

# Tooth surface loss, prevalence and associated risk factors among 12-14 years school children in Khartoum State, Sudan

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**Objectives:** Investigate Tooth Surface Loss TSL, among 12-14 years school children in Khartoum State, Sudan; evaluate pattern, severity and determine relationship between TSL, dietary habits and socio-economical status. **Basic Research Design:** Cross sectional survey among primary public and private schools. **Method and Participants:** Cluster sample of 1,138 12 to 14-year old students from both public and private school. Mild and moderate TSL was measured on buccal, lingual/palatal surfaces of maxillary and mandibular incisors and canines and occlusal, buccal, lingual/palatal surfaces of maxillary and mandibular premolars and molars. Surfaces scored according to criterion described by the National Survey of Child Dental Health. **Results:** The prevalence of TSL was found to be 74%. Mild and moderate TSL was detected on palatal surfaces of maxillary central incisors followed by occlusal surfaces of mandibular molars. TSL into the pulp was not detected. **Conclusion:** A high prevalence of 74% was found with mild and moderate TSL with no pulpal involvement. There was an association between consumption of erosive foods and the prevalence of TSL. Socio-economic status and gender did not present significant differences.

*Key words:* Gender, erosive foods, prevalence, socio-economic status, TSL

## Introduction

Dental erosion, a form of tooth surface loss TSL, is the physical result of a pathologic, chronic, localized loss of dental hard tissues that is chemically etched away from the tooth surface by acid without bacterial involvement (ten Cate and Imfeld, 1996). Intrinsic and extrinsic factors, both contribute to TSL. The extrinsic factors associated with TSL include acidic food and beverages (Dugmore and Rock, 2004), acids of environmental origin including swimming in poorly maintained pools with water pH of 2.7 (Centerwall *et al.*, 1986) and acidic medication.

Intrinsic factors include repeated direct contact of teeth with gastric contents. Hydrochloric acid produced by the parietal cells in the stomach can cause dental erosion (Lussi, 2006a). The acid reaches the teeth either through vomiting or regurgitation (Lussi, 2006a). Of significance are conditions associated with gastro-oesophageal reflux diseases (Bartlett *et al.*, 1998).

Many studies have associated extrinsic erosive lesions to buccal and occlusal /incisal surfaces of teeth (Bartlett, 2005) whereas intrinsic causes were associated to palatal lesions on maxillary teeth predominately incisors (Jarvinen *et al.*, 1988; Moazzez *et al.*, 2005).

TSL in young people is widespread and there seem to be complex relationship between it and the possible aetiological factors (Dugmore and Rock, 2004). It is unlikely that any one aetiological factor works in total isolation from other factors. It is therefore important to consider the strength and frequency of the erosive challenges to the teeth, since they influence the clinical expression of dental erosion.

The importance of saliva in relation to erosive tooth wear has been well demonstrated as a high salivary flow rate facilitates the prevention of erosive wear by increasing the ion reservoir of the oral cavity with calcium, fluoride, carbonic acid, hydrogen carbonate and di-hydrogenphosphate / hydrogenphosphate (Hara *et al.*, 2006).

Many epidemiological studies have investigated its prevalence among school children (McGuire *et al.*, 2009). Males seem to have more buccal/labial and lingual/ palatal TSL than females (Al-Dlaigan *et al.*, 2001b). More TSL was also seen in children from low socioeconomic groups (Al-Dlaigan *et al.*, 2001a). However, a study among Brazilian school children reported a higher prevalence of TSL in private schools students than public schools students (Peres *et al.*, 2005). On the other hand, a study in the Netherlands, reported no significant difference between the two socioeconomic groups (Truin *et al.*, 2004).

Epidemiological data from developing countries on TSL are limited. A study from Saudi Arabia reported a prevalence of 95% in the 12-14 and 5-6 year old groups (Al-Majed *et al.*, 2002). In another Saudi 2-5 kindergarten group, a prevalence of 31% prevalence was reported (Al-Malik *et al.*, 2002).

The aim of this study was to establish the prevalence of TSL among 12-14 year old school children in Khartoum State, Sudan. A secondary aim was to identify the associated risk factors in this group.

## Subjects and Methods

The study area Khartoum state is made up of seven provinces. The schools selected were the most densely populated schools in each province. Both boys and girls schools were included. The information obtained from the Ministry of Education in Khartoum indicate that there were 271 boys' and 399 girls' schools in the Khartoum State. The total number of boys was 20,170 and girls 22,297. Using this information and a power calculation made from the results of a pilot study from the same region (El Karim *et al.*, 2007), a cluster sample was chosen from a total of 38 schools (24 public and 14 private schools). Children were randomly selected from the different classes in each school. Most of the private schools have a maximum of 30 students per class whereas the public schools have multiples of this number and even more than one class for the same grade. Accordingly a random sample of 30 students was taken from each school making up a sample size of 716 students from public and 422 students from private schools with a total of 1138. Ethical approval was obtained from the State Ministry of Health Ethics Committee in Khartoum State. Permission to clinically examine the children was obtained from each school. In addition an informed written consent was signed by parents of the participants.

Those from public schools were considered the representative of the low socioeconomic group, while students from the higher socio economic group were from the private schools.

Students were only excluded if they were not Sudanese, they were over 14 years old or under the age of 12 years old, they had a history of bruxism or grinding, they had current or previous symptoms of facial or temporomandibular joint pain, their parents did not consent to their child participation.

A questionnaire was initially piloted and after modifications it was used for this study. The questionnaire was designed to evaluate the oral hygiene habits, use of hard tooth brushes, use of medium tooth brushes, use of soft tooth brushes and use of other methods such as use of Miswak as an oral hygiene tool. Commonly consumed acidic foods and drinks with their frequencies of intake were also investigated. Consumption of a group of traditional foods and drinks was also included in the questionnaire. The traditional food Baobab (Gongolaise) and Tamarind (Aradie) are Vitamin C rich citrus fruits that are grown locally and consumed by children as snacks and usually sucked and left for long period of time against the teeth to extract their acidic juices. The amount and frequency of food and drinks consumed were also evaluated and was categorized as follows:

0-No consumption, 1-Low consumption: 1-7 times per week, 2-Medium consumption: 8-21 times per week, 3-High consumption: more than 21 times per week.

The permanent teeth were the only teeth included in the examination. The buccal and lingual/palatal surfaces of maxillary and mandibular incisors and canines were examined, together with the occlusal, buccal and lingual/palatal surfaces of maxillary and mandibular premolars and molars. All cervical surfaces of teeth were excluded from the examination to exclude chances of abrasion and abfraction. Incisal edges of maxillary and mandibular

incisors and canines were also excluded from the examination to exclude all chances of attrition.

The surfaces were scored dental erosion according to a modification made by Millward (1996) on the Tooth Wear Index of Smith and Knight (1994). The criterion was used by the National Survey of Child Dental Health and by other investigators (Al-Malik *et al.*, 2002; El Karim *et al.*, 2007).

The scoring was as follows:

- 0- Normal, no loss of enamel surface characteristics
- 1- Enamel only-loss of enamel surface characteristics (mild TSL)
- 2- Enamel and dentine-loss of enamel exposing dentine (moderate TSL)
- 3- Enamel, dentine and pulp-loss of enamel and dentine exposing the pulp (severe TSL).
- 4- Assessment couldn't be made- tooth absent or crowned or had a large restoration.

The clinical examination was carried by two examiners trained in using this index. The Kappa statistic was performed and a value of 0.83 for inter-examiner agreement was obtained. Intra-examiner was found to be 0.92 and 0.95 for the two examiners.

The data were analyzed using SPSS version 13. Descriptive statistics cross tabulation using Neyman Pearson chi-square test. Pearson's correlation co-efficient and linear regression analysis was used to evaluate associations between different variables and the degree of TSL.

## Results

A total of 1,138 children were examined with an age range 12-14 years and an average age of 12.74 (SD=0.725). There were 601 (52.8%) females and 537 (47.2%) males.

The overall prevalence of TSL was 74.1%. Approximately 74.6% was in public schools and 73.2% was in private schools. Seventy-four percent of males and 73.5% of females had evidence of TSL. Approximately 66.7% of the maxillary teeth and 51.7% of the mandibular teeth were affected. Mild TSL affected 61.8% of the maxillary teeth while Moderate TSL affected 22.9% (Figure 1). On the mandibular teeth, Mild TSL was 46.3%, whereas Moderate TSL was 12.7% (Figure 1). The highest percent of mild TSL was on the palatal surfaces of maxillary incisors (34.85%) followed by the occlusal surfaces of the mandibular first molars (27%), with least TSL on the buccal and lingual surfaces of molars and premolars.

Moderate TSL was mostly seen on the palatal surfaces of maxillary incisors (14.8%), followed by the occlusal surfaces of mandibular first molars (7.45%), and least on the buccal surfaces of the maxillary and mandibular canines (0.1%), together with the lingual surfaces of maxillary and mandibular premolars and molars (Figure 1). Of interest, most of the participants had a symmetrical pattern of TSL (Figure 1).

A history of repeated excessive vomiting was provided by 11.7% of participants and 39.4% of these complained of gastroesophageal reflux disease symptoms. Hard tooth brushes were used by 15.5% of respondents, 49.9% used medium tooth brushes, 32.6% used soft tooth brushes and 0.8% used Miswak, while 1.2% reported no brushing.

Brushing after vomiting was reported by 35.8% and 7.8% brushed following drinking carbonated drinks.

The consumption of carbonated drinks was the highest (94.3%), followed by consumption of lemon juice (90.2%) and orange juice consumed by 88.5%. Herbal tea (9.7%) and sport drinks (8.5%) were the least consumed (Figure 2).

With regard to acidic foods, mango was eaten more than drunk by 61.9%. Traditional foods and drinks were moderately consumed with 66.1%, 51.3% and 63.1% consumption for Gongolaise, Aradieib and Karkadie respectively (Figure 2).

No statistically significant differences were found between the consumption of the different erosive foods in males and females except for the consumption of mango (p= 0.000), although females showed a higher consumption of most types of traditional foods. (Table 1)

*Correlation and Regression Analysis:*

TSL was higher in females than in males with a p value of 0.027(95% CI: 0.569-0.995). Mild TSL on mandibular teeth was significantly higher in students of (Low SES) public (49.3%) as compared to private schools (41.2%) (p=0.005, 95% CI 1.087-1.767). On the maxillary teeth moderate TSL was significantly more prevalent in students of (high SES) private (27.7%) as compared to students from public schools (20.1%) (p=0.002. 95% CI 0.496-

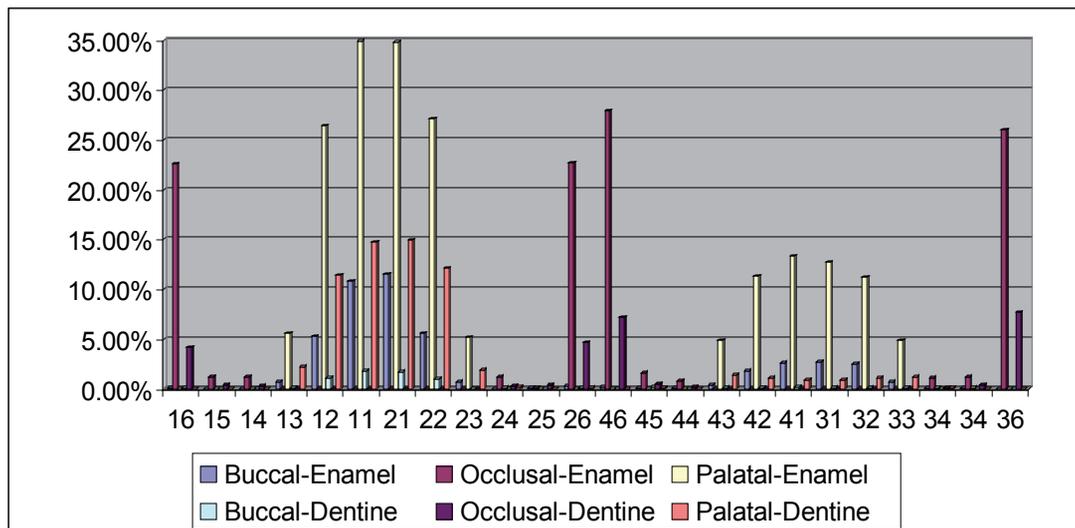
0.869). Moderate TSL was more prevalent in students from private (32%) than public schools (25.6%) with a p-value of 0.012 (95% CI 0.56-0.957).

The students, who brushed immediately after vomiting (35.8%), had more TSL on the occlusal surfaces of mandibular posterior teeth (p value 0.001) (95% CI of 1.147-1.879). Swimming regularly in chlorinated pools (20.4%) showed more erosion over the buccal surfaces of maxillary teeth (p = 0.015 95% CI 1.091-2.608) (Table 2).

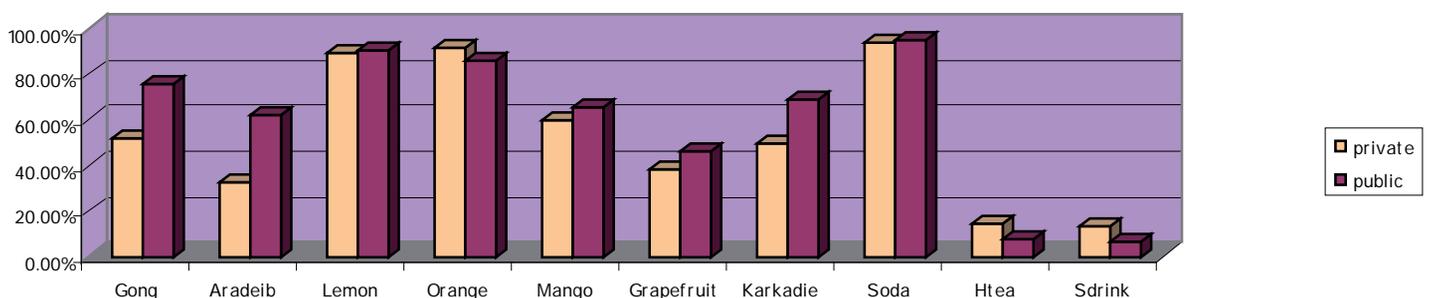
TSL on the palatal surfaces of maxillary anterior teeth was associated with frequent vomiting as a result of medical conditions (p-value 0.02). It also significantly associated with those complaining of dry mouth (p- value 0.044).

TSL on the lingual surface of mandibular anterior teeth was also related to dry mouth (p- value 0.005 95% CI 1.121-2.079) (Table 3).

For the different types of drinks and their relationship to the prevalence of mild and moderate TSL, grapefruit juice seemed to have a significant association with mild TSL (p=0.037, 95% CI 0.986-1.664) with 44% individuals having mild TSL. Karkadie had also a significant association with mild TSL (p=0.039, 95% CI 0.594-1.019) with 61.4% showing mild TSL. For sport drinks, 11.6% had moderate TSL with a p-value of 0.015 (95% CI 1.08-2.562). Some drinks were significantly associated with TSL of the occlusal surfaces of maxillary and mandibular



**Figure 1.** Percent Prevalence of Mild TSL on the Different Surfaces of Maxillary and Mandibular Teeth



**Figure 2.** The Percent Consumption of Different Types of Foods and Drinks in Public and Private Schools

**Table 1.** Consumption of the different foods in Males and Females

<i>p-Values</i>	<i>Females</i>	<i>Males</i>	<i>Food</i>
0.296	53.00%	47.00%	Gongolaise
0.291	53.30%	46.70%	Aradieb
0.323	52.60%	47.40%	Lemon
0.417	52.50%	47.50%	Orange
0.000	56.90%	43.10%	Mango
0.425	51.20%	48.20%	Grapefruit
0.198	51.10%	48.90%	Karkade
0.462	52.20%	47.80%	Soda
0.248	48.20%	51.80%	Herbal tea
0.210	45.30%	54.70%	Sport drink

**Table 2.** Chi-square test for the prevalence of erosion and, the habits among students

<i>95% CI Lower/Upper</i>	<i>p-value</i>	<i>Odds ratio</i>	<i>Surface affected</i>	<i>Variable</i>
1.147-1.879	0.001	1.468	Occlusal surface of mand. posterior teeth	Brushing after vomiting
1.091-2.608	0.015	1.687	Buccal surface of max. anterior teeth	Swimming

**Table 3.** Chi-square test for the prevalence of erosion and medical conditions

<i>Variable</i>	<i>Surface affected</i>	<i>Odds ratio</i>	<i>p-value</i>	<i>95% CI Lower/Upper</i>
Vomiting	Palatal surfaces of max. anterior teeth	0.672	0.02	0.467-0.966
Mouth dryness	Palatal surfaces of max. anterior teeth	1.526	0.005	1.121-2.079

**Table 4.** Chi-square test for the prevalence of erosion and, the different types of food consumed

<i>95% CI Lower/Upper</i>	<i>p-value</i>	<i>Odds ratio</i>	<i>Variable</i>
1.001-1.610	0.028	1.270	Grapefruit
1.07-1.731	0.007	1.361	Mango
0.602-0.980	0.019	0.768	Karkade
1.029-1.995	0.019	1.433	Gongolaise

**Table 5.** Logistic regression analysis results for significant variables affecting prevalence of erosion

<i>Variable</i>	<i>p-value</i>	<i>95% CI Lower/Upper</i>
Swimming	0.022	1.077-2.06
Brushing after vomiting	0.003	1.141-1.881
Grapefruit	0.018	1.052-1.706
Mango	0.026	1.035-1.696

posterior teeth (premolars and molars), TSL of the occlusal surfaces of maxillary posterior teeth was associated with the consumption of grapefruit juice ( $p=0.029$ ), and TSL over the occlusal surfaces of mandibular molars and premolars was associated with grapefruit and Karkade ( $p$ -values of 0.038 and 0.014 respectively). Fruits such as grapefruit, mango, and Karkade showed significant  $p$ -values of 0.028, 0.007, and 0.019 respectively in their association with TSL on the palatal surfaces of maxillary incisors and canines. Traditional fruit Gongolaise was found to be associated with TSL of the lingual surface of mandibular anterior teeth ( $p=0.019$ ).

#### Logistic Regression Analysis:

Table 5 shows logistic regression analysis performed for variables that gave significant  $p$ -values when associated with TSL. Swimming ( $p$ -value 0.022 95%CI 1.077-2.06) and brushing after vomiting ( $p$ -value 0.003 95% CI 1.141-1.881) were significantly associated with TSL over buccal surfaces of maxillary anterior teeth, and TSL over occlusal surfaces of mandibular premolars and molars. Grapefruit juice ( $p$ -value 0.018 95% CI 1.052-1.706) and Mango fruit ( $p$ -value 0.026 95% CI 1.035-1.696) gave significant associations with TSL into palatal surfaces of maxillary anterior teeth.

### Discussion

TSL specifically erosive tooth wear is a problem that received significant attention and in 1993 it was included as part of the assessment in the National Survey of Child Dental Health (NSCDH) for the first time the United Kingdom (O'Brien, 1994), reflecting the importance of this chronic, irreversible condition.

Many indices have been proposed with varying assessments of teeth, choice of teeth which makes comparison between studies difficult (Ganss and Lussi, 2008). In addition some of the indices may be difficult to apply in large scale surveys and to achieve a satisfactory inter and intra-examiner reliability.

Most of these indices emerged based on the work of Eccles and the Tooth Wear Index (Smith and Knight, 1984). A modification was used to measure erosive tooth wear in the national Survey of Child Dental Health (2004).

A need for a simple internationally reliable index has recently been suggested. This new erosion index known as the Basic Erosive Wear Examination (BEWE) (Bartlett *et al.*, 2008), is a partial scoring system recording the most affected surfaces of a sextant with a scoring that guides the practitioner to the management may be an index that might unify research findings in this area.

In this study, completed well before the recent introduced BEWE index were scored according to the criterion described by the National Survey of Child Dental Health and also used by a wide range of investigators (Al-Malik *et al.*, 2002; El Karim *et al.*, 2007). However, the term TSL was used instead of dental erosion in the National Survey of 2003 as it reflects the multifactorial aetiology of the condition (Chadwick *et al.*, 200

A prevalence of 74.1% in this group is higher than that reported in a pilot study of a similar group (66.9%) (El Karim *et al.*, 2007), since the current study is more representative of this group.

The prevalence in this study is higher than in studies from the United Kingdom (O'Brien, 1994), Brazil (Peres *et al.*, 2005), and the Netherlands (Truin *et al.*, 2004). It is however lower than that reported in Saudi Arabia (Al-Majed *et al.*, 2002). The prevalence of mild erosion TSL was higher than moderate TSL. This result agrees with findings from other investigators (Al-Dlaigan *et al.*, 2001b; Bartlett *et al.*, 1998; Dugmore and Rock, 2004).

Midline symmetry of TSL found in this study is consistent with findings by (Truin *et al.*, 2004).

Unlike the finding of Truin *et al.*, 2004 and Bardsley *et al.*, 2004, there was no significant difference between males and females in this study. However, there was more moderate TSL in females, which may be explained by their higher consumption of erosive foods than males. (Table 1)

It was not possible to classify children using conventional socio-economic status measures, a difficulty also reported in another study in Saudi Arabia (Al-Majed *et al.*, 2002). The school type was therefore used as a measure of the socio-economic background where children in private school were considered to be of the higher socio-economic group.

There was no significant difference between the two socioeconomic groups in agreement with Truin *et al.*, 2004 and Al-Malik *et al.*, 2002. On the other hand, Al-Dlaigan *et al.*, 2001b and Harding *et al.*, 2003 reported a higher prevalence among those of low socioeconomic groups.

It also does not agree with the findings of Millward *et al.*, 1994 that there was a higher prevalence in those of higher socioeconomic group.

Mild TSL over the palatal surfaces of maxillary incisors in this study (35%) was less than 58.5% reported by Chadwick *et al.*, 2005 and 48% (Al-Dlaigan *et al.*, 2001b). Moderate TSL was more prevalent in those of the higher socioeconomic group indicating that TSL is more pronounced in children with a higher socioeconomic status in agreement with Millward *et al.*, 1994.

The high prevalence of TSL on the palatal surfaces of maxillary teeth and occlusal surfaces of mandibular teeth is similar to other studies (Millward *et al.*, 1994; Truin *et al.*, 2004). Mild TSL was greater in public school children especially over the mandibular teeth as compared to moderate TSL over the maxillary teeth in the children of the private schools. This finding can be explained by the variations in the different types of foods consumed by the two groups especially the consumption of the traditional foods that are consumed mostly by the students from the public schools (Figure 2). The traditional foods are usually sucked against the palatal surfaces but Aradieeb, which is consumed by 62.4% of the public school children as compared to 32.1% by those from the private schools, is mostly chewed against the occlusal surfaces of the mandibular teeth.

A significant correlation between excessive vomiting and TSL that was not particularly related to GERD symptoms was found. Repeated vomiting which is always associated palatal TSL in this region could be attributed to Malaria incidents and episodes. There is underreporting of malaria episodes with the consequent underestimation of malaria burden. The overall incidence of malaria is estimated to be 282 per 1,000 population and the highest incidences is in children 5 – 14 years of age (Abdalla *et al.*, 2007) on the other hand.

In this study the palatal surfaces of molars and premolars were the least affected as no cases of moderate or severe pulp involvement were recorded. Indeed the most common presenting sign of gastric acid regurgitation is the development of tooth wear on the palatal surfaces of the upper incisor teeth. Only in severe progressive cases do palatal cusps of molars and premolars become involved (Lussi, 2006b).

Palatal TSL in this study could also be due to the consumption of traditional foods named Gongolaise and Aradieb which are usually sucked and left for long period of time against the teeth to extract their acidic juices and being citrus, they are likely to have a strong erosive potential.

The evidence is strong that TSL from extrinsic origins is associated with acidic food and drinks intake and this has been documented by many researchers (Al-Dlaigan *et al.*, 2001b; Bardsley *et al.*, 2004; Dugmore and Rock, 2004). In the current study different types of food and drinks showed significant results when associated with TSL on different tooth surfaces (Grapefruit, Mango, and Hibiscus). Carbonated drinks, showed no significant association between their consumption and TSL which disagrees with the findings by Al-Majed *et al.*, 2002 and agrees with the findings of others (Nunn *et al.*, 2003). This could be explained by the fact that although they were the most highly consumed but high consumption is only found in 3% of the students (taking them more than 3 times per day). That could be due to the fact that their cost is still considered high when compared with traditional and citrus fruit juices which are cheaper in this developing region.

There was a significant correlation between mandibular occlusal TSL and brushing immediately after vomiting ( $p=0.001$ ). Most people after vomiting tend to brush their tongues and the occlusal surfaces of the mandibular teeth in a way to clean their mouths of the vomitus. This probably leads to more tooth surface loss. The explanation for this is that during vomiting acids cause demineralization and softening to the tooth surface which is accelerated by the abrasive action of tooth pastes and tooth brushes although the abrasiveness of the tooth pastes was not investigated in this study (Wiegand *et al.*, 2008). In vitro softened enamel is found to be more susceptible to abrasion by very mild insults such as brushing and even tongue friction (Gregg *et al.*, 2004).

20.4% of the students who swim regularly in chlorinated swimming pools showed TSL over the buccal surfaces of their maxillary teeth with a significant p-Value of 0.015. This finding is consistent with the findings of Centerwall *et al.*, 1986.

Future studies should evaluate the pH and titrateeable acidity value of local carbonated drinks and indeed traditional drinks to identify their erosive potential. This is currently being investigated by the authors.

## Conclusion

The prevalence of TSL among this group was found to be 74.1%. The highest percent of mild TSL was found in the palatal surfaces of maxillary incisors (34.85%), and the least in the occlusal surfaces of maxillary premolars (1.1%).

Moderate TSL found to be highest on the palatal surfaces of maxillary incisors (14.8%), and least on the

buccal surfaces of the maxillary and mandibular canines (0.1%).

Risk factors identified included swimming, brushing after vomiting, and consumption of Grapefruit, Mango and Karkade.

No statistical difference found between the different socioeconomic classes (74.6% in public schools and 73.2% in private schools) and males and females (74% of the males and 73.5% of the females).

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