

Dental Erosion Among Secondary Schoolchildren: Sudan

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تعرية الأسنان لدى طلاب المرحلة الثانوية: السودان

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ABSTRACT

Dental erosion is a type of dental wear defined as loss of hard dental tissue caused by acids not produced by bacteria. This study aimed to determine the prevalence of dental erosion and its correlates among secondary schoolchildren in Omdurman, Sudan. A cross-sectional study was undertaken using stratified random sampling to select 10 secondary schools, from which all students were included. Data were collected via a self-administered questionnaire and clinical examination. Descriptive statistics were calculated, and associations were tested using a t-test, correlation, and logistic regression. Four hundred and eighty-three students participated in the study, most of whom (72.5%) attended public schools. The mean age was 12.4 years (SD: ±0.76). More than one-third (35%) of the students presented erosion. Those who reported the consumption of soft drinks or hibiscus had higher mean scores of erosion than those who did not, with mean differences of -0.61 and -0.31, respectively. These also had higher odds of erosion by an OR of 2.7 and 2.4, respectively. Those who had erosion had higher mean scores in tooth brushing, soft drink consumption, and hibiscus drink consumption, with mean differences -0.127, -0.36, and 0.28, respectively. The prevalence of erosion was thus positively associated with soft drink and hibiscus drink consumption, while being negatively associated with tooth brushing frequency.

المخلص

تعدّ التعرية نوعاً من أنواع تآكل الأسنان. هذا التآكل يحدث نتيجة لفقدان الأنسجة الصلبة للأسنان بسبب أحماض لا تنتجها البكتيريا. هدفت هذه الدراسة إلى تحديد مدى انتشار تعرية الأسنان، وتحديد علاقاته السببية المرتبطة بين تلاميذ المدارس الثانوية بمحلية أم درمان بولاية الخرطوم بالسودان. استُخدمت العينات العشوائية الطبقية في اختيار عشر مدارس ابتدائية. تم إجراء الدراسة على جميع تلاميذ هذه المدارس. جُمعت البيانات عن طريق الاستبانة والفحص السريري. شارك في الدراسة (483) تلميذاً، التحق معظمهم (72.5%) بالمدارس العامة. وكان متوسط العمر 12.4 سنة (± 0.76). من خلال استخدام الإحصاء الوصفي (اختبار T))، على المترابطات، وكذلك إجراء الارتباط والانحدار اللوجستي. أظهرت النتائج أنّ أكثر من ثلث التلاميذ المشاركين في الدراسة (35%) قد تعرّض لتعرية الأسنان. وقد كانت درجات التآكل أعلى عند المستهلكين للمشروبات الغازية والكركدي بالنسبة لمن لم يستهلكها بمتوسط فروق (-0.61، -0.31)، واحتمالات تآكل أعلى (2.7 و 2.4) على التوالي. جاء متوسط الدرجات لدى المصابين بتآكل الأسنان أعلى في تنظيف (تفريش) الأسنان واستهلاك المشروبات الغازية والكركدي مع فروق متوسطة (-0.127، -0.36، 0.28) على التوالي. وكانت نسبة انتشار التعرية 35%؛ حيث ارتبطت ارتباطاً إيجابياً باستهلاك المشروبات الغازية والكركدي، وارتباطاً سلبياً بتكرار تفريش الأسنان.

KEYWORDS

الكلمات المفاتيحية

Hibiscus, soft drinks, Omdurman, cross sectional

الكركدي، المشروبات الغازية، أم درمان، دراسة مستعرضة

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1. Introduction

Dental erosion is the most common type of serious dental wear (Jaeggi and Lussi, 2006). It is defined by the loss of hard dental tissue caused by acids that are not produced by bacteria (Arnadottir et al., 2010). The chemical process of dental erosion is similar to that of dental caries, being based on the dissolution of hydroxyapatite by acids. However, the clinical manifestations and management of erosion are fundamentally different from those of dental caries due to the fact that the erosive process does not begin as a subsurface enamel lesion, which is conducive to remineralization, but rather as a surface-softening lesion that is susceptible to wear and resistant to remineralization by conventional therapies. Dental erosion is widely spread and may involve the entire dentition (Dugmore and Rock, 2004). Other tooth wear forms, such as attrition, usually complicate hard dental tissue loss when associated with erosion and abrasion (Salas et al., 2017; Taji and Seow, 2010). It is clear that dental erosion is growing rapidly due to a lack of knowledge and the adoption of new industrial food products, such as hard candies, sport and vinegar diet drinks, and artificial citrus drinks (Salas et al., 2015b; Caglar et al., 2011; Salas et al., 2017; Taji and Seow, 2010; Kumar et al., 2013; Hou et al., 2009). Soft drinks and traditional hibiscus juice have low pH

levels beyond the critical pH level of 5.5 for enamel dissolution (Lussi and Schaffner, 2000). Significant physiological, psychological, aesthetic, and functional problems caused by dental erosion can have a negative impact on quality of life, especially among children (Mafla et al., 2017; Murakami et al., 2016). The prevention and prognosis of eroded teeth depends on early detection, diet assessment, preventive measurements, and appropriate treatment; the responsibility for this is often placed on laypeople, such as the pupils' parents and schoolteachers (Salas et al., 2015a; Huew et al., 2012; Basha et al., 2020). Topical fluoride application also prevents both dental caries and erosion (Johansson et al., 1997). Fluoride enhances the remineralization and inhibits the demineralization of tooth enamel by changing its crystalline structure to make it less soluble (Lussi and Schaffner, 2000). Effective management of dental erosion is largely dependent on an understanding of its etiology and early recognition of its signs and symptoms (Millward et al., 1994). Severe erosive dental wear can also be managed restoratively. Composite resins and ceramics can be used for partial- and full- coverage restoration to restore tooth function and aesthetics (Johansson et al., 1997).

Many studies have investigated the prevalence of dental erosion. Huwe et al. (2012) measured the prevalence of dental erosion among 12-year-old schoolchildren in Libya and found that over one-third

(35%) were affected. In Brazil, the prevalence of dental erosion among 12-year-old schoolchildren was found to be 15%, and more common among boys (Alves et al., 2015). El Karim et al. (2007) were the first to investigate the risk factors of dental erosion among Sudanese schoolchildren (12–14 years old). They reported that the overall prevalence of erosion in this group was 66.9%. Almost half (45.2%) had mild erosion, and 21.7% presented moderate erosion.

Due to a lack of recent data regarding the prevalence of erosion among schoolchildren in Sudan, the main objective of this study was to determine its prevalence among secondary schoolchildren in Sudan. In addition, we aimed to investigate possible correlations between dental erosion and socio-demographic characteristics, knowledge regarding dental erosion, consumption of soft drinks and hibiscus drinks, and tooth brushing behavior.

2. Materials and Methods

Study design, population, and area: Omdurman is the largest city in Khartoum state and Sudan, with a population of 2,395,013 (World Population Review, 2020). It is known for its multi-ethnic population and is therefore considered as representative of the entire population of the country. This descriptive cross-sectional study was conducted in Omdurman, Khartoum state, Sudan. There are 382 (179 private and 203 public) schools in the Omdurman locality. The sample size was calculated using the following formula: $n = z^2pq/d^2$, where n is the sample size, p is the prevalence, z is the standard deviation, and d is the degree of precision. In this study, $n = 34,166$, $p = 0.5$, $z = 1.96$, $q = 0.5$, $d = 0.5$, and $n = 384 + 5\% = 400$ (adding 5% non-response rate). Ten schools (five girls' and five boys' schools) were considered suitable for the calculated sample size. Schools were contacted based on a list provided by the locality's education authority, and all the listed schools agreed to participate. Stratified random sampling (by gender and public/private school) was used. All schoolchildren attending the ten schools were invited to participate via the list of students provided by the schools' authority. All of the guardians of the schoolchildren from the selected schools agreed to participate except for those of one female student. **Data collection:** Data were collected by a pre-designed (by the principal investigator and supervisor), pre-coded, and pre-tested self-administered questionnaire. The questionnaire was composed of three sections. The first section addressed socio-demographic variables (age, gender, grade, and type of school), while the second assessed oral health-related behaviors (types of drinking water, brushing tools and frequency, topical fluoride application, consumption of hibiscus and soft drinks). Finally, the third section investigated knowledge regarding non-bacterial acids, soft drinks, and topical fluoride as related to erosion. For the dental examination, the students were examined in their schools. They were seated in chairs, and the examination was carried out under natural daylight. The examiner used a dental mirror and probe. A cotton roll was used to dry the teeth before the examination. A visual evaluation was used to detect the presence of erosion. The principal investigator (A. I. Altayeb) conducted the clinical examinations using the Smith and Knight Tooth Wear Index (SKTWI). The index provides scores on a scale from 0 to 4 as follows: 0 = normal, no loss of enamel surface characteristics; 1 = enamel loss, only loss of enamel surface (mild erosion); 2 = enamel and dentine loss (moderate erosion); 3 = enamel, dentine, and pulp loss (severe erosion), and 4 = assessment cannot be made (due to tooth or crown loss). **Ethical considerations:** Ethical approval was obtained from the Sudanese Medical Specializations Board, the State Ministry of Education, the Omdurman locality education authority, and the participating schools, while individual informed consent was obtained from the participants' guardians. After having received a cover letter to explain the study objectives and ensure confidentially, all guardians consented in writing, agreeing that their children could participate in the study. **Statistical**

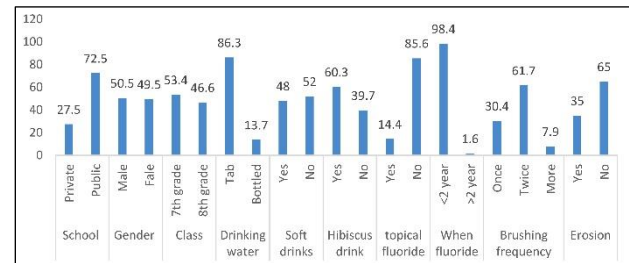
analyses: The Statistical Package for the Social Sciences (SPSS, version 23, IBM) was used for data analyses. The frequency distributions and means (\pm SD) of the descriptive statistics were calculated for all variables. The association of dental erosion with knowledge, behavior, and drinking habits was tested using student's t-test, correlation coefficients, and logistic regression. p values of ≤ 0.05 (95% confidence interval) were considered to indicate statistical significance.

3. Results

3.1. Sample Profile:

Four hundred and eighty-three schoolchildren from 10 different secondary schools in the Omdurman locality participated in the study. Most of the schoolchildren (72.5%) attended public schools, and just over half (53.4%) were in the seventh grade. The mean age was 12.4 years ($SD: \pm 0.76$). The study sample was almost equally distributed regarding gender, with 50.5% of the participants being male and 49.5% female (Figure 1).

Figure 1. Frequency and percentage distribution of personal characteristics and oral health-related behaviors.



3.2. Oral Health Behaviors:

The majority of the schoolchildren (86.3%) reported drinking tap water, compared with a few (13.7%) who drank bottled water. A small portion of the schoolchildren (14.4%) reported having had topical fluoride application, with almost all of these (98.4%) having received it within the past two years.

All of the schoolchildren used a toothbrush and toothpaste, though a number of different brushing frequencies were reported. Approximately one-third (30.4%) reported brushing once per day, while most (61.7%) reported brushing twice per day, and a few (7.9%) reported brushing more frequently than twice per day. Almost half (48%) of the schoolchildren reported consuming soft drinks, with a mean frequency of 2.4 times per day ($SD: \pm 0.80$). Most (60.3%) of the schoolchildren reported consuming hibiscus drinks, with a mean frequency 2.3 times per day ($SD: \pm 0.64$).

3.3 Oral Health Knowledge:

Approximately one-third (27.4%) of the schoolchildren knew that non-bacterial acids could cause dental erosion, while most (72.6%) did not possess this knowledge. At the same time, almost half (48.2%) of the schoolchildren knew that soft drinks could cause dental erosion. Less than one-third of the schoolchildren (26.5%) knew that topical fluoride application could prevent dental erosion (Table 1).

Table 1. Frequency and percentage distribution of knowledge responses.

Statement	% (no.)
Non-bacterial acids	
Yes	27.4 (132)
No	72.6 (350)
Soft drinks cause erosion	
Yes	48.2 (233)
No	51.8 (250)
Fluoride Application prevent erosion	
Yes	26.5 (128)
No	73.5 (355)

3.4. Erosion and its Relation to Knowledge and Dietary

Habits:

The prevalence of dental erosion among the schoolchildren was 35%, with a mean of 0.72 teeth (SD: ±1.23). There was a slight correlation between the distribution of erosion and the socio-demographic characteristics of the schoolchildren. In particular, 39.8% of the private schoolchildren versus 33.1% of the public schoolchildren had erosion. At the same time, 34.5% of those attending the seventh grade had erosion compared with 35.6% of those attending the eighth grade. Regarding gender, 35.7% of the boys and 34.3% of the girls presented erosion.

Table 2. Erosion severity (mean) by soft drink and hibiscus drink consumption (No/Yes).

Variable	Erosion Mean	M. Difference (S. E.)	CI	p value
Soft Drink No/Yes	0.43/1.04	-0.61 (0.11)	-0.82/-0.39	0.000***
Hibiscus Drink No/Yes	0.53/0.84	-0.31 (0.11)	-0.54/-0.09	0.006**

* p ≤ 0.05, ** p ≤ 0.001

As shown in Table 2, there was a statistically significant correlation between erosion severity and oral health-related habits, with those who reported the consumption of soft drinks having a higher mean erosion score than those who did not, with a mean difference of -0.61 (p = 0.000). In addition, those who reported the consumption of hibiscus drinks had higher erosion severity than those who did not, with a mean difference of -0.31 (p = 0.006). Overall, those with erosion compared with those with no erosion had a higher mean frequency of tooth brushing (mean difference: -0.13; p = 0.02), soft drink consumption (-0.28; p = 0.001), and hibiscus consumption (-0.36; p = 0.001) compared with their counterparts (Table 3).

Table 3. Mean difference (S.E.) and CI (p value) of tooth brushing, soft drink consumption, and hibiscus drink consumption by erosion status (No/Yes).

Variable	Erosion No/Yes	M. Difference (S. E.)	CI	p value
Tooth Brushing Frequency	1.73/1.86	-0.13 (0.06)	-0.24/-0.02	0.02*
Soft Drink Frequency	2.17/2.45	-0.28 (0.08)	-0.57/-0.14	0.001**
Hibiscus Drink Frequency	2.27/2.63	-0.36 (0.11)	-0.45/-0.12	0.001**

* p ≤ 0.05, ** p ≤ 0.001

Table 4. Logistic regression: erosion status regressed by socio-demographic, knowledge, and behavioral variables.

Variable	B	OR (S.E.)	C.I.	p value
Gender		1		
Male	3	0.64 (0.26)	0.38, 1.07	0.08
Female		1		
Class		1		
Seventh grade	-0.2	0.82 (0.26)	0.5, 1.4	0.49
Eighth grade		1		
Type of water		1		
Tap	-0.6	0.60 (0.4)	0.26, 1.2	0.19
Bottled		1		
Topical fluoride		1		
No	-0.31	0.73 (0.4)	0.3, 1.6	0.42
Yes		1		
Non-bacterial acids		1		
No	0.45	1.6 (0.31)	0.9, 2.8	0.14
Yes		1		
Soft drinks cause erosion		1		
No	0.62	1.9 (0.28)	1.08, 3.2	0.03*
Yes		1		
Fluoride App. prevents erosion		1		
No	-0.36	0.70 (0.31)	0.4, 1.3	0.30
Yes		1		
Hibiscus		1		
No	1.00	2.7 (0.3)	1.5, 5.0	0.001**
Yes		1		
Soft drink		1		
No	0.9	2.4 (0.27)	1.4, 4.0	0.001**
Yes		1		
Constant	-0.9	0.42 (0.31)		0.005

* p ≤ 0.05, ** p ≤ 0.001

When erosion score was correlated with dietary and oral hygiene habits, a number of statistically significant correlations were found. The highest was with soft drink consumption (r = 0.37, p = 0.000), followed by hibiscus consumption (r = 0.22, p = 0.006) and tooth brushing frequency (r = 0.17, p = 0.03).

Table 4 shows erosion status regressed against personal and dietary habit variables. Three variables were found to be statistically associated with erosion status. Those who knew that soft drinks caused erosion were almost twice as likely to have erosion compared with their counterparts (OR: 1.9, p = 0.03). Those with a high frequency of hibiscus drink consumption were almost three times more likely to have erosion compared with their counterparts (OR: 2.7, p = 0.001). Those who reported a high frequency of soft drink

consumption were also more than twice as likely to develop erosion compared with those who had a low frequency of consumption (OR: 2.4, p = 0.001).

4. Discussion

This study assessed the prevalence of dental erosion and its possible risk factors (socio-demographics, knowledge, and dietary habits) among schoolchildren in the Omdurman locality in Khartoum state, Sudan.

Schoolchildren from 10 different secondary schools (private and public) of both genders participated in the study. The overall prevalence of dental erosion among schoolchildren was found to be 35%. This is lower than the 66.9% reported in a study conducted in the Khartoum locality of Sudan in 2007 (El Karim et al., 2007). This might be due to change over time between the two studies or socioeconomic differences between the two localities and study samples. The participant age difference between the two studies might be the most significant factor, as the Khartoum study included Sudanese adults aged ≥16 years, while this study considered a random sample of 12–14-year-old schoolchildren. The number measured here was also higher than that found among children aged 13–14 years in Yemen (3.0%; Al-Ashtal et al., 2017) and Sweden (11.9%; Hasselkvist et al., 2010). At the same time, a study in Libya reported a prevalence of 40.8% among 12-year-olds, which is higher than that discovered here (Huew et al., 2011). In Saudi Arabia, one study found a prevalence of 26% of among 12–14-year-olds (Al-Majed et al., 2002). In Istanbul, it was reported that 28% of the 11-year-old children attending public school exhibited dental erosion (Caglar et al., 2005), and it was later found that 52.6% of those among the Greek minority in Istanbul exhibited dental erosion (Caglar et al., 2011). Nevertheless, the result here was higher than the prevalence in Southern Brazil, which was 15% for the same age group (Alves et al., 2015). The Brazilian authors explain that the low prevalence might be due to the fact that the children were not exposed to cola/pop culture. Overall, it should be noted that it is not always straightforward to compare the prevalence of erosion between studies with different scoring systems, samples, and examiners (Jaeggi and Lussi, 2014).

In previous studies, the prevalence of dental erosion among schoolchildren has been shown to be related to the type of the school, socioeconomic status, parent education, and geographic area (Shahbaz et al., 2016; Arnadottir et al., 2010; Habib et al. 2013; Zhang et al., 2014). In contrast, the results of our study revealed no significant differences associated with these factors. This may have been because the schoolchildren who participated in this study all had almost the same education level and socioeconomic status.

The age of the schoolchildren in this study ranged between 12 and 14 years. At this stage, children are developing their own eating habits and mostly decide their food consumption. Further, they are exploring eating styles outside of home from school canteens and grocery stores (Kirthiga et al., 2015; Marques Martinez et al., 2019; Mafla et al., 2017).

Regarding oral hygiene practice, all of the schoolchildren, without any exceptions, reported using a toothbrush and toothpaste for tooth brushing routinely at least once a day. There was a statistically significant correlation between erosion and tooth brushing (r = 0.167, p = 0.03). Those with erosion tended to have a higher frequency of brushing, with a mean difference of -0.127 (p = 0.02). This can potentially be explained by the results of a study by Sovik et al. (2015), who reported that manual tooth brushing causes the abrasion of sound and eroded dentin. However, in another study conducted in Sudan, no such association was detected (El Karim et al.,

2007).

The majority of the schoolchildren in the present study were not aware of dental erosion, and less than half knew that dental erosion could be caused by soft drinks, indicating that the term erosion was not fully understood. This might also indicate that there is a knowledge gap regarding aspects of erosion and prevention (Salas et al., 2017). In Brazil, only dental professionals were found to know about dental erosion and its factors and prevention methods (Alves et al., 2015).

Almost half (48%) of the schoolchildren reported consuming soft drinks. This was lower than in the previous study from Sudan, in which it was reported 94% of the participants consumed soft drinks (El Karim et al., 2007). Here, an association was found between erosion status and soft drink consumption. This is in agreement with a study from Istanbul, in which 40% of participants who consumed carbonated beverages showed erosion, compared with 36% of those who consumed fruit yogurt and 32% of those who consumed orange juice (Caglar et al., 2011). Likewise, in Saudi Arabia an association was found between the prevalence of dental erosion and the frequency of citrus and carbonated juice consumption in preschool children (Al-Dlaigan et al., 2017). An association has also been found between erosion in palatal surfaces and the consumption of carbonated soft drinks at night (Al-Majed et al., 2002; Vargas-Ferreira et al., 2011). In India, traditional lemon juice was found to be a cause of dental erosion (Kumar et al., 2013). Most (63%) of the school children in this study consumed hibiscus drinks, which is a lower percentage than that (78%) reported in the 2007 study (El Karim et al., 2007). Logistic regression analyses showed that hibiscus and soft drink consumption frequency was significantly associated with erosion. Our study is in agreement with the previous study from Sudan (El Karim et al., 2007) that hibiscus drink is a significant factor associated with dental erosion. Soft drinks and traditional hibiscus juice have low pH levels beyond the critical pH level of 5.5 for enamel dissolution (Lussi and Schaffner, 2000). This association might also be due to the major organic acids (citric and malic acids) in the flowers of *Hibiscus sabdariffa* L. (Owoade et al., 2019).

5. Conclusions

In conclusion, it was found that the prevalence of dental erosion was high among the study population, and the level of awareness regarding dental erosion and preventive measures was inadequate. The frequent consumption of acidic drinks seemed to be associated with the erosion.

Limitations: Selection and information biases due to voluntary participation and self-reporting might have affected the representativeness and the reliability of the information gathered. The limited study sample from the Omdurman locality also limits the generalizability of the results beyond the study population. There may also be unknown systematic and logistical errors or unmeasured confounding factors associated with the results. Accordingly, the results of this study should be interpreted and generalized cautiously.

Biographies

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