

Prevalence of Tooth Surface loss among a Group of Sudanese Children

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• Abstract

Background: Tooth surface loss (TSL) is a universal problem that describes an irreversible loss of hard dental tissues from the tooth surface. It remains a prevalent dental health concern impacting preschool and school children globally.

Aim of the study: This study aimed to examine the prevalence of tooth surface loss in Sudanese children and evaluate the associated factors.

Methods: This cross-sectional study involved 500 Sudanese children aged 4 to 12 years. The primary and mixed dentition participated in the study. Molars and canines and incisors teeth were examined. Data were collected from Sudanese children residing with their families in Cairo, representing various provinces of Sudan and diverse socioeconomic backgrounds. The study utilized a structured questionnaire to identify associated risk factors, followed by an oral examination to assess the participants' anthropometric characteristics. Prior to the investigation, all procedures were thoroughly explained to the parents or guardians, and informed consent was obtained to ensure their approval for participation.

Results:

74.8% of participants experienced tooth surface loss (TSL), with most affected children having moderate to severe levels. Males

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exhibited a significantly higher prevalence of TSL compared to females. Regarding the primary teeth, Incisors are the most affected in the maxillary teeth (33.47%) and in the mandibular teeth (28.57%).

Then come the affected maxillary molars (48.74%), especially the right maxillary first molars (16.00%) and the mandibular molars (57.29%), especially the right mandibular second molars (18.30%).

Canines show the least involvement in both arches. While in the affected permanent teeth, the maxillary incisors are the most affected, (76.83%) while in the mandibular incisors are the most affected, but to a lesser extent than maxillary incisors (51.24). The maxillary first permanent molars are the second most affected (21.62%). First permanent molars show a higher percentage of involvement compared to maxillary molars, with (48.14%). Premolars show very little involvement in both arches.

Among children who consumed citric foods and those who drank soda alone, 65.1% and 65.8% respectively had TSL. Meanwhile, the prevalence was highest almost 89% among those who consumed both citric foods and drinks. Notably, TSL was not significantly associated with consuming citric drinks alone. Most participants (66%) were from low economic backgrounds, with 77.5% of them presenting with TSL.

Conclusion: This study showed a high prevalence of TSL among Sudanese children living in Cairo. Incisor teeth and male children with from lower economic backgrounds and dietary habits, particularly the consumption of both citric foods and drinks, were strongly associated with increased TSL.

Keywords: Sudan, Prevalence, Tooth surface loss, Risk factors

انتشار فقدان سطح الأسنان بين مجموعة من الأطفال السودانيين

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• ملخص:

خلفية: فقدان سطح الأسنان (TSL) هو مشكلة عالمية يتوصف فقدان لا يمكن عكسه للأنسجة السنية الصلبة من سطح السن. (TSL) مشكلة صحية سنية شائعة بتأثر على الأطفال في مرحلة ما قبل المدرسة والمدرسة على مستوى العالم.

هدف الدراسة: كانت الدراسة تهدف لبحث انتشار فقدان سطح الأسنان عند الأطفال السودانيين وتقييم العوامل المرتبطة.

الطرق: الدراسة كانت دراسة مقطعية واشتملت على 500 طفل سوداني من 4 لـ 12 سنة. الأسنان الأولية والمختلطة شاركت في الدراسة. تم فحص الأسنان الضواحك والأنياب والأنياب. تم جمع البيانات من الأطفال السودانيين اللي عايشين مع عائلاتهم في القاهرة، ويمثلوا مختلف محافظات السودان وخلفيات اجتماعية واقتصادية متنوعة. استخدمت الدراسة استبيان منظم عشان تحدد عوامل الخطر المرتبطة، وراها كان فيه فحص طبي للفم لتقييم خصائص المشاركين الجسمانية. قبل بدء التحقيق، تم شرح كل الإجراءات تفصيلياً للآباء أو الأوصياء، وتم الحصول على موافقة مستنيرة لضمان موافقتهم على المشاركة.

النتائج: 74.8% من المشاركين عانوا من فقدان سطح الأسنان، مع معظم الأطفال المتأثرين عندهم مستويات متوسطة إلى شديدة. الأولاد أظهروا انتشار أعلى بشكل ملحوظ لفقدان سطح الأسنان مقارنةً بالبنات. بالنسبة للأسنان اللبنية، الأسنان الأمامية هي الأكثر

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تأثراً في الأسنان العلوية (33.47%) وفي الأسنان السفلية (28.57%). بعد كده، الأسنان الطواحن العلوية المتأثرة (48.74%)، خاصةً الطاحونة اليمنى الأولى العلوية (16.00%) والأسنان الطواحن السفلية (57.29%)، خاصةً الطاحونة الثانية السفلية اليمنى (18.30%). الأنياب كانت الأقل تأثراً في كل الفكين. من بين الأطفال اللي تتاولوا أطعمة حمضية واللي شربوا صودا لوحدها، 65.1% و 65.8% على التوالي كان عندهم فقدان سطح الأسنان. في نفس الوقت، الانتشار كان أعلى تقريباً 89% بين اللي تتاولوا الأطعمة والمشروبات الحمضية. ومن الملاحظ أن فقدان سطح الأسنان لم يكن مرتبط بشكل ملحوظ بشرب المشروبات الحمضية لوحدها. معظم المشاركين (66%) كانوا من خلفيات اقتصادية منخفضة، مع 77.5% منهم عندهم فقدان في سطح الأسنان.

الاستنتاج: الدراسة دي أظهرت انتشار عالي لتسوس الأسنان بين الأطفال السودانيين اللي عايشين في القاهرة. الأسنان القاطعة والأطفال الذكور من خلفيات اقتصادية منخفضة وعادات غذائية معينة، خصوصاً استهلاك الأطعمة والمشروبات الحمضية، كانوا مرتبطين بشكل كبير بزيادة تسوس الأسنان.

الكلمات المفتاحية: السودان، انتشار، فقدان سطح الأسنان، عوامل الخطر



- **Introduction:**

Throughout the last century, anthropological investigations into various contemporary and pre-contemporary societies. Encompassing hunter-gatherer, agricultural, medieval, and present-day populations, have figured out that tooth surface loss is a customary physiological occurrence. This phenomenon entails teeth experiencing wear while supporting functionality throughout an individual's life (**Brace, 1977**).

The prevalence of tooth surface loss is on the rise among younger patients. It is still uncertain whether this increase is attributed to heightened awareness among patients and dental health care professionals. It reflects an actual rise resulting from changes in dietary habits, dental practices, socioeconomic status, and cultural behaviors or a combination of these factors (**Bardsley et al., 2004 and Bardsley, 2008**).

TSL can be considered as physiological or pathological. Interproximal friction between adjacent teeth may result in physiological tooth surface loss, affecting the occlusal surface due to normal or natural consequences of aging, leading to vertical enamel loss approximately 0.02–0.04 mm (**Davies et al., 2002**) and (**Kaidonis, 2008**). While pathological TSL is a condition in which an abnormal destruction occurs of the hard dental tissue due to intrinsic or extrinsic factors.

It usually begins with the primary dentition and may persist involving the permanent dentition (**Linnett & Seow 2001**). Children with mild-to-moderate pathological tooth surface loss may not show symptoms. However, by the time of presentation, there will be extensive damage to the primary and young permanent teeth. Children with pathological tooth surface loss may experience symptoms such provoked or unprovoked teeth sensitivity, pulp involvement, change in appearance of teeth, loss of the vertical height, frequent fracture of teeth or restorations, drifting of teeth and mobility. These symptoms might be a significant factor affecting the long-term health of the dentition,

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which will require dental treatment (Davies et al., 2002) and (Bartlett et al., 2011).

There are three main classifications for tooth surface loss: attrition, abrasion, and erosion. TSL is described usually as a combination of all together (bio-corrosion), each classification corresponds to a different process with specific clinical features, while tooth erosion is usually the predominant underlying mechanism (Alves et al., 2015).

Subjects and methods:

Sample size

The sample size was calculated using StatCalc version 1.4.3 (Epi InfoTM, CDC, Atlanta, Georgia, USA), 74% prevalence of tooth surface loss based on a previous study by Sanhoury et al in 2009, 95% of confidence level and 4% margin of error, the calculated sample size was a total of 462 per population.

Study setting

A group of Sudanese children aged from 4 to 12 years. The data were collected from Sudanese children who lived with their families in Cairo, who came from different provinces in Sudan, and had different socioeconomic levels.

Also, some Sudanese children their examinations were conducted in New Giza University, during a medical convoy to examine Sudanese children. All The procedures were explained to the parents or guardians prior to the investigation and an informed consent was given to the parents or guardians to get their approval for work. The survey involved a structured questionnaire followed by an oral examination to assess different sociodemographic and anthropometric characteristics of the participants.

A structured questionnaire was administered for parents it was written in English and will be administered and translated in Arabic to the parents by the researcher during interview (Gatou and Homata, 2012).

The questionnaire was categorized as follows:



1. Sociodemographic and anthropometric variables:

Include the parental educational status and the child's age, gender, nationality, school and physical activity.

2. Diet variables:

Include the type of diet and the diet habits.

3. Physical variables

The physical variables were evaluated under the following subheadings:

- a) dental and occlusal variables
- b) soft tissue and functional variables.
- c) oral Habits

Clinical Examination

Infection control measures

The clinical examination was conducted using disposable mouth mirror and sharp explorers for each child.

Gloves and face masks changed before examination of every child, gloves and masks were disposed in waste bag (Kumar, 2010).

Oral examination

A clinical examination was conducted to assess the child's tooth surface loss. The examination was conducted in the public medical units that serve Sudanese refugees. In these units, the examination was performed on an ordinary chair or even while the child was standing in daylight facing the window. The examination used disposable mouth mirrors, probes, and mini portable air blowers for dryness.

Also, some Sudanese children their examinations were conducted in New Giza University, during a medical convoy to examine Sudanese children.

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All the examinations were conducted by a single examiner. To assess the severity or degree of tooth surface loss in primary and mixed dentition teeth, the examination followed a systematic approach, beginning with the upper first quadrant and progressing to the second, third, and fourth quadrants.

Scoring was performed according to the modified Smith and Knight Index.

core	Description
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 could not be made- tooth absent or crowned or had a large restoration.

Statistical Analysis:

Statistical analysis will be performed using Medcalc software, version 22 for windows (MedCalc Software Ltd, Ostend, Belgium). Continuous data will be presented as mean and standard deviation (SD) or median and range when proper. Categorical and binary data will be presented as frequency and percentage. The significance level will be set at $P \leq 0.05$ and all tests will be two tailed.

Results:

Table (1) and figure (1) presents the prevalence of tooth surface loss TSL among Sudanese children, The presence of TSL was significantly higher ($n=374/500$) 74.8% than its absence ($n=126/500$) 25.2% with a p -value <0.0001 .



Table (1): Prevalence of TSL among Sudanese children:

	Prevalence of TSL		P value
	N	%	
No	126	25.2%	<0.0001*
Yes	374	74.8%	

*Significant difference as $P < 0.05$.

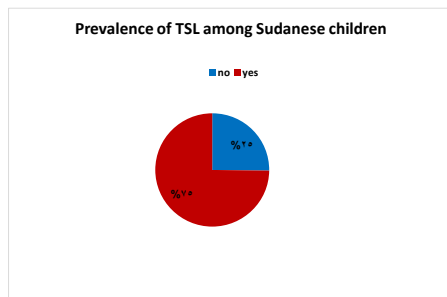


Figure (1): bar chart showing Prevalence of TSL among Sudanese children

A total of 500 children were examined with an age range of 4-12 years and an average age of 7. TSL prevalence: In males was 204 out of 295 (54.5% of males), while female was 170 out of 241 (45.5% of females) as present in table 2, with significant difference between them ($P=0.03$).

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Table (2): frequency and distribution of gender among total patients.

		Total		Prevalence of TSL				Chi square test	
				No		Yes			
		N	%	N	%	N	%	Chi square	P value
Sex	Male	259	51.8%	55	43.7%	204	54.5%	4.48	0.03*
	Female	241	48.2%	71	56.3%	170	45.5%		

Table (3) and figure (2) present data on the socioeconomic level among total patients and those with Tooth Surface Loss (TSL). The results showed that there is a statically difference between children with low and high economic status as $p=0.0001$, as children with low socioeconomic status have TSL prevalence (77.5%) while those with high socioeconomic status (22.5%).

Table 3: Prevalence of TSl on the socioeconomic factor.

		Total Number	%	Have no TSL	%	Have TSL	%	Chi square	P value
Socioeconomic	Low	330	66.0%	40	31.7%	290	77.5%	88.03	0.0001*
	High	170	34.0%	86	68.3%	84	22.5%		

*Significant difference as $P<0.05$

Figure (2) Prevalence of TSL about the socioeconomic factor.

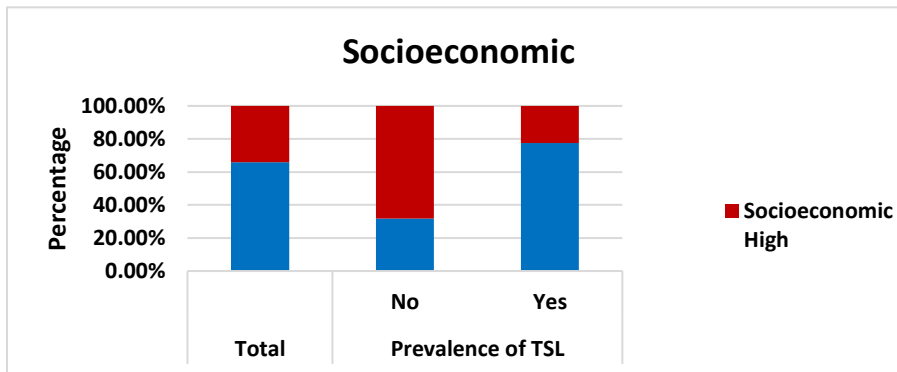


Table (4) presents the severity of TSL, comparison between different grades of severity. The most severity level that shows significant difference was the moderate level (44.6%), then severe (33.4%), while mild (21.9%) showed the least significance.

Table (4): Frequency and percentages severity of TSL:

		Prevalence of TSL		Chi square	P value
		N	%	53.4	<0.001
	Mild	82	21.9%		
	Moderate	167	44.6%		
	Severe	125	33.4%		

**Significant difference as $P < 0.05$.*

Table (5) presents the distinct types of drinks and food and their relationship with the prevalence of TSL. Consumption of citric food and drinking soda seemed to have a significant association with TSL ($p=0.001$). While drinking citric drinks seemed to have no significant difference in the prevalence of TSL as ($p=0.76$). While eating and drinking citric together show high significant difference in the prevalence of TSL that might function as synergetic effect as ($p<0.0001$).

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	Total /500		Prevalence of TSL				Chi square test	
			Yes		No			
	N	%	N	%	N	%	Chi square	P value
Eating citric food only	293	58.6%	191	65.1%	102	34.8%	27.04	0.0001*
Drinking citric drinks only	122	24.4%	66	54%	56	45.9%	0.82	0.365
Drinking soda	287	57.4%	189	65.8%	98	34.1%	28.8	0.0001
Both Drinking and eating citric	156	31.2%	139	89%	17	10.8%	95.42	0.0001*

Table (5) frequency and percentage of several types of diet.

**Significant difference as $P < 0.05$.*

Table (6) showed 180 children out of 500 reported swimming (36%) from the total sample, (62.2%) of them had TSL while only 37.7% didn't have TSL.

There was a statistically significant difference in the prevalence of TSL among children who swim.

Table (6): frequency and percentage of history of swimming and its distribution among TSL prevalence

Swimming children	Total n		Prevalence of TSL				Chi square test	P-value
			yes		No		10.76	0.001
	N	%	N	%	N	%		
	180	36%	112	62.2%	68	37.7%		

**Significant difference as $P < 0.01$*

Table (7) and figure (7) presents the frequency and percentage of primary teeth affected by Tooth Surface Loss (TSL) in maxillary and mandibular arches regarding Sudanese children. The study examines a total of 2,652 primary teeth, with 1,231 maxillary and 1,421 mandibular teeth affected. Regarding total Maxillary teeth affected with TSL (N=1231): Incisors are the most affected, (33.47%) showing TSL. While the molars collectively account for 48.74% of affected teeth, with the right first primary molars being the most affected (16.00%). Canines show the least involvement at 17.79%. Regarding Mandibular teeth affected with TSL (N=1421): In Incisors are again the most affected (28.57%) showing TSL. Molars account for a higher percentage (57.29%) of affected teeth compared to maxillary molars, with the right second primary molars being the most affected (18.30%). Canines show the least involvement at 14.14%.

Table (7) Presents the distribution of primary teeth affected with TSL among maxillary and mandibular teeth with significant difference as P- value <0.05.

Teeth			N	%	P-value
Maxillary teeth (N=1231)	Incisors		412	33.4	0.0001*
	Canines		219	17.7	0.0001*
	Molars (N=600)	Left second primary molar	134	10.8	0.0001*
		Left first primary molar	162	13.1	0.0001*
		right first primary molar	197	16	0.0001*
		Right second primary molar	107	8.6	0.0001*
Teeth			N	%	P-value
Mandibular teeth	Incisors		406	28.5	0.0001*
	Canines		201	14.1	0.0001*

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(N=1421)	Molars (n=814)	Left second primary molar	220	15.4	0.0001*
		Left first primary molar	175	12.3	0.0001*
		right first primary molar	159	11.1	0.0001*
		right second primary molar	260	18.3	0.0001*

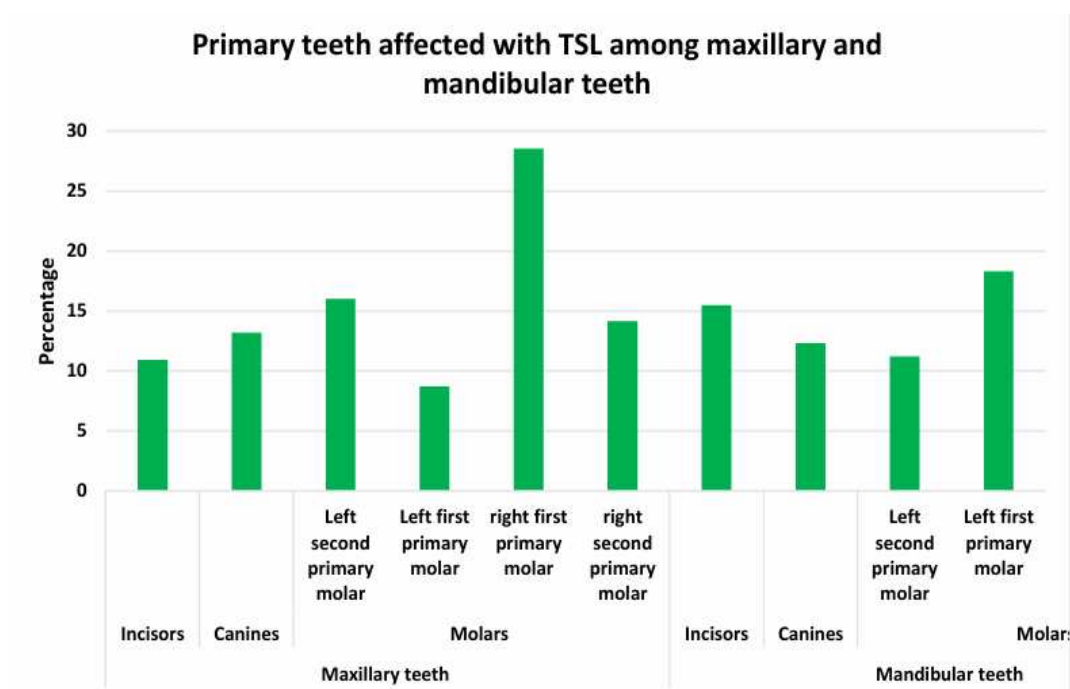


Figure (7): bar chart showing primary teeth affected by TSL among maxillary and mandibular teeth.

Table (8) and figure (8) presents data on the frequency and percentage of permanent teeth affected by (TSL) in maxillary and mandibular arches. The study examines a total of 840 permanent teeth, with 518 maxillary and 322 mandibular teeth affected. The p value of both arches indicates statistically significant differences in TSL distribution among different tooth types.



Regarding maxillary teeth incisors, they are the most affected, (76.83%) showing TSL. First permanent molars are the second most affected (21.62%). Premolars show minimal involvement.

Regarding mandibular teeth incisors are the most affected, but to a lesser extent than maxillary incisors (51.24%). First permanent molars show a higher percentage of involvement compared to maxillary molars, with (48.14%). Premolars show very little involvement.

Table (8) showed the distribution of permanent teeth affected with TSL among maxillary and mandibular teeth.

Teeth			N	%	P value
Maxillary teeth (N=518)	Incisors		398	76.83	<0.0001*
	Pre-molars	First premolar	5	0.965	
		Second premolar	3	0.579	
	First permanent Molar		112	21.62	
Mandibular teeth (N=322)	Incisors		165	51.24	<0.0001*
	Premolars	First premolar	2	0.62	
		Second premolar	0	0.00	
	First permanent Molar		155	48.14	

*significant difference as $P < 0.05$.

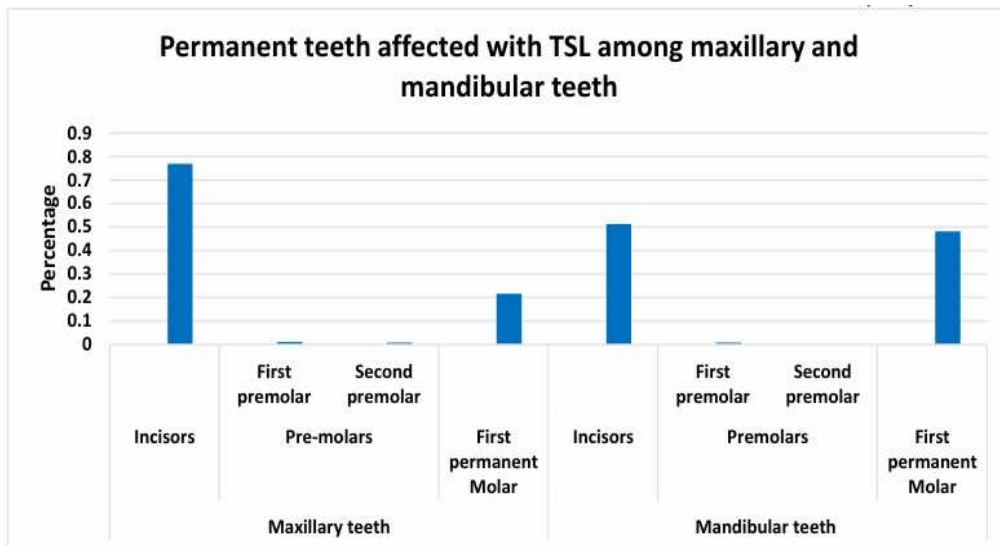


Figure (8): bar chart showing permanent teeth affected with TSL among maxillary and mandibular teeth.

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Discussion:

Tooth surface loss is characterized as an irreversible, progressive lesion involving the loss of hard teeth (**Alves et al ,2015**). It is caused by the interaction of chemical, mechanical, biological and behavior factors, where the tooth tissue is having demineralization but not due to the acid of bacterial metabolism (**Loureiro et al ,2015**).

Additionally, tooth surface loss may be attributed to intrinsic factors, such as gastric acid, which can enter the oral cavity through vomiting or gastroesophageal reflux. In contrast, extrinsic factors encompass diet, medications, environmental influences, and lifestyle choices (**Taji and Seow, 2010**).

The current study was an epidemiological survey examining tooth surface loss among Sudanese children. Its goal was to assess the prevalence and associated factors of tooth surface loss in primary and mixed dentition among school children with an average age of 7.4 years.

The study also aimed to explore potential associations between prevalence and factors such as dietary habits, oral habits, sports, oral hygiene practices, child health, and socioeconomic status.

This study assesses the prevalence of tooth surface loss in the primary and mixed dentition among the Sudanese children. It stands out because there are few studies in literature that address this issue.

In this research, the prevalence of tooth surface loss among Sudanese children in the primary and mixed dentition was found to be 74.8%, while 25.2% had no tooth surface loss.

The prevalence in this study shows the same results that conducted by **Sanhoury et al ,2010** that showed the occurrence of tooth surface loss varies among children in the Sudan was 74.1%.

In this group, the prevalence is higher than that reported in a pilot study done by (**El Karim et al., 2007**) of a similar



population (66.9%), as the current study is more representative of this group.

Moreover, the prevalence in this study is higher than that reported in studies from the Netherlands (**Train et al., 2004**), Brazil (**Peres et al., 2005**), and **Harding et al 2003**.

They showed the prevalence of tooth surface loss in 5-year-old Irish school children is 47% , but lower than the figures from Saudi Arabia (**Al-Majed et al., 2002**). **Halibi et al 2016** in Abu Dhabi that showed 97.6% prevalence of tooth surface loss.

Differences in prevalence rates across studies may arise from the difference in the demographic characteristics of the study populations, such as age, socioeconomic status, and geographical location, can influence prevalence rates.

Also, the differences in dietary habits, oral hygiene practices, and access to dental care can affect the incidence of tooth surface loss.

Moreover, the variations in study design, sampling methods, and diagnostic criteria can lead to differing prevalence estimates. These factors contribute to the variability in reported prevalence rates of tooth surface loss and other dental conditions across different studies.

Socioeconomic factors play a crucial role in shaping oral health behaviors and access to care, which can influence the prevalence of tooth surface loss. It was challenging to classify children based on traditional socioeconomic status measures, a difficulty noted in an earlier study in Saudi Arabia (**Al-Majed et al., 2002**).

As a result, school type was used as a proxy, with children in private schools considered part of the higher socioeconomic group. In the current study it shows statistically significant differences in TSL prevalence based on socioeconomic status.

Socioeconomic prevalence: of tooth surface loss in low socioeconomic status was (77.5%) while in high socioeconomic status was (22.5%).

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Al-Dlaigan et al. (2001) and **Harding et al. (2003)** reported higher prevalence rates of tooth surface loss in lower socioeconomic groups. While In contrast with findings from **Truin et al. (2004)** and **Al-Malik et al. (2002)** no significant differences were found between the two socioeconomic groups.

These differences in results might be due to the different socioeconomic factors such as access to dental care dietary, choices living environment, stress, and health.

In this current study it showed that consuming citric food plays a crucial role in the occurrence of tooth surface loss. The current study showed high significance between consuming citric food and prevalence of TSL.

The equivalent results showed by **Sanhoury et al ,2010, (Al-Dlaigan et al, 2001b and Bardsley et al, 2004; Dugmore and Rock, 2004)**. This might be explained that acidity can also cause a prolonged decrease in pH levels in the oral cavity and is likely to have strong erosive potential.

In this current study it showed that citric drinks showed a low significant difference with TSL, which agrees with the findings of **Pigno et al 2004 and Nunn et al., 2003**. While it disagrees with the findings of **Sanhoury et al, 2010 and Al-Majed et al., 2002**.

This may be explained by the fact that drinking alone may not cause TSL; there must also be certain behaviors, such as holding the drink in the mouth for a long time or brushing teeth immediately after drinking soda or citric.

As in the current study showed high statistical difference when children do both eating and drinking citric this finding might be explained the there is a synergetic effect happening.

This study shows that soda consumption, particularly cola, plays a significant role in the development of tooth surface loss.

Additionally, the study found a strong correlation between the consumption of soda and the prevalence of TSL. These findings



disagree with **Nunn et al., 2003**, while it agrees with **Hans et al., 2016**, **Sanhoury et al., 2010** and **Al-Majed et al., 2002**.

This may be explained by the fact that consuming soda drinks leads to a decrease in the salivary Ph. Soda drinks have an inherent acidity, due to the presence of carbonic acid formed by the addition of CO₂, which creates the fizz, along with other acids like phosphoric acid, citric acid, and tartaric acid that causes dissolution of enamel that's contributes to tooth surface loss (**Hans et al., 2016**) and (**Kregiel, 2015**).

In the current study there was a statistically significant difference in the prevalence of swimming between those with and without TSL ($p=0.01$).

This finding is consistent with the findings of **Sanhoury et al, 2010** that showed 20.4% of the students in chlorinated swimming pools showed TSL over the buccal surfaces of their maxillary teeth with a significant p-value of 0.015, this might be explained that the chemicals used to sanitize pool water, particularly chlorine, can lower the pH of the water. Low pH levels can lead to acidic conditions that may erode tooth enamel over time.

Also, prolonged swimming can lead to dehydration or dry mouth, reducing saliva production.

The current study found that tooth surface loss (TSL) is more prevalent in both primary and permanent incisors compared to canines.

This aligns with the findings of **Gatou and Mamai (2012)**, who reported that TSL is more common and severe in incisors than in molars.

However, these results contradict the findings of **Warren et al. (2002)** and **Kreulen (2010)**, who observed that primary canines exhibited the highest prevalence and severity of TSL.

This observation may be attributed to variations in the criteria used across studies to assess the presence and severity of tooth surface loss. Some studies focused on specific teeth rather than evaluating the entire dentition.

Conclusion and recommendations

- This study highlights the high prevalence of tooth surface loss (TSL) among Sudanese children living in Cairo, with the majority experiencing moderate to severe levels. Males were more affected than females, and dietary habits, particularly the consumption of both citric foods and drinks, were strongly associated with increased TSL. Additionally, children from lower economic backgrounds exhibited a higher prevalence of TSL.
- These findings emphasize the need for targeted preventive measures, including dietary education and improved oral health care, to reduce the impact of TSL in this population.

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