

Dental erosion. Etiologic factors in a sample of Valencian children and adolescents. Cross-sectional study



L. Marqués Martínez,
A. M. Leyda Menéndez,
M. Ribelles Llop, C. Segarra Ortells,
R. Aiuto*, D. Garcovich**

CEU-Cardenal Herrera University, Valencia, Spain
*Department of Oral Rehabilitation, University of Milan,
Istituto Stomatologico Italiano, Milan, Italy
**Universidad Europea de Valencia, Valencia, Spain

e-mail: laura.marques@uchceu.es

DOI 10.23804/ejpd.2019.20.03.04

Abstract

Aim To establish the relationship between dental erosion prevalence in children aged 6–14 and all the aetiological factors that lead to the development of the lesions.

Methods Study design: A correlational cross-sectional study of a sample of 400 Valencian children was conducted. First, a questionnaire was completed to analyse the patients' health status, their dietary and oral hygiene habits, the kind of school they attended and their parents' academic level. Then, a clinical exploration of the permanent dentition was done, calculating the BEWE index and the risk of erosion for each patient.

Results The prevalence of dental erosion of the studied sample was 22.3%. A positive correlation was observed between the presence of dental erosion and the frequent intake of fruit juices, carbonated and isotonic drinks ($p < 0.05$), presenting a higher correlation if the liquid was kept in the mouth before swallowing. Aetiological factors such as the use of inhalers in patients with asthma ($p = 0.006$), frequency of vomiting and regurgitation ($p < 0.001$), frequent swimmers ($p < 0.001$) or a low socioeconomic status ($p < 0.05$) were also positively associated to the development of erosive lesions. Statistics: A descriptive and inferential statistical analysis was performed, using the Mann-Whitney U and the Kruskal-Wallis tests in the latter.

Conclusion The results of this study suggest that the frequent intake of fruit juices, carbonated and isotonic drinks, the use of inhalers and belonging to a low socioeconomic level family are factors positively associated to the development of erosive lesions.

Introduction

Dental erosion has long been a scarcely studied condition, however, in recent years the number of investigations conducted on this topic has significantly incremented due to its increasing prevalence, especially in children and adolescents [Lussi and Jaeggi, 2008; Stenhagen et al., 2017]. A recent systematic review revealed an estimated prevalence rate of 30.4% with rates ranging from 7.2% to 74% [Salas et al., 2015].

Dental erosion is defined as a chronic, localised, painless pathological loss of mineralised dental tissues, due to the chemical action of acids, where the action of microorganisms is not involved [Esber et al., 2005; Salas et al., 2015]. By analysing this definition, it could seem the aetiology is fairly simple; however, it is a complex process [Lussi and Jaeggi, 2008; Stenhagen et al., 2017] in which biological factors such as salivary flow and buffer capacity coalesce with chemical factors present in food and behavioural factors, individually determining the risk of developing the disease and the severity of the lesions [Ceyhan et al., 2018; Mika et al., 2018; Paduano et al., 2018; Plczak-Kowalczyk et al., 2017].

In order to make an accurate diagnosis of dental erosion, a complete clinical history including data on general health, diet and patients' habits is essential, together with a careful intraoral exploration, complemented by the assessment of salivary flow, pH and buffer capacity of stimulated saliva [Lussi and Jaeggi, 2008].

The detection and assessment of lesions in the most objective and reproducible way requires the use of indices. The BEWE index (Basic Erosion Wear Examination) is the most used one and does not take into account wear due to other aetiologies. It is easy to learn, apply and calibrate, presenting appropriate specificity and sensitivity, surpassing in these aspects other indices such as the TWI or the Lussi index [Bartlett et al., 2008].

The objectives of the present investigation were to establish the relationship between dental erosion prevalence and all the aetiological factors which can lead to the development of the lesions in a sample of 400 Valencian children aged 6 to 14 years.

KEYWORDS Dental erosion, Tooth erosion, Aetiology, Index.

Methods

The present correlational, cross-sectional descriptive study was designed and conducted following the STROBE checklist for cross-sectional studies and approved by the Ethics Committee of the Cardinal-Herrera CEU University (Valencia, Spain) (CEI 12/002).

The selection of the sample was carried out by non-probability consecutive sampling of a convenience sample; selecting 400 children aged 6 to 14 by order of arrival to a dental practice in Valencia. The inclusion criteria required patients to be at least 6 years of age and not older than 15, to present first mixed dentition, second mixed dentition or permanent dentition, to have parents/guardians sign an informed consent form and fully and correctly complete the questionnaire.

Exclusion criteria were: patients with deciduous dentition, unsigned informed consent forms, incorrectly or incompletely filled questionnaires, patients presenting physical, sensory or physiological disabilities that could prevent clinical exploration, wearers of orthodontic appliances or space maintainers, patients with enamel defects of genetic or environmental origin, patients with dental fractures and patients with premature loss of one or more teeth.

All data collection was carried by two researchers: researcher 1 (LM) and researcher 2 (AL).

Prior to the start of the study, researcher 1 was trained in the clinical assessment of erosive lesions by the BEWE system. Subsequently, the protocol was tested on 25 patients. The results obtained from these patients were not included in the database. This trial allowed the calibration of researcher 1 for the clinical diagnosis of erosive lesions using the BEWE index, obtaining an inter-examiner Kappa value of 0.95.

In the first appointment, researcher 2 evaluated the relevance of inclusion of the child, handed the parents/guardians a brief written description of the study, its objective and the reason the child was selected, together with a consent form and a closed questionnaire containing 20 questions related to possible aetiological factors of dental erosion.

Once the consent form was signed and the questionnaire was completed, researcher 1 performed the clinical examination of the patient, registered the permanent teeth present in the patient's mouth on the odontogram, did a careful dental cleaning using a prophylactic nylon brush, and dried each tooth for 5 seconds to determine the BEWE index first per tooth, then per sextant, and finally calculating the index for each patient (Table 1).

The patient's risk level of developing dental erosion was obtained from the BEWE index, being none (≤ 2), low (3–8), medium (9–13) or high (≥ 14).

The schematic description of the various procedures performed in the study is depicted in Figure 1.

The statistical analysis was conducted using IBM SPSS Statistics 22 statistical package. For the descriptive analysis the number of subjects (n), the mean values, the standard deviation (SD) and percentiles 25, 50 and 75 were used. For the inferential analysis the Mann-Whitney U test was used to correlate the BEWE index with the consumption of medicines, and the Kruskal-Wallis test was used to correlate the BEWE index with the consumption of solid foods and liquids, the frequency of vomiting, nausea and regurgitation, the frequency of swimming, the dietary habits and the

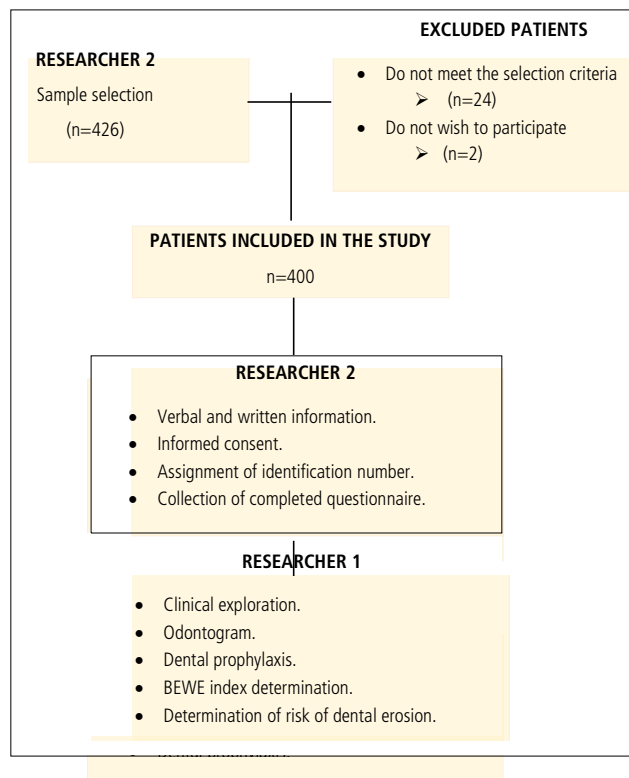


FIG. 1 Outline of the study procedures.

ingestion of solid foods and liquids at night. A confidence level of 95% was established.

Results

Subsequent to the clinical exploration of permanent teeth using the BEWE index, the prevalence of dental erosion in the population (Fig. 2) was 22.3%, noting that 85.2% of the sample did not present a risk of dental erosion.

A statistically significant relationship between weekly fruit consumption and the development of erosive lesions was not observed. However, it was verified that out of the 6 kinds of beverages that were analysed (carbonated beverages, isotonic drinks, fruit juices, fruit juices with dairy, shakes, yogurts and tea) only one statistically significant relationship was established ($p < 0.05$) between the intake of carbonated beverages, isotonic drinks and fruit juices with the BEWE index, presenting a higher BEWE percentage the more times

Score	Criteria
0	No erosion.
1	Initial loss of surface texture.
2*	Loss of less than 50% of the surface area.
3*	Loss of more than 50% of the surface area.
* in scores 2 and 3 dentin often is involved.	

TABLE 1 Scoring criteria for erosive lesions according to the BEWE index.



FIG. 2 Dental erosion was observed on the occlusal surface or first permanent molars and on the vestibular surface of permanent upper incisors.

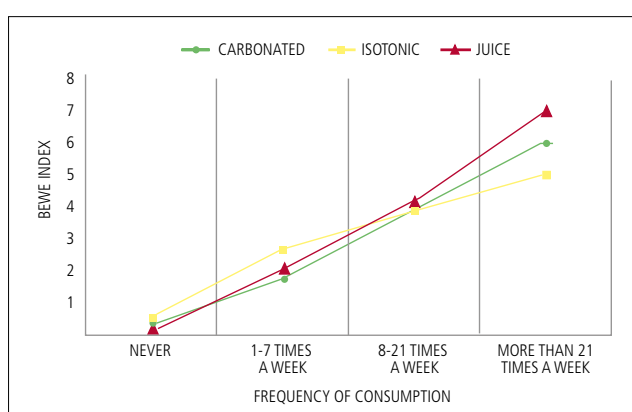


FIG. 3 Relationship between the frequency of consumption of different beverages and the BEWE index.

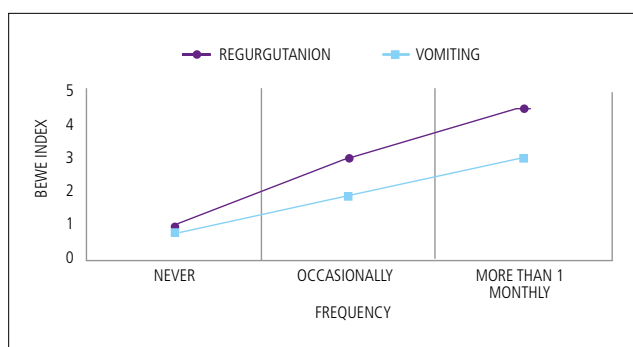


FIG. 4 Relationship between the frequency of vomiting/regurgitation and the BEWE index.

a week these were consumed (Fig. 3).

Regarding the use of medicines that could potentially produce dental erosion, the present study involved patients who used inhalers (5.3%), multivitamins (3.8%), antihistamines (2.8%) and vitamin C (0.5%). The only statistically significant correlation ($p=0.006$) with the BEWE index was found in the case of inhalers.

When analysing the relationship between the frequency of vomiting, nausea and regurgitation and the BEWE index, it was observed that only vomiting and regurgitation

presented a statistically significant correlation ($p<0.001$) as their frequency increased over time (Fig. 4).

In order to examine their oral hygiene habits, participants in the study were asked about the frequency and duration of their daily toothbrushing; it was noted that these did not present a statistically significant relationship with the BEWE index and thus, with the development of dental erosion.

When assessing the relationship between the frequency of patients who went swimming and the BEWE index, a statistically significant correlation ($p<0.001$) was observed between both variables.

When analysing the data on dietary habits a statistically significant relationship ($p<0.001$) was observed (Table 2) between the BEWE index and the prolonged maintenance of food in mouth.

Participants who consumed fruit juices at night presented a statistically significant relationship ($p<0.001$) with the presence of dental erosion, showing an average BEWE index of 4.714, with 25% of the patients presenting a BEWE index of 9.

In order to analyse the existing relationship between the BEWE index and factors related to the participants' socioeconomic status, the parents' level of studies and the type of school the participants attended were considered, finding a statistically significant relationship with the BEWE index, showing more dental erosion in children of low socioeconomic status ($p<0.05$).

Discussion

The present study observed a statistically significant relationship between the presence of dental erosion and the intake of carbonated beverages, isotonic drinks and fruit juices. These results are similar to others found in literature [Chrysanthakopoulos, 2012; Garrocho et al., 2017]. However, some of them only found a positive association with the consumption of fruit juices and carbonated drinks [Habib et al., 2013; Matos et al., 2012], while in others it was only found with the intake of carbonated drinks [Nahas et al., 2011] or with the intake of only fruit juices [Shankar et al., 2012].

When analysing dairy products and tea, the present study observed a low prevalence of dental erosion in patients who consumed these drinks, coinciding with some authors [El Aidi et al., 2011; Nahas et al., 2011], who defend their protective nature.

	Average BEWE	Min BEWE	Max BEWE	BEWE Percentile
Chews and swallows rapidly	0.455±1.2125	0	9	P ₂₅ = 0.000 P ₅₀ = 0.000 P ₇₅ = 0.000
Maintains food and drinks in mouth	1.633 ±2.2937*	0	9	P ₂₅ = 0.000 P ₅₀ P ₇₅ = 3.000*
Consumes drinks with a straw	0.227 ±0.8691	0	4	P ₂₅ = 0.000 P ₅₀ = 0.000 P ₇₅ = 0.000
*Statistically significant				

TABLE 2 Relation between eating habits and the BEWE index.

It was also observed that there was no statistically significant relationship between fruit consumption and the presence of dental erosion, as confirmed previously in some studies [Shankar et al., 2012]. However, it seems that not all fruit has the same erosive potential, and several authors found a positive relationship between the intake of apples, oranges, bananas and grapes with the development of erosive lesions [Chrusanthakopoulos, 2012; Järvinen et al., 1991]. The lack of consensus in the results could be due to the multifactorial nature of the pathology studied, in which every factor is influenced by the others until reaching an equilibrium compatible with health or disease.

The risk of developing dental erosion is also influenced by when and/or how the food is consumed [Mantonanaki et al., 2013]. In the present study a statistically significant association was found between participants who kept food and drinks in their mouths for a longer period than considered normal and the prevalence of dental erosion. Several studies [Chrusanthakopoulos, 2012; Al Hadi et al., 2014] obtained similar results. However, some authors [Bartlett et al., 2013; Nahas et al., 2011] did not find statistically significant differences between keeping drinks in the mouth before their ingestion or rapidly swallowing them and the prevalence of dental erosion. This may be due to the difficulty in estimating the period (in seconds) in which patients keep liquids in their mouths before ingesting them and, thus, questionnaire responses are highly subjective, with scarce objective, quantifiable and reliable data that could allow comparison between data from different studies.

A physiological decrease of salivary flow occurs while sleeping. Consequently, if the patient ingests solid foods and drinks at night, this will significantly increase their erosive potential due to the diminished protective effect of saliva. The data obtained in this study when analysing this variable show a statistically significant relationship between the prevalence of dental erosion and the intake of fruit juices at night. Some authors [Bartlett et al., 2013; Mantonanaki et al., 2013] confirmed this significant association especially when consuming acidic drinks such as carbonated drinks and/or juices, acting primarily on the maxillary incisors.

The relationship observed between the development of dental erosion and the intake of certain medications could be due to the acidic pH of the latter and/or to the decreased salivary flow they produce as a secondary effect [Caglar et al., 2011; Uhlen et al., 2014]. In the current study the

use of inhalers for the treatment of asthma were the only medications presenting a statistically significant relationship with the BEWE index. The data are similar to those found in the literature [Al Hadi et al., 2014; Chrusanthakopoulos, 2012; El Karim et al., 2007]. The discrepancies found between the results from some studies may be because the erosive potential of the medications is related not only to their chemical characteristics, but also to when the intake occurs, and to the time of exposure.

The present study observed that only vomiting and regurgitation presented a statistically significant relationship with the development of dental erosion. This is possibly caused by the frequent contact of acidic substances originating from the oesophagus or the stomach (pH between 2.9 and 5) on the dental tissues [Murakami et al., 2011]. These results are supported by some previous studies [Järvinen et al., 1991; Murakami et al., 2011; Uhlen et al., 2014]. The frequency and duration of emetic episodes are highly significant factors in the development of dental erosion and should therefore always be included in questionnaires. It is observed that studies in which participants were only asked if they suffered from vomiting or regurgitations or not, irrespective of the frequency and duration, tended to be unable to prove their association to dental erosion [Caglar et al., 2011; Järvinen et al., 1991].

When analysing patients' oral hygiene, the present study, like other previous studies [Marqués et al., 2010], observed that neither the frequency nor the duration of toothbrushing presented a statistically significant relationship with the BEWE index, and therefore neither with the development of dental erosion. However, there are studies in the literature reviewed in which a statistically significant relationship was found between the frequency of toothbrushing and dental erosion, observing that children who brushed twice daily were one-third less likely to develop dental erosion compared to those who brushed once daily or not at all [Dawes and Boroditsky, 2008; Murakami et al., 2011]. This could be caused by the toothpastes used in their oral care, which despite presenting a low pH could provide sufficient fluoride content to favour its incorporation into the formation of fluoridated hydroxyapatite, increasing the microhardness of enamel [Buczowska et al., 2013].

Swimming is the sport most frequently linked to the development of dental erosion because of the chlorine used to disinfect swimming pool water, leading to a decreased water pH and, consequently, to a high erosive potential as the frequency and duration of training increase, as proved by several reviewed studies [Edwards et al., 1998]. In the present study, a tendency to an increase in the prevalence of dental erosion was observed when comparing children who only swam in the summer and children who swam once or twice weekly all year round.

The relationship between the family's socioeconomic level and the prevalence of dental erosion is very controversial in the literature and authors do not reach a definitive conclusion in this respect. Some claim that the prevalence of dental erosion does not seem to follow a clear pattern in its association with socioeconomic status [Harding et al., 2003], others defend that habits of intake of solid foods and liquid can be influenced by socioeconomic status and therefore could be a risk factor. In this study, a statistically significant association was found between socioeconomic status, rated by the type of school the child attended and the academic level of the parents, and dental erosion,

showing that children with a lower socioeconomic status presented more dental erosion. There are numerous studies that have not found a significant relationship between the parents' academic level and dental erosion [Caglar et al., 2011; Habib et al., 2013], however, there are authors who did find a significant association between the mother's academic level and dental erosion in the child, observing that the prevalence of the disease decreased as the mother's educational level increased [Asmyhr et al., 2012].

When considering socioeconomic status and its relationship with dental erosion, results are inconclusive, even opposing. Thus, there are authors that evidenced a positive relationship between the prevalence of dental erosion and lower socioeconomic levels [Asmyhr et al., 2012], while others [Al Hadi et al., 2014; Bartlett et al., 2013] proved this disease is more prevalent in patients with greater economic possibilities. These differences could be caused, on the one hand, by a lack of consensus on criteria used to analyse socioeconomic status in the several studies reviewed, and on the other hand, to the fact that both the type of school the children attend and the academic level of their parents are not parameters that directly and exactly assess the family's socioeconomic level, as the monthly family income could, for instance.

The present descriptive transversal study has certain limitations that should not be dismissed, mainly the non-causal association due to the absence of a time sequence, and consequently the impossibility to calculate the incidence rate of the disease. Nevertheless, due to the lack of published data in the studied population, and as a first approach to the health issues it presents, it was considered the most appropriate design and, in the light of the results obtained, it is considered essential to conduct further research of a longitudinal design that take into account the multifactorial nature of this pathology of increasing prevalence.

Conclusions

Of all the studied aetiological factors, the ones that seem to be associated to the development of dental erosion are: 1) the intake of carbonated drinks, isotonic beverages and fruit juices; 2) the nocturnal intake of fruit juices; and 3) the habit of keeping food and drinks in the mouth before swallowing them. The use of inhalers as an acute or chronic treatment for asthma also appears to be an aetiological factor of this disease, in the same way that frequent vomiting and/or regurgitation or habitual, non-sporadic swimming are. Family socioeconomic level appears as a risk factor in the development of erosive lesions, observing more dental erosion in children with lower socioeconomic levels.

Conflict of interest

The authors declare no conflict of interest.

References

- › Al Hadi A, Zawaideh FI, Al Hadithy RT. Risk indicators associated with dental erosion among Jordanian school children aged 12-14 years of age. *Int J Paediatr Dent* 2014; 24:56-68.
- › Asmyhr O, Grytten J, Holst D. Occurrence of risk factors for dental erosion in the population of young adults in Norway. *Community Dent Oral Epidemiol* 2012; 40:425-31.
- › Bartlett D, Ganss C, Lussi A. Basic erosive wear examination (BEWE): a new scoring system for scientific and clinical needs. *Clin Oral Invest* 2008; 12:65-8.
- › Bartlett DW, Lussi A, West NX, Bouchard P, Sanz M, Bourgeois D. Prevalence of tooth wear on buccal and lingual surfaces and possible risk factors in young European adults. *J Dentistry* 2013; 41:1007-13.
- › Buczkowska J, Lagocka R, Kaczmarek W, Gorski M, Nowicka A. Prevalence of dental erosion in adolescent competitive swimmers exposed to gas-chlorinated swimming pool water. *Clin Oral Invest* 2013; 17:579-83.
- › Caglar E, Sandall N, Panagiotou N, Tonguc K, Kuscü OO. Prevalence of dental erosion in Greek minority school children in Istanbul. *Eur Arch Paediatr Dent* 2011; 12:267-71.
- › Ceyhan D, Akdik C, Kirzioglu Z. An educational programme designed for the evaluation of effectiveness of two tooth brushing techniques in preschool children. *Eur J Paediatr Dent* 2018; 19(3):181-6.
- › Chrysanthakopoulos NA. Prevalence of tooth erosion and associated factors in 13-16 years old adolescents in Greece. *J Clin Exp Dent* 2012; 4:60-6
- › Dawes C, Boroditsky CL. Rapid and severe tooth erosion from swimming in an improperly chlorinated pool: case report. *JCDA* 2008; 74:359-61
- › Edwards M, Ashwood RA, Littlewood SJ, Brocklebank LM, Fung DE. A videofluoroscopic comparison of straw and cup drinking: the potential influence on dental erosion. *British Dent J* 1998; 185:244-9
- › El Aidi H, Bronkhorst EM, Huysmans MCD, Truin GJ. Multifactorial analysis of factors associated with the incidence and progression of erosive tooth wear. *Caries Res* 2011; 45:303-12.
- › El Karim LA, Sanhoury NM, Hashim NT, Ziada HM. Dental erosion among 12-14 years old school children in Khartoum: A pilot study. *Community Dent Health* 2007; 24:176-80.
- › Esber C, Kagul B, Tanboga I, Lussi A. Dental erosion among children in an Istanbul public school. *JDC* 2005; 72:5-9.
- › Garrocho A, Rosales MA, Pozos A. Significance of observational studies in clinical paediatric Dentistry research. *Eur J Paediatr Dent* 2017; 18(3):213-20.
- › Habib M, Hottel TL, Hong L. Prevalence and risk factors of dental erosion in American children. *J Clin Pediatr Dent* 2013; 38:143-8.
- › Harding MA, Whelton H, O'Mullane DM, Cronin M. Dental erosion in 5 years old Irish school children and associated factors: a pilot study. *Community Dent Health* 2003; 20:165-70.
- › Järvinen VK, Tytömaa II, Heinonen OP. Risk factors in dental erosion. *J Dent Res* 1991; 70:942-7.
- › Lussi A, Jaeggi T. Erosion diagnosis and risk factors. *Clin Oral Invest* 2008; 12:5-13.
- › Mantonanaki M, Koletsis H, Mamai E, Papaioannou W. Dental erosion prevalence and associated risk indicators among preschool children in Athens, Greece. *Clin Oral Invest* 2013; 17:585-93.
- › Marqués H, Rios D, Ferreira C, Rabelo MA, Moreira MA. Influence of dental plaque on human enamel erosion: in situ/ex vivo study. *Oral Health Prev Dent* 2010; 8:179-84.
- › Matos GK, Brandao CA, Nahas F, Procida D, Nahas MS. Erosive potential of different types of grape juices. *Braz Oral Res* 2012; 26:457-63.
- › Mika A, Mitus-Kenig M, Zeglen A, Drapella-Gasior D, Rutkowska K, Josko-Ochojska J. The child's first dental visit. Age, reasons, oral health status and dental treatment needs among children in Southern Poland. *Eur J Paediatr Dent* 2018; 19(4):265-70.
- › Murakami C, Oliveira LB, Sheiham A, Nahas MS, Haddad AE, Bönecker M. Risk indicators for erosive tooth wear in Brazilian preschool children. *Caries Res* 2011; 45:121-9.
- › Nahas MS, Correa P, Nahas F, Nahas JP, Murakami C, Medeiros F. Prevalence and associated factors of dental erosion in children and adolescents of a private dental practice. *Int J Paediatr Dent* 2011; 21:451-8.
- › Paduano S, Rongo R, Bucci R, Aiello D, Carvelli G, Ingenito A, et al. Is there an association between various aspects of oral health in Southern Italy children? An epidemiological study assessing dental decays, periodontal status, malocclusions and temporomandibular joint function. *Eur J Paediatr Dent* 2018; 19(3):176-80.
- › Plczak-Kowalczyk D, Danko M, Banas E, Gozdowski D, Popinska K, Krasuska-Slawinska E, et al. Parenteral nutrition in childhood and consequences for dentition and gingivae. *Eur J Paediatr Dent* 2017; 18(3):69-76.
- › Salas M, Nascimento GG, Huysmans MC, Demarco FF. Estimated prevalence of erosive tooth wear in permanent teeth of children and adolescents: An epidemiological systematic review and meta-regression analysis. *J Dent* 2015; 43: 42-50.
- › Shankar S, Ankola A, Ashokkumar BR, Hebbal MI. Association of erosion with dietary factors among 5 years old children in India. *J Dent Child* 2012; 79:122-9.
- › Stenhagen KR, Berntsen I, Odegaard M, Mulic A, Tveit AB. Has the prevalence and severity of dental erosion in Norway changed during the last 30 years? *Eur J Paediatr Dent* 2017; 18(3):177-82.
- › Uhlen MM, Tveit AB, Mulic A. Self induced vomiting and dental erosion - a clinical study. *BMC Oral Health* 2014; 14:92-8.