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ORIGINAL ARTICLE

Relationship between erosive tooth wear and possible etiological factors among dental students

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Abstract

Objectives The aim of this study was to assess the relationship between erosive tooth wear (ETW) and possible etiological factors in a group of dental students.

Materials and methods A total of 126 dental students from a public dental school were included in this study. A questionnaire was used to investigate the possible etiological factors related to ETW. The Basic Erosive Wear Examination (BEWE) criteria were used to examine the status of ETW. A univariable and multivariable logistic regression models were used to assess the relationship between the presence of ETW and explanatory variables.

Results Univariable analysis revealed that taking acidic foods and alcohol more than 4–5 times per week increases the odds of ETW by 6.043 and 2.532 times, respectively, and taking dairy products, fruit juice, and milk more than 4–5 times per week decreases the likelihood of ETW by 61%, 66%, and 80%, respectively. The results of multivariable regression analysis showed that the frequency of consumption of especially acidic foods significantly increased the risk of ETW (OR = 9.981, 95% CI 3.577–27.849, $p < 0.001$).

Conclusions Although the ETW status of dental students, who are the future dentists, varies depending on different possible etiological factors, especially the consumption of acidic foods has increased the risk of ETW approximately 10 times.

Clinical relevance The findings highlight the high relevance of ETW, especially with acidic food consumption, and the importance of controlling potential etiological factors in dental students.

Keywords Dental erosion · Dental students · Erosive tooth wear · Prevention and control · Questionnaire

Introduction

Erosive tooth wear (ETW) is described as the loss of hard tissues of teeth owing to various acidic factors without any bacterial involvement. In clinical examination, eroded tooth surfaces differ from the original tooth morphology in some specific features [1]. Intrinsic acids caused by endogenous acids such as gastroesophageal reflux or extrinsic acids usually caused by various nutritional habits, especially acidic beverages, or industrial/environmental chemicals, can lead to ETW [2]. Based on the origin of the erosion-causing acids, a distinction between ETW originating from intrinsic and extrinsic acids can be made [2, 3]. However, since the etiology of ETW, which is an oral biological health problem, can be multifactorial, this clinical distinction must be made carefully.

Besides any aesthetic consequences, the severity and longevity of ETW may lead to hypersensitivity, pulpal inflammation, and finally the loss of the affected teeth. The

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etiological and host-related factors are the most important determinants of the severity and form of ETW. Although host-related factors such as salivary flow rate, buffering capacity, pH, and/or components establish the progression of defects, etiological factors such as personal lifestyle, habits and/or behaviors, medical conditions, environmental exposures, or inborn or inherited characteristics are the main determinants of ETW [2, 4].

Extrinsic acid exposures to dental hard tissues include consumption of acidic foods such as citrus fruits, acidic beverages, wine, and salad dressings; usage of medications such as acetylsalicylic acid and vitamin C supplements; long-term occupational exposures in places such as battery, galvanizing, or ammunition factories; and/or professional swimmers and wine tasters. Patients with eating disorders are also known to consume more acidic foods [5, 6].

ETW caused by intrinsic acids is mostly seen in some gastrointestinal and psychosomatic disorders in which acidic gastric fluid enters the oral cavity, such as bulimia nervosa and gastroesophageal reflux. Besides, chronic alcohol consumption is also a determinant for ETW due to alcohol's effects on the degradation mechanisms [7, 8].

Studies on the possible etiological factors of ETW in different populations have been conducted in different countries and regions. Today, practitioners are given numerous different diagnostic materials, methods, and indexes for qualitative and quantitative evaluation of ETW [9]. One of the most commonly used indexes is the Basic Erosive Wear Examination (BEWE). The BEWE, which was introduced in 2008, was developed to provide a simpler way to follow and record the severity and progression of ETW in clinical use and to enhance awareness of erosive lesions [10]. Since its publicity, the scientific authorities have approved the BEWE for clinical usage and research, in spite of infrequent data concerning reliability and validity [10].

Considering the importance of oral and dental health and the high prevalence of oral and dental diseases, the efforts of dentists to ensure the oral and dental health of people are very important. In this context, dental students, the future dental professionals, will play an important role in improving public oral and dental health [11, 12]. Oral health professionals' behaviors related to oral and dental health reflect their understanding of oral and dental preventive measures, which have an important effect on their delivery of oral health care and the health of patients [13, 14]. While dental students have also been found to have a generally positive attitude towards oral health in this regard [15], their own oral health behaviors need to evolve if they are to serve as positive role models for their patients, families, and friends [12, 16, 17]. In addition, the diet-related behaviors of dental students and changes in these behaviors are also reflected to the behaviors and habits of their patients [18]. Therefore, it is very important for dental students to be conscious about oral and dental health, as they will provide health services in the future [14].

The objective of this study was to investigate the ETW status of senior dental students in the School of Dentistry, Marmara University, and to identify the possible etiological factors associated with their ETW status.

Materials and methods

Study group

The present study was approved by the Ethical Committee of Marmara University School of Dentistry with protocol number 2018/186. The study was carried out in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. A total of 130 senior dental students were invited to the study. Before starting, the participants were informed about the study and signed informed consent forms.

The inclusion criteria required for participants are to be a senior student at the School of Dentistry, Marmara University; to sign an informed-consent form; and to complete the questionnaire fully and correctly. Participants with unsigned informed consent forms and incorrectly and/or incompletely filled questionnaires were excluded.

Calibration and training of examiners

The study consisted of a questionnaire and a clinical examination. All data collection was carried out by two researchers: researcher 1 (BG) and researcher 2 (BS). Researcher 1's role in the study was to assess ETW by performing an intraoral examination of the participants, and researcher 2's role was to explain the research to the participants, to evaluate their suitability for the research, and to apply the questionnaire. Prior to the study, researcher 1 was trained for clinical evaluation of ETW by the BEWE scores. Subsequently, the assessment was tested on 20 individuals. The outcomes from these participants were not added to the main study database. This pilot study allowed the calibration of researcher 1 for the assessment of ETW using BEWE scores, resulting in an intra-examiner Kappa value of 0.95. To determine the reproducibility of the BEWE criteria, almost 20% of the students were re-examined.

Questionnaire

Of the 130 invited, four did not accept, and finally, 126 senior dental students aged between 21 and 34 participated in the study. Researcher 2 assessed the relevance of the inclusion criteria of the participants and presented the study together with an informed consent form and a questionnaire

related to the potential etiological factors behind the ETW status as recommended by Lussi and Carvalho [19]. The questionnaire included closed-ended questions concerning demographic information, education level of the parents, frequency of some types of drinks and foods (including acidic foods, dairy products, fruit juice, acidic drinks, carbonated drinks, sports drinks, tea, milk, and alcohol), usage of straw during consumption of acidic beverages, frequency of smoking and swimming in pools, general health (including presence of gastroesophageal reflux, regurgitation, rumination, anorexia, and bulimia nervosa), usage of some medications (including acetylsalicylic acid, psychotropics, antiemetics, and vitamin C tablets), and oral hygiene habits. The questionnaire was completed prior to the intraoral examination.

Clinical examination

After the questionnaire was completed, a clinical examination of the participants was performed by researcher 1. To minimize bias, it was preferred that researcher 1 not be aware of the questionnaire results.

The clinical examination was conducted with a standard dental probe (PCP11) and a front-surface dental mirror (#5), and gauze to dry the teeth surfaces luminated by an overhead dental reflector in the pediatric dentistry clinic of Marmara University School of Dentistry. The caries status of the participants was evaluated with the DMFT index, which was approved by the World Health Organization (WHO) [20].

The ETW status of the individuals was assessed and recorded using BEWE criteria [21]. All third molars and primary and supernumerary teeth were excluded. The four-level score stages of the severity of ETW are: no ETW (0), initial loss of surface texture (1), hard tissue loss < 50% of the surface area (2), and hard tissue loss ≥ 50% of the surface area (3) [21]. The buccal/labial, palatinal/lingual, and occlusal/incisal surfaces of all teeth were examined to detect the BEWE score of each tooth, sextant, and individual. Each participant was assigned to a group in accordance with the greatest code determined for any tooth, forming two categories: No erosive tooth wear (BEWE = 0): all tooth surfaces had a code "0", and erosive tooth wear (BEWE ≥ 1): at least one tooth surface had a code "1" or higher.

Statistical analysis

Categorical variables were expressed as frequencies and percentages (%). Continuous variables were expressed as mean ± standard deviation (SD), median (IQR) as appropriate. Intra-examiner agreement was evaluated using Cohen's kappa. The Shapiro–Wilk test was used to assess the normality assumption for the continuous variables. Categorical variables were evaluated by the chi-square test or Fisher exact test as appropriate. The comparison between two groups (BEWE = 0 and BEWE ≥ 1) for the non-normally distributed continuous variables was assessed by the Mann–Whitney *U* test. Odds ratios (95% confidence intervals) of the independent parameters were calculated with univariable and multivariable logistic regression models to predict the presence of ETW. Since the more frequently and traditionally used significance levels such as 0.05 may fail to identify variables known to be important for regression analysis [22], multivariable logistic regression analysis was built by performing stepwise variable selection on those variables with a univariate p value < 0.25 [23]. The Hosmer and Lemeshow tests were computed to detect goodness of fit in the multivariable logistic regression models, and a non-significant p value indicated a good fit. All statistical analyses were conducted using SPSS version 19.0 software (IBM Corp., Armonk, NY, USA). p values of less than 0.05 were considered to indicate statistical significance.

Results

One hundred twenty-six senior dental students participated in this study. Participants were aged between 21 and 34, and their mean age was 22.95 ± 1.5. Of a total of 126 students, 80 (63.5%) were female and 46 (36.5%) were male. There was a statistically significant difference in BEWE scores between females and males ($chi^2 = 5.31$, $p = 0.021$). While 65.1% of all students (58 female and 24 male) were free of ETW (BEWE code 0), 34.9% of all students (22 female and 22 male) had a BEWE code greater than or equal to 1. Clinical examination of teeth using the BEWE scores in this study showed that gender was found to be a significant determinant in ETW. As the income of the participants that were examined was unknown, socioeconomic and sociocultural factors were built on the parents' education levels. Although the mother's educational status did not have a significant effect on the ETW ($p = 0.243$), a statistically significant relationship was found between the father's educational status and BEWE codes ($p = 0.001$). Table 1 shows the distribution of ETW status of dental students by age, gender, and parental education level.

When the distribution of ETW status according to tooth types was examined, it was seen that BEWE 1 and 2 codes mostly affected the right and left permanent first molars in the lower jaw (27% and 25.4%, respectively), and the right permanent first molars and left permanent second molars in the upper jaw (22.2% and 22.2%, respectively). While the teeth least affected by ETW in the upper jaw were the right and left permanent lateral incisors (2.4% and 3.2%, respectively), the least affected teeth in the lower jaw were the right permanent canines, and right permanent lateral and central incisors (8.7%, 8.7%, and 8.7%, respectively). When evaluating the whole mouth, it can be said that

Table 1 Distribution of erosive tooth wear status of dental students by age, gender, and parental education level

Variable	Total (*N*)	Frequency according to ETW (%)		Test statistics	*p* value
		BEWE = 0	BEWE ≥ 1		
Age mean ± SD	22.95 ± 1.5	23.05 ± 1.70	22.77 ± 1.01	1663	0.445*
Median (IQR)	23 (22–23)	23 (22–23)	23 (22–23)		
Gender					
Female	80	58 (70.7)	22 (50)	5.31	**0.021****
Male	46	24 (29.3)	22 (50)		
Mother's educational status					
No education	7	3 (3.7)	4 (9.1)	4.26	0.243***
Primary school	31	17 (20.7)	14 (31.8)		
High school	34	23 (28)	11 (25)		
University	54	39 (47.6)	15 (34.1)		
Father's educational status					
No education	2	1 (1.2)	1 (2.3)	15.02	**0.001*****
Primary school	29	24 (29.3)	5 (11.4)		
High school	35	28 (34.1)	7 (15.9)		
University	60	29 (35.4)	31 (70.5)		

ETW erosive tooth wear, *BEWE* Basic Erosive Wear Examination, *SD* standard deviation, *IQR* interquantile range

*Mann–Whitney *U* test, **Pearson chi-square test, ***Fisher exact test, bold values mean statistically significant ($p < 0.05$)

the teeth most affected by ETW were the permanent first molars (between 21.4% and 27%), and the least affected teeth were the permanent lateral incisors (between 2.4% and 9.5%).

Table 2 presents the weekly consumption frequency of foods and drinks, and some habits according to the presence of ETW. Statistically significant differences in the presence of ETW were found with respect to the weekly consumption frequency of acidic foods, dairy products, fruit juice, milk, and alcohol ($p < 0.001$, $p = 0.031$, $p = 0.026$, $p < 0.001$, and $p = 0.026$, respectively). In addition, no statistically significant effect was found on the ETW status of acidic drinks, carbonated drinks, sports drinks, tea/coffee consumption frequency, and straw use while consuming acidic/carbonated drinks ($p = 0.354$, $p = 0.082$, $p = 0.326$, $p = 0.067$, and $p = 0.415$, respectively).

Table 3 shows the distribution of senior dental students with respect to BEWE scores and according to habits that may be associated with ETW. Statistically significant differences were observed between the frequency of weekly swimming in a pool, fluoride-containing toothpaste usage, dental visit frequency, toothbrush type, and hypersensitivity and presence of ETW ($p < 0.001$, $p = 0.017$, $p < 0.001$, $p < 0.001$, and $p = 0.004$, respectively). There was no statistical difference in terms of DMFT scores ($p = 0.163$). In addition, no statistically significant difference was observed between the frequency of toothbrushing, the use of electrical toothbrush, the presence of bruxism, and BEWE scores ($p = 0.724$, $p = 0.303$, and $p = 0.706$, respectively).

No statistically significant associations were found between the status of ETW and medical conditions (gastroesophageal reflux, regurgitation, anorexia/blumia nervosa/rumination) ($p > 0.05$). When the relationship between usage of medications and ETW was examined, a statistically significant relationship was observed between only usage of vitamin C tablets and ETW ($p = 0.014$) (Table 4).

We established univariable and multivariable logistic regression analyses to further examine the association of these risk factors with ETW. Univariable analysis revealed that taking acidic foods and alcohol more than 4–5 times per week increases the odds of ETW by 6.043 and 2.532 times, respectively. In addition, taking dairy products, fruit juice, and milk more than 4–5 times per week decreases the likelihood of ETW by 61%, 66%, and 80%, respectively, compared to those who take them less than 1–3 times a week. According to age- and gender-adjusted multivariable model, the odds of ETW was found to be ten fold higher in individuals taking acidic foods more than 4–5 times per week when compared to those who takes less than 1–3 times per week ($p < 0.001$, 95% CI for OR 3.577–27.849) (Table 5).

Discussion

This study contributes information about the distribution of ETW and its possible related etiological variables among senior dental students. The outcomes of this investigation should be evaluated with attention due to its limitations

Table 2 Distribution of dental students with respect to erosive tooth wear according to frequency and habits associated with the consumption of foods and drinks

Variable	Total (*N*)	Frequency according to ETW (%)		Test statistics	*p* value[†]
		BEWE = 0	BEWE ≥ 1		
Acidic foods					
Less than 1–3 times per week	55	47 (57.3)	8 (18.2)	17.83	**< 0.001**
More than 4–5 times per week	71	35 (42.7)	36 (81.8)		
Dairy products (yoghurt/cheese, etc.)					
Less than 1–3 times per week	29	14 (17.1)	15 (34.1)	4.68	**0.031**
More than 4–5 times per week	97	68 (82.9)	29 (65.9)		
Fruit juice					
Less than 1–3 times per week	94	56 (68.3)	38 (86.4)	4.94	**0.026**
More than 4–5 times per week	32	26 (31.7)	6 (13.6)		
Acidic drinks					
Less than 1–3 times per week	91	57 (69.5)	34 (77.3)	0.86	0.354
More than 4–5 times per week	35	25 (30.5)	10 (22.7)		
Carbonated drinks					
Less than 1–3 times per week	88	53 (64.6)	35 (79.5)	3.02	0.082
More than 4–5 times per week	38	29 (35.4)	9 (20.5)		
Drinking with straw or not during consumption of acidic/carbonated drinks					
Without straw	40	24 (29.3)	16 (36.4)	0.67	0.415
With straw	86	58 (70.7)	28 (63.6)		
Sports drinks					
Less than 1–3 times per week	103	65 (79.3)	38 (86.4)	0.97	0.326
More than 4–5 times per week	23	17 (20.7)	6 (13.6)		
Tea/coffee					
Less than 1–3 times per week	29	23 (28)	6 (13.6)	3.36	0.067
More than 4–5 times per week	97	59 (72)	38 (86.4)		
Milk					
Less than 1–3 times per week	64	31 (37.8)	33 (75)	15.85	**< 0.001**
More than 4–5 times per week	62	51 (62.2)	11 (25)		
Alcohol					
Less than 1–3 times per week	45	35 (42.7)	10 (22.7)	4.97	**0.026**
More than 4–5 times per week	81	47 (57.3)	34 (77.3)		

ETW erosive tooth wear, *BEWE* Basic Erosive Wear Examination

[†]Pearson chi-square test was used for all test variables; bold values mean statistically significant ($p < 0.05$)

and possible risk of bias. A suitable sampling method was applied but was unable to reach a wider population due to time and cost limitations and pandemic conditions. The main problem with estimating the relationship between ETW and possible etiological factors is that it is difficult to compare various research and publications. There are large variations in scoring systems, sample sizes, types of recordings, the selection of the reference values and sample groups, standards, and choice of results. The selection of a scoring system, in particular, has an effect on the outcome of a study and might be a determinant of the status of ETW. In addition, differences in nutritional habits observed in different countries and even different cities lead to changes in the etiological factors of ETW [24]. Besides defining ETW as a chemical–mechanical process that results in cumulative loss of enamel and/or dentine not caused by microorganisms, it is difficult to pinpoint the main etiological factor of ETW observed on tooth surfaces [25]. In particular, it is important to make a differential diagnosis of whether the wear on the occlusal surfaces of the teeth occurs chemically and/or mechanically. Although the highest scoring surface of a tooth determines the score of that tooth according to the BEWE [21], the fact that not being able to evaluate separately the degree of affection of the different surfaces in the study appears to be a limitation.

According to the most recent studies, ETW is a widespread condition, and there is evidence that its incidence is continuously increasing, particularly among younger adult age groups. It is also reported that males are more affected by ETW than females [26]. Socioeconomic and sociocultural

Table 3 Distribution of dental students with respect to erosive tooth wear according to swimming, oral hygiene habits, hypersensitivity, bruxism, frequency of dental visits and DMFT scores

Variable	Total (N)	Frequency according to ETW (%)		Test statistics	*p* value
		BEWE = 0	BEWE ≥ 1		
Swimming in pools					
None	95	80 (97.6)	15 (34.1)	62.35	**< 0.001*****
1–2 times per week	24	2 (2.4)	22 (50)		
3–4 times per week	4	0	4 (9.1)		
More than 5 times per week	3	0	3 (6.8)		
Toothbrushing					
Rarely	1	1 (1.2)	0	2.47	0.724***
Once a week	1	0	1 (2.3)		
Once a day	5	3 (3.7)	2 (4.5)		
Twice a day	119	78 (95.1)	41 (93.2)		
Usage of fluoride-containing toothpaste					
Never	2	1 (1.2)	1 (2.3)	7.79	**0.017*****
Rarely	1	0	1 (2.3)		
Sometimes	27	23 (28)	4 (9.1)		
Always	96	58 (70.7)	38 (86.4)		
Type of toothbrush					
Extra-soft	10	7 (8.5)	3 (6.8)	40.91	**< 0.001*****
Soft	53	50 (61)	3 (6.8)		
Medium	59	25 (30.5)	34 (77.3)		
Hard	4	0	4 (9.1)		
Usage of electrical toothbrush					
No	106	71 (86.6)	35 (79.5)	1.06	0.303**
Yes	20	11 (13.4)	9 (20.5)		
Hypersensitivity					
Never	35	28 (34.1)	7 (15.9)	11.17	**0.004****
Rarely	36	27 (32.9)	9 (20.5)		
Sometimes	55	27 (32.9)	28 (63.6)		
Bruxism					
No	89	57 (69.5)	32 (72.7)	0.14	0.706**
Yes	37	25 (30.5)	12 (27.3)		
Dental visits					
Never	7	4 (4.9)	3 (6.8)	19.38	**< 0.001*****
Once a year	24	14 (17.1)	10 (22.7)		
Twice a year	32	31 (37.8)	1 (2.3)		
More than twice a year	63	33 (40.2)	30 (68.2)		
DMFT Mean ± SD Median (IQR)	4.68 ± 3.77 4 (2–7)	5.12 ± 4.07 4 (2–8)	3.86 ± 2.99 3.5 (1–6)	1532.5	0.163*

ETW erosive tooth wear, *BEWE* Basic Erosive Wear Examination, *SD* standard deviation, *IQR* interquantile range

*Mann–Whitney *U* test, **Pearson chi-square test, ***Fisher exact test; bold values mean statistically significant ($p < 0.05$)

factors have an effect on nutritional and oral hygiene habits. Low socioeconomic level and income can lead to erosive lesions affecting the dentine or pulp due to the increase of consumption of acidic fruits and carbohydrate products. In addition, it is known that children whose parents have high socioeconomic levels have higher living standards, healthier dietary habits, and more regular oral hygiene habits [27, 28]. Parents' educational levels might have an impact on their daily decisions concerning their children's nutritional habits. Therefore, a lack of parental education might raise the likelihood of ETW in their children [29]. In parallel with this information, the results of the current study showed that the frequency of ETW in males was statistically significantly higher than in females. In addition, a significant relationship

Table 4 Distribution of dental students with respect to erosive tooth wear according to medical conditions and usage of medications

Variable	Total (N)	Frequency according to ETW (%)		Test statistics	*p* value†
		BEWE = 0	BEWE ≥ 1		
Gastroesophageal reflux					
No	115	74 (90.2)	41 (93.2)	0.31	0.746
Yes	11	8 (9.8)	3 (6.8)		
Regurgitation					
No	123	80 (97.6)	43 (97.7)	0.01	1.000
Yes	3	2 (2.4)	1 (2.3)		
Anorexia/bulimia nervosa/rumination					
No	126	82 (100)	44 (100)	n.a.	n.a.
Yes	0	0	0		
Usage of acetylsalicylic acid					
No	113	74 (90.2)	39 (88.6)	0.08	0.767
Yes	13	8 (9.8)	5 (11.4)		
Usage of psychotropics					
No	121	79 (96.3)	42 (95.5)	0.06	1.000
Yes	5	3 (3.7)	2 (4.5)		
Usage of antiemetics					
No	123	81 (98.8)	42 (95.5)	1.36	0.279
Yes	3	1 (1.2)	2 (4.5)		
Usage of vitamin C tablets					
No	122	82 (100)	40 (90.9)	7.70	**0.014**
Yes	4	0	4 (9.1)		

ETW erosive tooth wear, *BEWE* Basic Erosive Wear Examination, *n.a.* not applicable

†Fisher exact test was used for all test variables; bold values mean statistically significant ($p < 0.05$)

was found between the father's educational status and the presence of ETW.

The main cause of ETW is thought to be the frequent and regular consumption of acidic foods [30, 31]. But there is no clear relationship between acid exposure and the formation of ETW for all evaluated resources [32–34]. Therefore, whether chronic exposure to different acid sources has a real impact on ETW status and severity is still under investigation [24]. It is critical to be able to recognize the wide range of foods, beverages, and medications that have highly erosive potential [35]. Jarvinen et al. [36] reported that consumption of acidic citrus fruits and products derived from them increased the risk of ETW up to 37 times. It is reasonably safe to assume that any nutritional food or drink containing added fruit will be acidic and therefore have an erosive potential [35, 37]. It is known that high consumption of fruits, fruit juices, and soft drinks by children and young adults due to their taste preferences is responsible for the increased risk of ETW [35, 38, 39]. Besides, it is known that the frequency of consumption of acidic foods and beverages is more important than the type of food or beverage in terms of ETW risk [40]. A longitudinal study of 55 adults over 6 years observed that frequent consumption of nutritional acids was related to ETW progression [41]. Similarly, in this study, a statistically significant relationship was found between the frequency of acidic foods and fruit juice consumption and the ETW. The main reason why milk and other dairy products such as yoghurt and cheese with acidic pH values do not cause ETW is the calcium and casein they contain [37, 42]. The results of this study also show that the increase in the frequency of consumption of milk and dairy products has a statistically significant effect on the ETW. The results of the multivariable regression analysis of the study showed that the increase in the frequency of consumption of acidic foods elavates the risk of ETW by approximately 10 times. Frequent daily acid intake is an important factor in the occurrence of severe ETW, affecting 1–3% of the total population [43, 44]. In this direction, Martignon et al. [44] showed that the increase in the frequency of daily acid intake with diet was statistically significantly associated with the presence and severity of ETW in young adults aged 18–25.

Table 5 Crude and adjusted odds ratio of the univariable and multivariable logistic regression models between erosive tooth wear and independent explanatory variable for dental students

	Univariable				Multivariable*			
	p value	OR	95% CI for OR		*p* value	OR	95% CI for OR	
			Lower	Upper			Lower	Upper
Frequency of acidic foods**	**< 0.001**	6.043	2.501	14.602	**< 0.001**	9.981	3.577	27.849
Frequency of dairy products	**0.033**	0.398	0.170	0.930				
Frequency of fruit juice	**0.031**	0.340	0.128	0.905				
Frequency of milk	**< 0.001**	0.203	0.090	0.458				
Frequency of alcohol	**0.028**	2.532	1.104	5.806				

OR odds ratio, *CI* confidence interval

*Adjusted according to age and gender

**Less than 1–3 times per week was taken as reference

Bold values mean statistically significant ($p < 0.05$)

Incorrect tooth brushing habits or the use of toothpaste containing high abrasives have long been implicated as etiological factors of tooth wear [45]. Abrasive tooth wear is caused by factors such as toothbrush type, filament stiffness, and tooth brushing method, force, time, and frequency [36]. Several studies conducted have reported synergistic effects of erosive and abrasive tooth wear [46, 47]. Enamel and dentine, which are softened by erosive attacks, can be affected by toothpaste or even tooth brushing without toothpaste [46, 47]. Tooth wear due to toothpaste abrasion reaches dangerous levels in cases of ETW, acting additively or synergistically [48]. When analysing individuals' oral hygiene habits, in the present study, it was observed that the usage of fluoride-containing toothpaste, type of toothbrush, presence of hypersensitivity, and frequency of dental visits presented a statistically significant relationship with ETW scores.

Lussi et al. [37] reported that some medications containing vitamin C caused ETW by statistically significantly reducing the enamel surface hardness values. Similarly, in the current study, it was observed that the use of vitamin C tablets had a significant effect on the ETW. In spite of this, no significant relation was found between the presence of gastroesophageal reflux, regurgitation, and usage of acetylsalysilic acid, psychotropics, and antiemetics, which are known to be associated with ETW [5, 6, 49, 50]. We are of the opinion that the existence of this relationship can only be determined by evaluations conducted in populations containing more individuals with these diseases and medication usages.

Transforming knowledge about health problems into healthy behaviors remains a challenging task in health promotion. Given that most chronic disorders and conditions are caused by lifestyle and behavioral factors, increasing knowledge is beneficial to the extent that it subsequently leads to behavior change [51]. Studies have shown that dental students with clinical experience have more knowledge about oral health than preclinical dental students who have no experience with patients, and this knowledge is reflected in their attitudes and behaviors [52]. Hong et al. [53] showed that dental students have more accurate knowledge and more positive attitudes about ETW than medical and non-medical students. It was also stated that the attitudes of dental students toward ETW were in significant and positive correlation with their knowledge of this subject. As a limitation, questions about the level of knowledge of dental students on ETW were not included in the questionnaire. Only the effects of nutritional and oral hygiene behaviors, different medical conditions and medication usage, and various sociodemographic factors on the presence and level of ETW were examined. Therefore, there is a need for studies that investigate the relationship between all of these parameters in larger sample groups by evaluating both the level of knowledge of dental students about ETW and how and at what level they reflect this knowledge in their behavior and attitudes, as well as evaluating the ETW status of these students.

Conclusions

The results of this study confirmed that there is a relationship between ETW and some nutritionally consumed foods and beverages, some oral hygiene habits, and usage of vitamin C tablets. Considering that dental students, who are the dentists of the future, reflect their own behaviors and habits to their patients, the consumption of acidic foods increases the risk of ETW approximately 10 times. On the contrary, milk and dairy product consumption can help prevent or control ETW.

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Declarations

Ethics approval The present study was approved by the Ethical Committee of Marmara University School of Dentistry with protocol number 2018/186. The study was carried out in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Before starting the study, the participants were informed about the study and signed informed consent forms.

Conflict of interest The authors declare no competing interests.

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