

ORIGINAL RESEARCH

Risk indicators for the severity of erosive wear in deciduous dentition of Mexican schoolchildren aged 5 to 7 years

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Abstract

The objective of this work was to estimate the prevalence and severity of erosive tooth wear (ETW), and to identify risk indicators of deciduous dentition of a group of schoolchildren from public schools in Tlalnepantla de Baz, State of Mexico. A cross-sectional study was carried out in 352 schoolchildren from 5 to 7 years old. The severity of the ETW was evaluated using the Basic Erosive Wear Examination (BEWE). Risk indicators were evaluated through a survey which included food and beverage consumption, consumption habits, vitamin C consumption, gastroesophageal reflux, heartburn, belching, xerostomia, vomiting and teeth grinding. Multinomial logistic regression models were fitted. The prevalence of ETW was 99.7% (n = 351). Regarding severity, 46.6% were at a null/mild level, 27.3% moderate, and 26.1% severe. Males were more likely to present severe ETW (odds ratio (OR) = 2.23, 95% confidence interval (CI), 1.27–3.93; $p = 0.005$). The risk indicators for the severity of ETW were the frequent consumption of citrus fruits (OR = 2.09, 95% CI, 1.12–3.89; $p = 0.021$), fruit juice (OR = 1.99, 95% CI, 1.06–3.75; $p = 0.033$), processed beverages (OR = 2.15, 95% CI, 1.23–3.78; $p = 0.008$) and hot sauce (OR = 1.82, 95% CI, 1.03–3.20; $p = 0.036$). The prevalence of ETW in the deciduous dentition was very high (99.7%) and ~1/3 for severe ETW. The dietary factors associated with severe ETW are part of the regular consumption of Mexican school-age children, which impact their oral health condition. It is important to establish intervention strategies from the infant stage, focused on both children and their caregivers.

Keywords

Erosive dental wear; Epidemiology; Deciduous dentition; Severity

1. Introduction

The term erosive tooth wear (ETW) refers to dental wear where tooth erosion is the main etiological factor, and is defined as the chemical (dental erosion) and mechanical (attrition and abrasion) process, that results in the cumulative loss of dental hard tissue not caused by bacteria [1].

Deciduous dentition presents anatomical and histological characteristics that increase the risk of presenting lesions because of ETW. Deciduous teeth have thinner and more porous enamel compared to permanent teeth [2]. Therefore, the tissue loss includes dentin, resulting in more severe lesions compared to permanent teeth [3].

In general, the enamel of deciduous teeth is considerably less mineralized than permanent teeth [4], and has less hardness [5]. Also, it has been shown that, under acid attack, the enamel of deciduous teeth is lost faster than permanent teeth [6]. These differences mean that deciduous teeth have a disadvantage against dissolution compared to permanent teeth [2].

Although there are only few reports on the prevalence of ETW in deciduous teeth, it has been estimated that it is between 30–50% worldwide, having higher ranges than those reported in permanent dentition (20–41%) [7]. This can also be observed in the severity of the wear, since a higher frequency of ETW has been detected in deciduous dentition than in permanent dentition, with 21–48% and 2–30%, respectively [8–10].

The acids that cause ETW come from two sources: extrinsic if it comes from the diet and medications with low pH [11, 12], or intrinsic when it comes from the gastric juice that travels through the esophagus and comes into contact with the dental tissues in the oral cavity [1]. Some risk indicators for ETW in deciduous dentition are frequent consumption of chewable vitamin C tablets [13], and suffering from gastroesophageal reflux [14]. However, frequent consumption of an acidic diet has been the most reported risk indicator, specifically the consumption of acidic beverages [15–17].

Acid beverages such as fruit juices (natural and artificial)

and soft drinks are highly consumed by Mexican children [18]. In the 2022 National Health Survey (in Spanish, ENSANUT), it was shown that between 82.6% and 93.6% of Mexican children consume sweetened beverages, where this type of acidic beverages is classified [19].

Considering this important risk indicator for the development of ETW and that there are high prevalence data in permanent dentition (62.5%) and mixed dentition (62.0%) [20, 21], the objective of this study was to estimate the prevalence and severity of ETW, and to identify risk indicators in deciduous dentition of a group of schoolchildren from public schools in Tlalnepantla de Baz, State of Mexico. The hypothesis is that food and beverage consumption, vitamin C consumption, gastroesophageal reflux, heartburn, headache, xerostomia, vomiting and teeth grinding will be risk indicators of the presence of severe ETW.

2. Materials and methods

This is a cross-sectional study conducted in first grade schoolchildren from public elementary schools in the municipality of Tlalnepantla de Baz, State of Mexico, and it was carried out between October 2021 and June 2022. The study was carried out under the guidelines established in the Strengthening Reporting of Observational Studies in Epidemiology.

2.1 Participants

The municipality of Tlalnepantla de Baz has a population of 672,202 of which 3% are between 5–9 years old. It has a population of 148,924 people aged 5 and over, who attend school. On average, the population has 10.9 years of schooling, 30.1% of the population has a university education, an average of 3.3 people live in a household, and 71.1% of the population is a beneficiary of some health service. According to the National Population Council (in Spanish, CONAPO), the marginalization index of the Municipality is “very low”. The municipality has 196 public elementary schools with a first-grade students’ group each. Each first grade group has 15 students on average [22, 23].

The sample size was estimated based on a known prevalence of 32% obtained from a previous study with an age-matched population [24]. Considering an error of 5 percentual points of the real value and a 95% confidence level, the result was $n = 323$ participants. Considering a non-response rate of 20%, a total of 391 schoolchildren were invited. A probabilistic sampling by conglomerates was carried out, considering each first-grade students’ group of public elementary schools of Tlalnepantla de Baz, a conglomerate. Twenty-six first-grade students’ groups were selected to reach the necessary sample size. The selection was carried out randomly through the statistical program Stata v. 17 (StataCorp, College Station, TX, USA).

Schoolchildren who presented a health condition that prevented dental evaluation or who wore fixed orthodontic appliances that prevented the student’s oral examination were excluded ($n = 2$).

2.2 Variables

The dependent variable was defined based on the Basic Examination for Erosive Wear (BEWE) criteria. To obtain the BEWE scores, each dental sextant was evaluated, and the total sum was obtained [25, 26]. BEWE scores were categorized as: none/mild (0–8), moderate (9–13) and severe (≥ 14) [27]. The independent variables (risk indicators) were: food and beverage consumption (citrus fruits, non-citrus fruits, fruit juices, milk, yogurt, processed beverages, sweets, hot sauce and ketchup), consumption habits (lemon sucking, consumption of acidic drinks while doing sports, consumption of acidic drinks before sleeping, keeping or swirling drinks in the mouth), vitamin C consumption, gastroesophageal reflux, heartburn, belching, suffering from xerostomia, vomiting and teeth grinding. During the application of the survey, the answer was considered as “Yes”, if it was experienced it at least once a week. The following variables were also included: age, sex, frequency of teeth brushing (1 time/2 times/3 times or more) and the simplified oral hygiene index (OHI-S Acceptable/Deficient) [28].

2.3 Data collection

2.3.1 Survey

Information about diet and health was collected from an adapted survey, from the one used in a previous study [29], and which was validated for this study. Content and construct validity was evaluated in 26 schoolchildren (different from the study sample), obtaining a correlation (Spearman’s rho) of 0.799 ($p < 0.001$), and an area under the receiver operating characteristic (ROC) curve of 0.96. Internal consistency and test-retest reliability were evaluated, obtaining a Cronbach’s alpha coefficient of 0.80 and an agreement percentage of 80%, between applications.

The survey was answered by the main caregiver of each child through an interview. The interviewers were trained and standardized for the application of the survey, so that they did not influence the answers of the interviewees. Table 1 presents the questions comprising the survey.

2.3.2 Dental evaluation

Dental evaluation was performed by a standardized examiner (MAVO) to detect ETW lesions using the BEWE index (the risk level category), and oral hygiene using the OHI-S. Standardization consisted of theoretical and practical sessions with models, photographs and participants different from the study sample, but of similar age. Subsequently, inter-rater reliability against the gold standard (AEGAP) and intra-rater reliability were evaluated in 18 participants. Kappa coefficients >0.8 were obtained.

For the dental evaluation, the participant laid down on a school table and a portable artificial light was used to illuminate the oral cavity. First, oral hygiene was evaluated and then the presence and severity of ETW. For the examination, a PCP11 probe (Hu-Friedy, Chicago, Ill., USA), a dental mirror (Arain, Sialkot, Punjab, Pakistan) and gauze were used.

According to the OHI-S for oral hygiene, the buccal surfaces of teeth 55, 51, 65 and 71 and the lingual surfaces of 75 and

TABLE 1. Questions of the survey made to the main caregiver of the child.

Variable	Question	Answer
Lemon sucking	Does your child like to suck lemon?	No/Yes
Consumption of acidic beverages while playing sports	Does your child consume acidic drinks (e.g., soft drinks, sports drinks) during or after sports activities?	No/Yes
Consumption of acidic drinks before sleeping	Does your child drink any acidic drinks just before sleeping?	No/Yes
Keeping or swirling drinks in the mouth	When your child consumes any kind of drink, does he/she keep or swirl in his or her mouth before swallowing?	No/Yes
Food and beverage consumption	How often does your child consume the following foods and beverages: citrus, non-citrus fruits, fruit juices, milk, flavored milk, plain yogurt, fruit yogurt, soft drinks, sports drinks, and artificial juices?	Never/One day/Some days (2–4 days)/Most days (5–7 days)/Several times a day
Vitamin C consumption	How often does your child consume vitamin C effervescent tablets/chewable tablets?	Never/One day/Some days (2–4 days)/Most days (5–7 days)/Several times a day
Gastroesophageal reflux	Has a doctor or health professional diagnosed your child with gastroesophageal reflux?	No/Yes
Heartburn	Have you ever noticed that your child has heartburn?	No/Yes
Belching	Have you ever noticed that your child belches a lot?	No/Yes
Xerostomia	Has your child ever told you that he has a dry mouth?	No/Yes
Vomiting	Have you noticed that your child vomits frequently?	No/Yes
Frequency of teeth brushing	How many times a day does your child brush his/her teeth?	1 time/2 times/3 times or more
Teeth grinding	Does your child grind his teeth while sleeping or while awake?	No/Yes

85 were evaluated. If any were absent, a contiguous tooth was evaluated [28].

For the ETW, the examiner evaluated all deciduous teeth present from the buccal, palatal/lingual and occlusal/incisal surfaces. The examiner identified the ETW according to the following codes: 0: when there was no evidence of erosion, 1: initial loss of enamel, 2: distinctive defect less than 50% of the surface, and 3: distinctive defect greater than 50% of the surface. In case of doubt between two criteria, the examiner chose the lower criterion. If the tooth surface presented any extensive restoration ($>1/3$), the surface was excluded.

2.4 Data analysis

The data was recorded in the EpiData Entry 3.1 program (EpiData Association, Odense, Denmark) and analyzed with the Stata v. 17 software.

The severity of ETW and the distribution of risk indicators were obtained. Subsequently, a bivariate analysis was performed between the ETW severity and the independent variables (risk indicators). For the bivariate analysis, the Chi-square test was used and a value of $p < 0.05$ was considered statistically significant.

Multiple models for ETW severity were fitted using multinomial logistic regression. The value of $p \leq 0.35$ was established to include the variable in the model and the biological plausibility (all adjusted according to the number of examined

deciduous teeth). Odds ratios (OR) and 95% confidence intervals (CI) were calculated. A statistically significant result was considered if the 95% confidence interval did not include one and a value of $p < 0.05$. Finally, possible interactions between the associated variables were sought.

3. Results

Of the 391 children who were invited to participate, 352 accepted. The non-response rate was 10% ($n = 39$) where the main cause of refusal was fear of contagion by Sars-Cov-2 (COVID-19).

The ages of the 352 children ranged from 5 to 7 years, with a mean of 6.17 ± 0.45 years. The mean number of deciduous teeth present was 17.49 ± 2.06 , with a median of 18 and a minimum of 12 teeth.

3.1 Erosive tooth wear

The prevalence of ETW was 99.7% ($n = 351$). The mean BEWE score was 9.80 ± 4.80 (Minimum: 0–Maximum: 18) for all children. Regarding severity, 46.6% were at a null/mild level (BEWE score: 0–8), 27.3% moderate (BEWE score: 9–13) and 26.1% severe (BEWE score ≥ 14).

All 5-year-old children ($n = 11$) presented null or mild severity, 23.8% of 6-year-old schoolchildren presented severe ETW, compared to 38.8% of 7-year-old schoolchildren ($p <$

TABLE 2. Severity of erosive tooth wear according to age and sex.

Variable	Total (%)	Null/mild (%)	Moderate (%)	Severe (%)	<i>p</i> *
Age					
5-year-old	11 (100)	11 (100.0)	0 (0.0)	0 (0.0)	
6-year-old	269 (100)	131 (48.7)	74 (27.5)	64 (23.8)	<0.001
7-year-old	72 (100)	22 (30.6)	22 (30.6)	28 (38.8)	
Sex					
Male	168 (100)	72 (42.9)	42 (25.0)	54 (32.1)	0.050
Female	184 (100)	92 (50.0)	54 (29.4)	38 (20.6)	
Total (%)	352 (100)	164 (46.6)	96 (27.3)	92 (26.1)	

**Chi-square test.*

0.001). Regarding sex, 32.1% of males presented severe ETW, compared to 20.6% in females ($p = 0.050$). Table 2 shows the severity of ETW according to age and sex.

3.2 Risk indicators

The prevalence of severe ETW was higher in schoolchildren with frequent consumption of citrus fruits (30.4% vs. 18.4%), fruit juices (36.4% vs. 22.7%), and processed drinks (34.8% vs. 20.9%) ($p < 0.05$). No differences were found in the prevalence of severe ETW regarding the consumption of non-citrus fruits, natural milk, flavored milk, natural yogurt, fruit yogurt, sweets and ketchup ($p > 0.05$) (Table 3).

No significant differences were observed according to consumption habits, vitamin C consumption, gastroesophageal reflux, suffering from heartburn, belching, xerostomia, vomiting, grinding teeth, brushing frequency and the simplified oral hygiene index regarding ETW severity ($p > 0.05$) (Table 4).

3.3 Multiple analysis

In the multinomial logistic regression model, the variables age, sex, citrus fruits, non-citrus fruits, fruit juice, flavored milk, processed drinks, sweets, hot sauce, consumption of erosive drinks while doing sports, consumption of erosive drinks before bedtime, heartburn, vomiting, reflux, hygiene and teeth grinding were included.

The final model showed that for each year in the children's age, the odds of presenting moderate ETW increased by more than twice (OR = 2.46, 95% CI, 1.32–4.57; $p = 0.004$) and the odds increased four times for severe ETW (OR = 4.04, 95% CI, 2.10–7.79; $p < 0.001$). Males had twice the odds of presenting severe ETW compared to females (OR = 2.23, 95% CI, 1.27–3.93; $p = 0.005$).

Schoolchildren who had frequent consumption of citrus fruits (OR = 2.09, 95% CI, 1.12–3.89; $p = 0.021$) and processed beverages (OR = 2.15, 95% CI, 1.23–3.78; $p = 0.008$) were twice as likely to suffer from severe ETW.

Those who frequently consumed natural fruit juice (OR = 1.99, 95% CI, 1.05–3.75; $p = 0.033$) and hot sauce (OR = 1.82, 95% CI, 1.03–3.20; $p = 0.036$) had 99% and 82% higher odds of presenting severe ETW, respectively (Table 5).

4. Discussion

According to the present study, in a representative sample from the State of Mexico, almost all children with deciduous dentition (99.7%) had ETW, with a 26.1% presenting severe ETW. In Mexico, there are a few studies that report the prevalence of ETW in deciduous dentition. In children from 6 to 12 years in Mexico City, a prevalence of 62% in mixed dentition was reported [21].

Worldwide, ETW has been detected, for example, in five-year-old children from Norway a prevalence of ETW in the deciduous dentition of 80% was reported [30], also, in Colombian children from two to five years of age, a prevalence of 100% was reported in the deciduous dentition [31] and in six-year-old children from Greece, a prevalence of 78.8% using the BEWE index was found [32]. Similar results were found in the present study.

The variation in the prevalence of ETW in deciduous dentition could be explained by different criteria for its diagnosis and the impact of different risk indicators between populations [14, 33].

Likewise, in the present study, several factors were related to the prevalence of severe ETW in children in deciduous dentition, including age, sex, consumption of citrus fruits, fruit juices and hot sauce. It has been observed that as age increases, the severity of ETW increases. It was observed that for each year of increase in age, the probability of presenting moderate ETW increased more than two times (OR = 2.46) and four times (OR = 4.04) for severe ETW in deciduous dentition. The results observed in the present study confirm previous findings showing that the severity of dental wear is proportionally related to the increase in age and is related to a longer exposure to acids [31, 34].

Another variable found to be associated with the severity of ETW in the deciduous dentition was sex (OR = 2.23). Regarding sex, several studies carried out on permanent dentition have reported a greater presence of ETW in males, which is consistent with the present study [14, 15]. Bite force, which has been proven to be greater in males than in females [35], may account for these variations.

Erosive tooth wear is highly variable, some people experience total tooth destruction and others maintain most of their dental structure throughout their lives, it is likely that other factors are related to ETW which could help to explain some

TABLE 3. Severity of erosive tooth wear according to the frequent consumption* of food and beverages.

Variable	Total (%)	Null/mild (%)	Moderate (%)	Severe (%)	<i>p</i> **
Citrus fruits [§]					
No	125 (100)	64 (51.2)	38 (30.4)	23 (18.4)	0.049
Yes	227 (100)	100 (44.0)	58 (25.6)	69 (30.4)	
Non-citrus fruits [†]					
No	285 (100)	127 (44.6)	80 (28.0)	78 (27.4)	0.280
Yes	67 (100)	37 (55.2)	16 (23.9)	14 (20.9)	
Fruit juices					
No	264 (100)	135 (51.2)	69 (26.1)	60 (22.7)	0.007
Yes	88 (100)	29 (32.9)	27 (30.7)	32 (36.4)	
Milk					
No	97 (100)	47 (48.4)	22 (22.7)	28 (28.9)	0.468
Yes	255 (100)	117 (45.9)	74 (29.0)	64 (25.1)	
Flavored milk					
No	179 (100)	81 (45.3)	45 (25.1)	53 (29.6)	0.297
Yes	173 (100)	83 (48.0)	51 (29.5)	39 (22.5)	
Natural yogurt					
No	318 (100)	149 (46.9)	85 (26.7)	84 (26.4)	0.777
Yes	34 (100)	15 (44.1)	11 (32.4)	8 (23.5)	
Fruit yogurt					
No	298 (100)	136 (45.6)	80 (26.9)	82 (27.5)	0.382
Yes	54 (100)	28 (51.9)	16 (29.6)	10 (18.5)	
Processed drinks [§]					
No	220 (100)	110 (50.0)	64 (29.1)	46 (20.9)	0.016
Yes	132 (100)	54 (41.0)	32 (24.2)	46 (34.8)	
Sweets					
No	95 (100)	52 (54.7)	23 (24.2)	20 (21.1)	0.166
Yes	257 (100)	112 (43.6)	73 (28.4)	72 (28.0)	
Hot sauce					
No	213 (100)	104 (48.8)	62 (29.1)	47 (22.1)	0.097
Yes	139 (100)	60 (43.2)	34 (24.4)	45 (32.4)	
Ketchup					
No	313 (100)	148 (47.3)	84 (26.8)	81 (25.9)	0.756
Yes	39 (100)	16 (41.0)	12 (30.8)	11 (28.2)	
Total (%)	352 (100)	164 (46.6)	96 (27.3)	92 (26.1)	

*Greater than or equal to 5 days of consumption, **Chi-square test. [§]Lemon, orange, tangerine and grapefruit,

[†]Pineapple, Grape, Strawberry, and Tamarind, [§]Soft drinks, sports drinks and artificial juices.

TABLE 4. Severity of erosive tooth wear according to consumption habits, vitamin C, gastroesophageal reflux, heartburn, belching, xerostomia, vomiting, teeth grinding and hygiene.

Variable*	Total (%)	Null/mild (%)	Moderate (%)	Severe (%)	<i>p</i> **
Lemon sucking					
No	207 (100)	96 (46.4)	56 (27.0)	55 (26.6)	0.975
Yes	145 (100)	68 (46.9)	40 (27.6)	37 (25.5)	
Acidic drinks while doing sports					
No	309 (100)	148 (47.9)	79 (25.6)	82 (26.5)	0.151
Yes	43 (100)	16 (37.2)	17 (39.5)	10 (23.3)	
Acidic drinks before sleeping					
No	290 (100)	130 (44.8)	79 (27.3)	81 (27.9)	0.209
Yes	62 (100)	34 (54.8)	17 (27.4)	11 (17.8)	
Keeping or swirling drinks in the mouth					
No	235 (100)	107 (45.5)	69 (29.4)	59 (25.1)	0.452
Yes	117 (100)	57 (48.8)	27 (23.0)	33 (28.2)	
Effervescent Vitamin C					
No	295 (100)	136 (46.1)	8 (27.8)	77 (26.1)	0.870
Yes	57 (100)	28 (49.1)	14 (24.6)	15 (26.3)	
Chewable Vitamin C					
No	264 (100)	125 (47.4)	70 (26.5)	69 (26.1)	0.838
Yes	88 (100)	39 (44.3)	26 (29.6)	23 (26.1)	
Gastroesophageal reflux					
No	321 (100)	150 (46.7)	90 (28.1)	81 (25.2)	0.380
Yes	31 (100)	14 (45.2)	6 (19.3)	11 (35.5)	
Heartburn					
No	307 (100)	140 (45.6)	89 (29.0)	78 (25.4)	0.166
Yes	45 (100)	24 (53.3)	7 (15.6)	14 (31.1)	
Belching					
No	313 (100)	144 (46.0)	87 (27.8)	82 (26.2)	0.781
Yes	39 (100)	20 (51.2)	9 (23.1)	10 (26.6)	
Xerostomia					
No	266 (100)	125 (47.1)	72 (27.0)	69 (25.9)	0.965
Yes	86 (100)	39 (45.4)	24 (27.9)	23 (26.7)	
Vomiting					
No	341 (100)	160 (46.9)	94 (27.6)	87 (25.5)	0.332
Yes	11 (100)	4 (36.4)	2 (18.2)	5 (45.4)	
Teeth grinding					
No	214 (100)	99 (46.3)	58 (27.1)	57 (26.6)	0.965
Yes	138 (100)	65 (47.1)	38 (27.5)	35 (25.4)	
Frequency of teeth brushing					
1 time	89 (100)	43 (48.3)	21 (23.6)	25 (28.1)	0.925
2 times	157 (100)	73 (46.5)	44 (28.0)	40 (25.5)	
3 times or more	106 (100)	48 (45.3)	31 (29.2)	92 (25.5)	
OHI-S[§]					
Acceptable	246 (100)	117 (47.6)	66 (26.8)	63 (25.6)	0.856
Deficient	106 (100)	47 (44.3)	30 (28.3)	29 (27.4)	
Total (%)	352 (100)	164 (46.6)	96 (27.3)	92 (26.1)	

*Yes = at least once a week, **Chi-square test for all variables and Fisher's exact test for vomiting, [§]Simplified oral hygiene index.

TABLE 5. Crude and adjusted odds ratios (OR) of the multinomial logistic regression model for the severity of erosive tooth wear (ETW).

MODERATE ETW*				
Variable	Crude		Adjusted**	
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Age (Years old)	2.40 (1.32–4.37)	0.004	2.46 (1.32–4.57)	0.004
Sex (Reference = female)	0.99 (0.60–1.65)	0.981	1.07 (0.63–1.81)	0.804
Citrus fruits*** (Reference = no)	0.98 (0.58–1.63)	0.929	0.99 (0.57–1.70)	0.962
Fruit juices (Reference = no)	1.82 (1.00–3.32)	0.050	1.75 (0.94–3.26)	0.080
Processed drinks [§] (Reference = no)	1.02 (0.60–1.74)	0.946	0.99 (0.57–1.71)	0.971
Hot sauce (Reference = no)	0.95 (0.56–1.61)	0.850	0.94 (0.54–1.61)	0.820
Gastroesophageal reflux (Reference = no)	0.71 (0.26–1.92)	0.506	0.62 (0.22–1.72)	0.362
OHI-S [†] (reference = acceptable)	1.13 (0.65–1.96)	0.659	0.96 (0.54–1.70)	0.902
Teeth grinding (Reference = no)	1.00 (0.60–1.68)	0.994	1.02 (0.60–1.73)	0.943
SEVERE ETW*				
Variable	Crude		Adjusted**	
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Age (Years old)	3.36 (1.85–6.10)	<0.001	4.04 (2.10–7.79)	<0.001
Sex (Reference = female)	1.82 (1.08–3.04)	0.024	2.23 (1.27–3.93)	0.005
Citrus fruits*** (Reference = no)	1.92 (1.09–3.38)	0.024	2.09 (1.12–3.89)	0.021
Fruit juices (Reference = no)	2.48 (1.38–4.47)	0.002	1.99 (1.05–3.75)	0.033
Processed drinks [§] (Reference = no)	2.03 (1.21–3.43)	0.008	2.15 (1.23–3.78)	0.008
Hot sauce (Reference = no)	1.66 (0.99–2.79)	0.055	1.82 (1.03–3.20)	0.036
Gastroesophageal reflux (Reference = no)	1.45 (0.63–3.35)	0.379	1.26 (0.51–3.12)	0.613
IHO-S [†] (Reference = acceptable)	1.14 (0.65–1.99)	0.631	0.98 (0.53–1.83)	0.972
Teeth grinding (Reference = no)	0.93 (0.55–1.59)	0.802	0.97 (0.55–1.72)	0.933

*Reference: Null/mild ETW, **Adjusted according to number of examined deciduous teeth, ***Lemon, orange, tangerine, and grapefruit, §Soft drinks, sports drinks and artificial juices, †Simplified oral hygiene index. ETW: erosive tooth wear; OR: odds ratios; CI: confidence intervals.

of the variability in the results. One of them is the frequent and excessive consumption of citrus fruits in the form of lemon and orange juice and soft drinks and citrus drinks. In the present study, children who had a frequent consumption of citrus fruits (OR = 2.09) and processed drinks (OR = 2.15) were twice as likely to present severe ETW, similarly, those children who consumed natural fruit juice (OR = 1.99) and hot sauce (OR = 1.82). This can be explained by the fact that the ingredients of the hot sauce include vinegar, which has been demonstrated to have erosive potential on dental tissue [36]. The findings of the current study are consistent with prior research, which have linked ETW to the frequent consumption of fruit juices and soft drinks [14].

In Mexico, the consumption of hot sauces is usually accompanied by food and snacks with lemon. A recent study conducted in Mexican schoolchildren reports that the consumption of food and snacks accompanied with chili and lemon is associated with the prevalence of ETW (OR = 1.59; 95% CI: 1.07–2.38; $p = 0.023$) [21].

The relationship found between processed beverages and ETW could be due to unusual eating, drinking, or swallowing habits, since during feeding, children could hold the acidic beverage in the oral cavity before swallowing it, increasing the exposure time of the acid substance on the teeth and therefore, increasing the risk of erosion [37]. Previous studies have shown that the pH and buffering capacity of soft drinks determine their erosive potential, which in turn contributes to erosive tooth wear [13].

Even though in the present study, no association was found between the consumption of acidic beverages before bedtime and the severity of ETW ($p = 0.209$). Studies have reported that increased consumption of acidic fruit juices, fruit drinks, and carbonated beverages may be causing an increase in the prevalence of ETW, especially in children and teenagers [14, 20, 38].

Few studies have found an association between ETW and teeth grinding, gastric reflux and/or vomiting. In children with special needs, an association was found between gastric reflux (OR = 2.24) and the presence of ETW [38], likewise vomiting (OR = 3.27) in children from six to 16 years old, and gastric reflux (OR = 3.21) were shown to be associated with ETW [39]. In the present study, no association was found between the presence of reflux and ETW. The reason for not finding an association could be due to the fact that previous studies focus on adolescents and adults with permanent dentition [40].

One of the limitations of this study is its cross-sectional design since it is not possible to determine the cause-effect relationship of the independent variables with the ETW. Another limitation is that various studies have used different criteria for the diagnosis of ETW and this makes it difficult to compare its prevalence and severity [14]. Finally, future studies should consider measuring bite force.

An advantage of the present study was that the evaluation of the ETW was carried out through the BEWE index, which is an easy-to-use index and is currently used in various studies, making the present study comparable with similar studies worldwide. The BEWE is easy to use and has good acceptance for epidemiological studies. The required levels of validity, reliability, sensitivity, and specificity provided by the BEWE

have been demonstrated [25, 26].

In a 5-year follow-up, Ganss *et al.* [41], reported that subjects with ETW in their deciduous dentition had an increased risk (relative risk of 3.9) of ETW in their permanent teeth. This highlights the need to provide children with comprehensive dental care, early diagnosis by general dentists and specialists, identifying the main etiological factors involved and implementing relevant preventive measures.

Future studies should focus on designing strategies to educate children and their parents and/or caregivers about the care and preservation of teeth in the face of possible acid attacks that may occur throughout their lives.

5. Conclusions

The prevalence of ETW in deciduous dentition was very high (99.7%) and ~1/3 was severe. The dietary factors associated with severe ETW are part of the regular consumption of Mexican school-age children, which impact their oral health condition.

Given that children who present ETW in the deciduous dentition have a high risk of presenting it in their permanent dentition, it is important to establish intervention strategies from the infant stage, focused on both children and their caregivers.

ABBREVIATIONS

ETW, erosive tooth wear; BEWE, Basic Erosive Wear Examination; OHI-S, simplified oral hygiene index; OR, odds ratios; CI, confidence intervals.

AVAILABILITY OF DATA AND MATERIALS

The data is available upon request. Please write to the corresponding author.

AUTHOR CONTRIBUTIONS

MFVO, SABY and AEGAP—designed the research study. MFVO and AEGAP—performed the research; analyzed the data; wrote the manuscript. SABY and AL—reviewed the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The research protocol was submitted to the Ethics and Research Committee of the Faculty of Dentistry, of the National Autonomous University of Mexico, who approved the study protocol (CIE/0505/11/2021), and to the Ethics Committee of the Faculty of Higher Education Iztacala, of the National Autonomous University of Mexico (CE/FESI/052020/135). The parents or guardians who agreed to participate signed an informed consent form, and the students were asked for their assent.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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