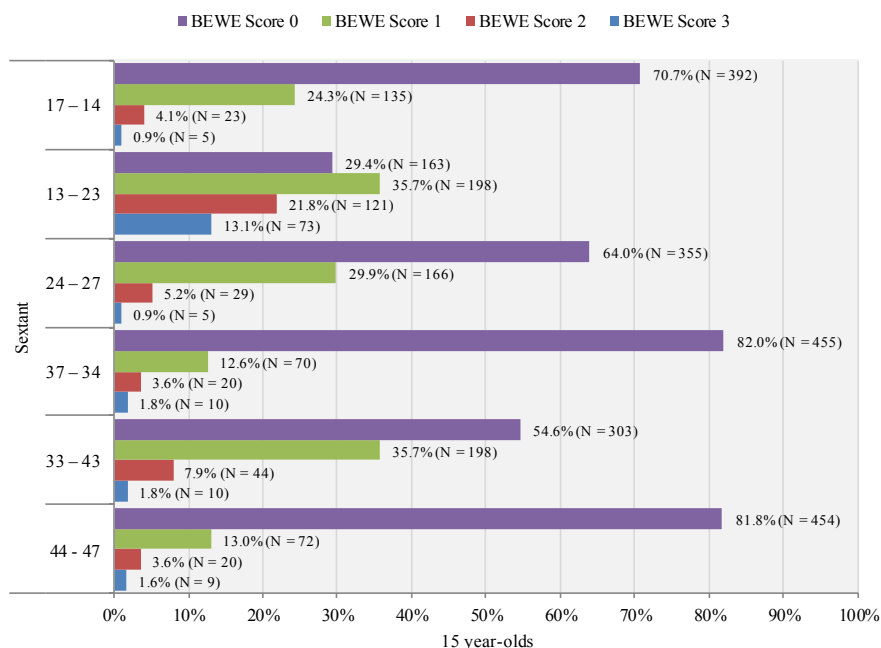


Figure 4: Sextant BEWE scores for 15-year olds.

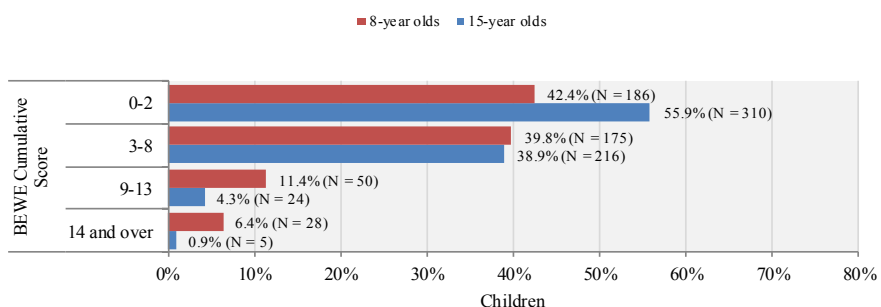


Figure 5: BEWE Cumulative score distribution for 8 and 15-year olds.

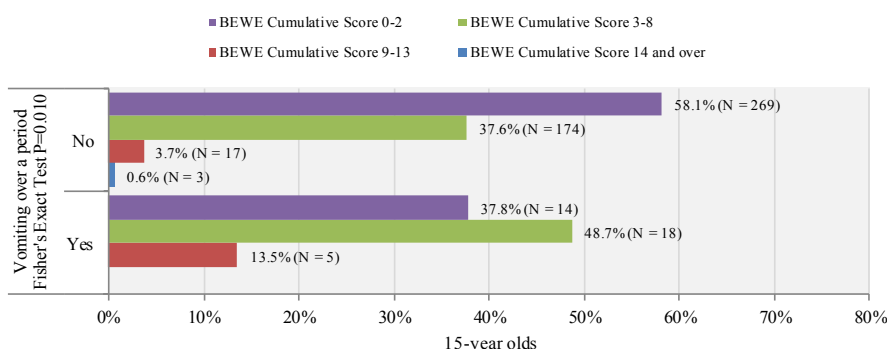


Figure 6: Correlation of vomiting over a period and incidence of tooth erosion for 15-year olds.

pattern follows the results of a study carried out by Kreulen et al. where higher percentages of wear into dentine of deciduous teeth compared to permanent teeth were recorded [15].

A consistent finding from epidemiological surveys carried out in other countries, is that males have more tooth wear than females [8,26]. A similar finding is being reported in this study where gender

has also been found to be a predisposing factor for erosion for both age groups. Whilst the incidence of erosion scores in the 15-year old male subjects (44.6%) over the female subjects (43.2%) was minimal and not statistically significant, a wider gap was observed in the 8-year old subjects. In fact within the 8-year olds group, the mean BEWE cumulative scores of females and males determined a statistically

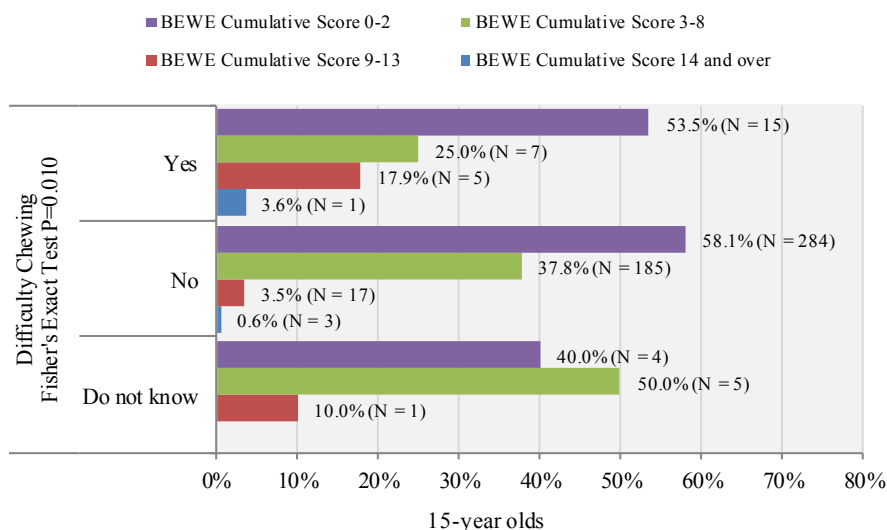


Figure 7: Masticatory problems vs. incidence of tooth erosion in 15-year olds.

significant difference (Unpaired *t*-test: $p=0.0147$) between the gender groups; the incidence of erosion being higher in males (58%) compared to females (49.2%).

These results follow the gender related trends observed by Árnadóttir et al. [26] and Milosovic et al., [8] in their respective studies however in our study the results for the 15-year olds group did not reflect the wide gap between genders observed in the other mentioned studies. In a prevalence study carried out in Liverpool by Milosovic et al. on 14-year olds, 35% of males had erosion into dentine compared to the 24% observed in females [8]. Similarly in a prevalence study in Iceland by Árnadóttir et al. on 12-year olds, erosion was present in 19% of boys and 11% of girls and in the same study erosion among 15-year old boys was 38.3% and 22.7% in 15-year old girls [26]. As suggested by Bardsley et al. [9] the lower incidence of tooth wear in females could be attributed to better oral hygiene and lower consumption of carbonated beverages or alcoholic drinks when compared to their male counterparts. These attributes were also observed in this study.

Similar to the findings observed in our study, vomiting over a period of time was also been identified by Järvinen et al. [28] as being crucial in approximately one quarter of all cases of dental erosion. While medical assistance should be sought to treat disorders with vomiting, regurgitation or reflux of gastric contents over a prolonged period, it is important to minimize the tooth wear whilst the condition is being treated. A neutralization procedure is useful for the prevention of erosion, given it is employed immediately following the acid challenge [29]. Acid neutralization may be attempted by holding some milk in the mouth for a short time after vomiting [30]. Consuming milk [31] or cheese [32-35] was reported to rehardened enamel specimens.

The author recognises a number of limitations in this study relating to the collection of data and the study subjects. It is recommended that a concise questionnaire with additional completion guidance is drafted to reduce incomplete questionnaires; follow-up dental examination at schools are scheduled to reach unexamined subjects due to school absenteeism on the examination day; and holding a short informative session about the study and examination procedure prior to the actual examination of subjects to avoid uncooperative subjects during dental examination.

Examining at 15 years may not be ideal as the determinants of erosion have not acted for long and subjects are too young for the aetiological factors to have fully exerted their effects, thus late teenage years may be a more appropriate age group for the study; examining at 8 years may not be ideal as the subjects are at a mixed dentition stage making the analysis of erosion inconsistent due to the presence of both deciduous teeth which have been exposed to erosion-contributing factors for a number of years and newly erupted permanent teeth. It is recommended to select a younger age group where subjects have not yet reached the mixed dentition stage; and undertaking a prospective study to overcome the limitations of this cross sectional design study which only reports incidence of tooth erosion at one specific point in time thus does not observe the progression of the subjects' tooth erosion through time and the relevant contributing factors.

Conclusion

A significant number of 8- and 15-year olds were reportedly suffering from tooth erosion and attrition to some extent. This study underscores the fact that tooth wear is indeed an important dental condition within the young population with obvious long-term effects on their dentition and quality of life.

The study suggests that, self-reporting symptoms are low and therefore increased education on the signs and symptoms of tooth erosion should be introduced. This should also be accompanied by an increased education to introduce the use of adult toothpaste containing fluoride as early as the permanent teeth erupt.

In conclusion monitoring of patients following diagnosis of tooth wear, removal of causative factors and simple dental treatments may enable the patient to avoid extensive restorative procedures. More preventive interventions that are targeted at young children and teenagers are required to promote a healthier lifestyle.

References

- Holbrook WP, Arnadóttir IB, Kay EJ (2003) Prevention of tooth wear. *British Dental Journal* 195: 75-81.
- Ibbetson R, Eder A (1999) Tooth surface loss. *British Dental Journal* 60.
- Bartlett DW (2003) Retrospective long term monitoring of tooth wear using study models. *British Dental Journal* 194: 211-213.

4. Gupta M, Pandit IK, Srivastava N, Gugnani N (2009) Dental erosion in children. *Journal Oral Health Community Dentistry* 3: 56-61.
5. Kelleher M, Bishop K (1999) Tooth surface loss: an overview. *British Dental Journal* 186: 61-66.
6. Lussi A, Schaffner M, Hotz P, Suter P (1991) Dental erosion in a population of Swiss adults. *Community Dental Oral Epidemiol* 19: 286-290.
7. Downer MC (1995) The 1993 national survey of children's dental health. *British Dental Journal* 178: 407-412.
8. Milosevic A, Young PJ, Lennon MA (1994) The prevalence of tooth wear in 14-year old school children in Liverpool. *Community Dental Health* 11: 83-86.
9. Bardsley PF, Taylor S, Milosevic A (2004) Epidemiological studies of tooth wear and dental erosion in 14- year- old children in North West England. Part 1: The relationship with water fluoridation and social deprivation. *British Dental Journal* 197: 413-416.
10. Chadwick BL, White DA, Morris AJ, Evans D, Pitts NB (2006) Non-Carious Tooth Conditions in Children in the UK, 2003. *British Dental Journal* 200: 379-384.
11. O'Brien M (1994) Children's dental health in the United Kingdom. London: Highline Medical Services Organisation.
12. Sinha P, Abdullah S, Saha S, Verma A (2016) Prevalence of dental erosion in 12-year old school children of Lucknow City. *Journal of Indian Association of Public Health Dentistry* 14: 409-412.
13. Smith BGN, Robb ND (1996) The prevalence of tooth wear in 1,007 dental patients. *Journal of Oral Rehabilitation* 23: 232-239.
14. Venkatesh NS, Kavyashree BS (2015) Prevalence of Dental Erosion in School going Children of South Bangalore: A Cross-Sectional Study. *International Journal of Scientific Study* 3: 74-78
15. Kreulen CM, Van't Spijker A, Rodriguez JM, Bronkhorst EM, Creugers NH (2010) Systematic review of the prevalence of tooth wear in children and adolescents. *Caries Research* 44: 151-159.
16. Dugmore CR, Rock WP (2003) The progression of tooth erosion in a cohort of adolescents of mixed ethnicity. *International Journal of Paediatric Dentistry* 13: 295-303.
17. Al-Dlaigan YH, Shaw L, Smith A (2001) Dental erosion in a group of British 14-year-old school children. Part I: Prevalence and influence of differing socioeconomic backgrounds. *British Dental Journal* 190: 145-149.
18. Lussi A (2002) Dental erosion clinical diagnosis and case history taking. *European Journal Oral Science* 104: 191-198
19. Restarski J S, Gortner RA, Mccay CM (1945) Effect of acid beverages containing fluorides upon the teeth of rats and puppies. *Journal of the American Dental Association* 32: 668-675.
20. Eccles JD (1978) The treatment of dental erosion. *Journal of Dentistry* 6: 217-221.
21. Xhonga FA, Vladmanis S (1983) Geographic comparisons of the incidence of dental erosion: a two-centre study. *Journal of Oral Rehabilitation* 10: 269-277.
22. Bardsley PF (2008) The evolution of tooth wear indices. *Clinical Oral Investigation* 12: 15-19.
23. Bartlett DW (2003) Retrospective long term monitoring of tooth wear using study models. *British Dental Journal* 194: 211-213.
24. Smith BGN, Knight JK (1984) An index for measuring the wear of teeth. *British Dental Journal* 156: 435-438.
25. Bartlett DW, Ganss C, Lussi A (2008) Basic Erosive Wear Examination (BEWE): a new scoring system for scientific and clinical needs. *Clinical Oral Investigation* 12: 65-68.
26. Árnadóttir IB, Holbrook WP, Eggertsson H, Gudmundsdóttir H, Jonsson SH (2010) Prevalence of dental erosion in children: a national survey of tooth erosion using the BEWE index. *Community Dental Oral Epidemiol* 38: 521-526.
27. El Aidi H, Bronkhorst EM, Huysmans MCD, Truin GJ (2010) Dynamics of tooth erosion in adolescents: a 3-year longitudinal study. *Journal of Dentistry* 38: 131-137.
28. Järvinen V, Rytömaa I, Meurmann JH (1992) Location of dental erosion in a referred population. *Caries Research* 26: 391-96.
29. Imfeld T (1996) Prevention of progression of dental erosion by professional and individual prophylactic measures. *European Journal of Oral Science* 104: 215-220.
30. Schweizer-Hirt CM, Schait A, Schmid R, Imfeld T, Lutz F (1978) Erosion und Abrasion des Schmelzes: Eine Experimentelle Studie. *Schweiz Monatsschr Zahnheilk* 88: 487-529.
31. Gedalia I, Dakuar A, Shapira L, Lewinstein I, Goultshin J (1991) Enamel softening with Coca-Cola and rehardening with milk or ?. *American Journal of Dentistry* 4: 120-122.
32. Gedalia I, Davidow I, Lewinstein I, Shapira L (1992) Effect of hard cheese exposure with and without fluoride pre-rinse on the rehardening of softened human enamel. *Caries Research* 26: 290-292.
33. Jensdóttir T, Árnadóttir IB, Thorsdóttir I, Bardow A, Gudmundsson K (2004) Relationship between dental erosion, soft drink consumption and gastroesophageal reflux among Icelanders. *Clinical Oral Investigations* 8: 91-96.
34. Milosevic A (2010) Dental erosion in a series of referred patients was statistically associated with gastric reflux, acidic drink intake of more than 0.5 L per day and low salivary buffering capacity. *The Journal of Evidence-based Dental Practice* 10: 176-178.
35. World Health Organization Geneva. Growth reference 5-19 years, BMI for age (5-19 years)