Original Article

Relationship between Food Habits and Tooth Erosion Occurrence in Malaysian University Students

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Abstract

Background: **Tooth erosion is a growing dental problem; however, the role of diet in the aetiology of tooth erosion is unclear. A cross-sectional study was conducted to determine the association between tooth erosion occurrence and the consumption of acidic foods and drinks among undergraduate university students.**

Methods: **A total of 150 undergraduate students (33 males and 117 females) aged 19 to 24 years at Universiti Kebangsaan Malaysia participated in this study. The Basic Erosive Wear Examination was used to assess the occurrence of tooth erosion. Information regarding dental hygiene practices, usual dietary habits, and consumption of acidic foods and drinks was obtained through a structured questionnaire.**

Results: **In all, 68% of subjects had tooth erosion. Subjects who reported having received information about healthy eating were less likely to have tooth erosion (χ^2 [1, N = 150] = 7.328, *P* = 0.007). The frequencies of milk (OR = 0.29, 95% CI = 0.13–0.67) and tea/coffee (adjusted OR = 0.42, 95% CI = 0.19–0.95) consumption were negatively associated with tooth erosion. Dental hygiene practice, the frequency and amount of acidic food and drink intake, and body mass index classification were not significantly associated with the risk of tooth erosion (*P* > 0.05).**

Conclusion: **A high prevalence of tooth erosion was observed among this group of students. Preventive measures, such as dietary advice and increased consumption of milk at a younger age, may reduce the occurrence of tooth erosion among this age group.**

Keywords: *beverages, cross-sectional study, food habits, public health, tooth erosion, young adult*

Introduction

Tooth erosion is defined as a pathological disease characterised by the loss of dental hard tissue due to its chemical removal from the surface by an acid or chelation without bacterial involvement (1). The causative factors of this multi-factorial disease are divided into extrinsic and intrinsic types. Extrinsic causes include the environment, medication, lifestyle factors, and diet. Intrinsic tooth erosion may occur if gastric acid reaches the month due to regurgitation, vomiting, or gastro-oesophageal reflux disease (2). An individual may not be aware of having this problem until it reaches the dentine and pulp, which eventually leads to tooth sensitivity, altered occlusion, and poor aesthetics (3).

There is a considerable body of evidence from laboratory studies to indicate that the acidity of carbonated drinks, sports drinks, and fruit juices can cause tooth erosion. Research has demonstrated that drinks with a pH of 5.5 or less tend to erode and soften the enamel surface. Examples of common acidic food items that have an increased potential for causing tooth erosion include carbonated beverages (4,5), sports drinks (2,6), citrus fruits, and fruit juices (7,8). Carbonated soft drinks have a pH ranging 2.3–3.4, whereas acidic fruit juices and alcoholic drinks have a pH ranging 2.1–3.6 and 2.8–3.9, respectively (6,9). In vitro and in situ studies have also found that natural fruit juices (10,11) and fruit-flavoured drinks have an increased erosive potential (12–14). In addition, certain dietary habits, such as retaining an acidic drink in the mouth for a longer period of time, could

also cause this dental problem (15). A laboratory study indicated that yogurt does not have erosive potential on enamel, even though it is acidic (16). In addition, it was found that milk and tea have little or no potential for causing erosion (5).

Most studies on children and adolescents support the finding that acidic foods and drinks cause tooth erosion (3,5,8,17,18), but comparatively few have assessed these risk factors in adults (19,20). In Malaysia, data regarding the prevalence of tooth erosion in all age groups is limited. Studies about tooth erosion and its relationship with dietary factors in any age group are also limited. In Kelantan, on the East Cost of Malaysia, Saerah et al. (21) reported that the proportion of raw tooth wear was 100%, and pathological tooth wear was 20.1% among 16-year-old teenagers. Tooth wear is a non-caries loss of dental tissue that results from an interaction between 3 processes: abrasion, attrition, and erosion, which may happen in isolation or in combination. Although this study included erosion as a component of tooth wear, they did not report tooth erosion as a separate dental problem that may be related to an individual's dietary pattern. Among 81 adults aged 18–80 years who attended a dental clinic in Kelantan, 29 (35.8%) had abrasion, 25 (30.9%) had attrition, 1 (1.2%) had erosion, and 26 (32.1%) presented a combined type of tooth wear (22). In this study, the prevalence of tooth erosion was low, and the dietary patterns of patients who attended dental clinics may not be representative of other adults. Thus, the aim of the present study was to investigate the association between dietary patterns and tooth erosion among young adults.

Materials and Methods

Study population and design

A cross-sectional study was conducted at Universiti Kebangsaan Malaysia, Kuala Lumpur campus. A convenience sample of 150 students from various departments was recruited. Based on the sample size calculation formula (23), 150 subjects were required to provide 80% power at a significance level of 5%. The prevalence of tooth erosion was obtained from a previous study among university students in China (24). Ethical approval for this study was obtained from the Ethics Research Committee of Universiti Kebangsaan Malaysia. An information sheet about the study was given to all subjects, and informed consent was obtained from each subject before participation in the study. Undergraduate students who were not pregnant and were not receiving orthodontic treatment were eligible for this study. Subjects were excluded if they were postgraduate students, had medical problems, such as gastro-oesophageal reflux disease, bulimia, or anorexia nervosa, or were professional swimmers.

Questionnaire

A self-administered questionnaire was designed to obtain information about demographics, dental health history, medical history, oral hygiene practices, and dietary patterns. Subjects were asked to recall the frequency and amount of acidic foods and drinks consumed per day, per week, and per month for the past 1 month using a self-administered questionnaire adapted from previous studies (18,19,25). The questionnaire was pilot tested for clarity among 30 undergraduate students, and minor amendments to the questionnaire were made as needed. The reliability of the questionnaire was assessed; Cronbach's alpha coefficient showed a satisfactory result of 0.78.

Subjects completed the questionnaire before dental examinations were performed. A food frequency questionnaire was used to calculate participants' mean daily consumption. Actual dietary habits of the subjects may not have been captured accurately if they were asked to recall their consumption of acidic foods and drinks for the past 24 hours or 1 week, or to record their diet intake in 3-day food diary. Therefore, dietary data were assessed for the past 1 month. Food frequency questionnaires are the recommended method for research on diet-disease relationships (25).

Acidic foods were classified into 2 groups: acidic drinks and acidic foods. Acidic drinks included fruit juice (natural fruit juice and diluted fruit juice), fruit-flavoured drinks (cordial diluted and cocktail drinks), sugared carbonated drinks (carbonated drinks and sparkling water), non-sugared carbonated drinks, sports drinks (also known as isotonic drinks), alcoholic drinks, and honey drinks. Non-erosive drinks included tea, coffee, and milk. Acidic foods included ketchup, pickles, citrus fruit–flavoured ice-cream, vinegar-containing foods, baked beans, fruit jam, sour sweets, dried fruits, and fruits (26). Non-erosive foods included cheese and yogurt; these 2 foods are also high in calcium.

Clinical examination

A tooth erosion assessment was performed using the Basic Erosive Wear Examination (BEWE) index (27). Dental examinations were performed

by a final-year dental student and were calibrated against a dental specialist. The kappa value was 0.75. Clinical examinations were conducted in the main hall of the students' accommodation. The BEWE is a partial scoring system recording the most severely affected surface in a sextant, and the cumulative score guides the management of the condition for the practitioner. The 4-level score (0–3) grades the appearance or severity of wear on the teeth as no surface loss (0), initial loss of enamel surface texture (1), distinct defect, hard tissue (dentine) loss of less than 50% of the surface area (2), or hard tissue loss of greater than 50% of the surface area (3). The reliability of the BEWE has been proven to be acceptable for scoring the severity of dental erosive wear and for recording such lesions in prevalence studies (28). The result of the BEWE is not only a measure of the severity of the condition for scientific purposes but, when transferred into risk levels, is also a possible guide towards management.

Buccal/facial, occlusal, and lingual/palatal surfaces were examined for the highest score recorded. The examination was repeated for all teeth in a sextant, but only the surface with the highest score was recorded for each sextant. Once all the sextants had been assessed, the sum of the scores was calculated.

Anthropometry measurement

Anthropometry measurements, including body weight and height, were conducted at the first meeting with subjects. Body weight was measured using a TANITA digital scale HD-306 (TANITA Corporation, JP) to the nearest 0.1 kg, and height was measured using a SECA 208 body meter (SECA, DE) to the nearest 0.1 cm. During body weight measurements, subjects were required to wear minimal clothing and to stand on the centre of the scale with their weight distributed evenly between both feet. Height measurements were performed using the stretch stature method. Subjects were asked to stand with their feet together and their heels, buttocks, and upper part of their back touching the scale, with their head positioned in the Frankfort plane. Body mass index (BMI) was calculated by dividing the weight (kg) by the square of height (m) and was classified into 4 categories: underweight (BMI < 18.5 kg/m^2), normal (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2), and obese (BMI ≥ 30.0 kg/m^2) (29).

Statistical analyses

Data were compiled and analysed using SPSS version 17.0 (SPSS Inc., Chicago, IL, US). Data normality was tested using the Kolmogorov–Smirnov test. Descriptive analyses were performed to determine the percentages, means, and standard deviations for qualitative data. A chi-square analysis was used to test the associations between tooth erosion occurrence and dietary and socio-demographic variables. Normally distributed data were presented using the mean and standard deviation. Fisher's exact test was used to test the association between the frequencies of acidic food and drink consumptions and the occurrence of tooth erosion. Binary logistic regression was used to calculate the adjusted odds ratio for the amount of non-erosive drinks consumed and tooth erosion occurrence with the inclusion of confounding factors, such as ethnicity, gender, whether the participant had ever received dietary advice, saliva volume, and the frequency of milk consumption. The significance level was set to 0.05.

Results

A total of 150 subjects completed the questionnaire and underwent dental examination for tooth erosion (a response rate of 100%). The majority of subjects were females (78.0%), Chinese (60.0%), aged between 19 and 21 years (80.7%), and had father (54.0%) and mother (52.7%) with an educational level of secondary school (Table 1).

Sixty-eight percent (n = 102) of the subjects had tooth erosion (Table 1). A total of 78.4% (n = 80) of females and 21.6% (n = 22) of males had tooth erosion (χ^2 [1, N = 150] = 0.035, P = 0.853). A greater percentage of Chinese students (65.7%) had tooth erosion compared with Malays (27.4%) and Indians (6.9%) (χ^2 [1, N = 150] = 4.448, P = 0.108); however, the difference was not statistically significant. There was no significant difference in the percentage of students with tooth erosion by age groups (P = 0.705) as well as by father's (P = 0.730) and mother's (P = 0.084) educational levels (Table 1).

A greater percentage of subjects without tooth erosion (50.0%) reported that they had received information about healthy eating compared with subjects with tooth erosion (27.5%) (Table 2). The risk of tooth erosion among subjects who had ever received information on healthy eating was lower than for those who had not (OR = 2.64, 95% CI = 1.30–5.94). Subjects reported that parents, friends/relatives, and television/magazines were the primary sources of their dietary information. More than two-thirds of the subjects in both groups reported that

Table 1: Occurrence of dental erosion according to the socio-demographic characteristics

Characteristic	Dental erosion				*P* value [a]
	Yes		No		
	n	(%)	*n*	(%)	
Gender					
Male	22	(21.6)	11	(22.9)	0.853
Female	80	(78.4)	37	(77.1)	
Ethnicity					
Malay	28	(27.4)	19	(39.6)	0.108
Chinese	67	(65.7)	23	(47.9)	
Indian	7	(6.9)	6	(12.5)	
Age (years)					
19–21	83	(81.3)	38	(79.2)	0.705
22–24	19	(18.7)	10	(20.8)	
Father's educational level [b]					
Primary school	22	(23.2)	9	(19.1)	0.730
Secondary school	52	(54.7)	29	(61.8)	
Tertiary education	21	(22.1)	9	(19.1)	
Mother's educational level [c]					
Primary school	34	(34.0)	7	(15.9)	0.084
Secondary school	51	(51.0)	28	(63.6)	
Tertiary education	15	(15.0)	9	(20.5)	

[a] Data were analysed using chi-square test. There were [b] 8 missing data for fathers' educational level and [c] 6 missing data for mother's educational level.

their most recent dental check-up was more than 6 months ago. There was no significant difference in the dental hygiene practices between subjects with and without tooth erosion (Table 2). Based on anthropometry measurements, the majority of subjects with (61.8%) and without (66.7%) tooth erosion had a normal BMI (Table 3). There was no significant difference in the occurrence of tooth erosion between subjects with different BMI classifications ($P = 0.468$).

Food and drink intake frequencies were dichotomised into 2 categories: high consumption and low consumption (Table 4). The majority of subjects frequently consumed non-erosive drinks, which included tea or coffee and milk, compared with acidic drinks. Less than 5% of subjects consumed any acidic drinks or milk more than 4 to 5 times daily. However, 22.7% of subjects consumed tea or coffee 4 to 5 times daily. No significant association was found between the frequency of acidic drink consumption and the occurrence of tooth erosion. However, there was a significant negative association between the frequency of milk consumption and the occurrence of tooth erosion ($P = 0.004$). For subjects who reported a greater frequency of milk consumption, only 12.7% had tooth erosion compared with 87.3% in the low consumption group (OR = 0.29, 95% CI = 0.13–0.67, $P = 0.004$). Subjects with and without tooth erosion reported low frequencies of acidic food consumption, except for fruits (Table 5). Less than half of the subjects (49.0%) reported a high frequency of fruit intake. Although a greater percentage of subjects with tooth erosion (49.0%) consumed fruits at a higher frequency than subjects without tooth erosion (41.7%), there was no association found between the frequency of fruit consumption and the risk of tooth erosion (OR = 1.35, 95% CI = 0.67–2.69).

Dietary analysis indicates that the amounts of acidic and erosive foods consumed by the subjects were low and were not associated with the risk of tooth erosion (Table 6). However, based on the amount of non-erosive drinks consumed, tea or

Table 2: Occurrence of dental erosion according to the status of receiving information on healthy eating and dental hygiene practices

Variable	Dental erosion				*P* value [a]	OR (95% CI)
	Yes		No			
	n	(%)	*n*	(%)		
Ever received information on healthy eating?						
Yes	28	(27.5)	24	(50.0)	0.007 [b]	2.64 (1.30–5.94)
No	74	(72.5)	24	(50.0)		
Source of dietary information on healthy eating [c]						
Medical doctors	9	(8.8)	10	(20.8)	–	–
Parents	22	(21.6)	13	(27.1)		
Friends/relatives	17	(16.7)	11	(22.9)		
Dentists	5	(4.9)	4	(8.3)		
Television/magazines	17	(16.7)	12	(25.0)		
Dieticians	2	(2.0)	5	(10.4)		
Nurses	2	(2.0)	0	(0.0)		
School teachers	11	(10.8)	7	(14.6)		
Last dental check-up						
> 6 months ago	71	(69.6)	35	(72.9)	0.678	1.18 (0.55–2.52)
Recently/within last 6 months	31	(30.4)	13	(27.1)		
Type of toothbrush						
Hard/medium bristled toothbrush	62	(60.8)	34	(70.8)	0.232	1.57 (0.75–3.28)
Soft-bristled toothbrush/unsure	40	(39.2)	14	(29.2)		
Frequency of daily teeth brushing						
1–2 times per day	77	(75.5)	37	(77.1)	0.831	1.09 (0.49–2.46)
≥ 3 times per day	25	(24.5)	11	(22.9)		

[a] *P* values were based on chi-square test, with [b] $P < 0.05$ considered significant. [c] Only respondents who had received information on healthy eating answered this question, and they were allowed to choose more than 1 answer.

Table 3: Occurrence of dental erosion according to the body mass index classification

Body mass index	Dental erosion						*P* value [a]
	Yes		No		Total		
	n	(%)	*n*	(%)	*n*	(%)	
Underweight (< 18.5)	28	(27.5)	9	(18.7)	37	(24.7)	0.468
Normal weight (18.5–24.9)	63	(61.8)	32	(66.7)	95	(63.3)	
Overweight or obese (25.0–34.9)	11	(10.7)	7	(14.6)	18	(12.0)	

[a] *P* values were based on chi-square test.

Table 4: Occurrence of dental erosion according to the frequency of acidic and non-acidic drink consumption

Consumption level	Dental erosion				*P* value [a]	OR (95% CI)
	Yes		No			
	n	(%)	*n*	(%)		
Acidic drink						
Fruit juice						
High [c]	4	(3.9)	4	(8.3)	0.268	0.45 (0.11–1.88)
Low [d]	98	(96.1)	44	(91.7)		
Fruit-flavoured drink						
High [c]	6	(5.9)	4	(8.3)	0.727	0.69 (0.19–2.56)
Low [d]	96	(94.1)	44	(91.7)		
Sugared carbonated drink						
High [c]	3	(2.9)	1	(2.1)	> 0.95	1.42 (0.14–14.06)
Low [d]	99	(97.1)	47	(97.9)		
Non-sugared carbonated drink						
High [c]	2	(2.0)	1	(2.1)	> 0.95	0.94 (0.08–10.63)
Low [d]	100	(98.0)	47	(97.9)		
Sports drink						
High [c]	1	(1.0)	1	(2.1)	0.539	0.47 (0.03–7.60)
Low [d]	101	(99.0)	47	(97.9)		
Non-acidic drink						
Tea or coffee						
High [c]	34	(33.3)	21	(43.8)	0.276	0.64 (0.32–1.30)
Low [d]	68	(66.7)	27	(56.2)		
Milk						
High [c]	13	(12.7)	16	(33.0)	0.004 [b]	0.29 (0.13–0.67)
Low [d]	89	(87.3)	32	(67.0)		

[a] *P* values were based on Fisher's exact test, with [b] $P < 0.05$ considered significant. [b] High consumption was defined as drink consumption of 4–5 times per week or more than once per day. [c] Low consumption was defined as drink consumption of 1–3 times per week or never.

coffee intake of more than 150 mL/day (the 75th percentile) indicated a reduced risk (to 43%) of experiencing tooth erosion (OR = 0.43, 95% CI = 0.21–0.90) (Table 6). In addition, a significantly reduced risk of tooth erosion was found at 107 mL/day (the 75th percentile) of milk intake (OR = 0.46, 95% CI = 0.22–0.94). However, after adjustment for confounding factors, binary logistic regression analysis revealed that the risk of tooth erosion remained statistically significant only for tea or coffee intake 150 mL/day or more, with a reduction in the risk of tooth erosion to 42% (Table 7).

Discussion

More than half of the university students aged 19–24 years who participated in this study had dental erosion. Unfortunately, limited data are available on the prevalence of tooth erosion among young adults in Malaysia. Although it is difficult to accurately compare the results of this study with other prevalence studies due to the differences in the indices used, the study criteria, the diagnostic criteria, and the tooth surfaces examined, it appears that the prevalence of tooth erosion in this study is greater than that reported

Table 5: Occurrence of dental erosion according to the frequency of acidic food consumption

Consumption level	Dental erosion				*P* value [a]	OR (95% CI)
	Yes		No			
	n	(%)	*n*	(%)		
Yogurt						
High [b]	1	(1.0)	1	(2.1)	0.539	0.47 (0.03–7.60)
Low [c]	101	(99.0)	47	(97.9)		
Ketchup						
High [b]	4	(3.9)	1	(2.1)	> 0.95	1.92 (0.21–17.64)
Low [c]	98	(69.1)	47	(97.9)		
Fruit jam						
High [b]	3	(2.9)	2	(4.2)	0.655	0.70 (0.11–4.32)
Low [c]	99	(97.1)	46	(95.8)		
Sour candy						
High [b]	4	(3.9)	1	(2.1)	> 0.95	1.92 (0.21–17.64)
Low [c]	98	(69.1)	47	(97.9)		
Dried fruit						
High [b]	12	(11.8)	6	(12.5)	> 0.95	0.93 (0.33–2.66)
Low [c]	90	(88.2)	42	(87.5)		
Fruit						
High [b]	50	(49.0)	20	(41.7)	0.483	1.35 (0.67–2.69)
Low [c]	52	(51.0)	28	(58.3)		

[a] *P* values were based on Fisher's exact test. [b] High consumption was defined as food consumption of 4–5 times per week or more than once per day. [c] Low consumption was defined as food consumption of 1–3 times per week or never.

by an aforementioned local study among adults in Kelantan (21), among university students in the United States of America (36.5%) (19) and among adults aged 26–30 years in Switzerland (29.9%) (20). Tooth erosion was reportedly higher (77%) among Saudi military men similar in age to the participants in our study (19–25 years old) (30). In the present study, there was no significant difference in the proportion of tooth erosion between genders, ethnic groups, or parental education levels. A study among adolescents aged 13–14 years in Brazil (18) also reported that gender and socio-economic class were not significantly associated with the risk of tooth erosion.

Our study found that there were no relationships between tooth erosion and the frequency and amount of acidic foods and drinks consumed. Tooth erosion is more frequently reported to be associated with acidic drinks among children (31), adolescents (5,31–33) and adults (15) when the consumption was high, and the association is not reported in children (3) when the consumption was low. In our study, the proportion of subjects who reported frequently consuming acidic drinks was too small to show a significant association with tooth erosion occurrence.

Another potential explaination for why dietery habits were not found to have any significant association with tooth erosion is that the study was cross-sectional, and therefore only assessed dietary patterns 1–2 months prior to the study. Dietary patterns during data collection may not have been the same as the dietary patterns when tooth erosion occurred. Moreover, tooth erosion is a progressive disease resulting from frequent and prolonged exposure to acidic food items. Finally, the risk of tooth erosion is multi-factorial in nature and is influenced by the tooth composition and structure and the saliva composition (31), which we did not examine in this study due to financial and time constraints.

The present study found that the amount of

Table 6: Consumption of acidic foods and non-erosive drinks, in percentiles and crude ORs

Parameter	Percentile					
	25th	OR (95% CI)	50th	OR (95% CI)	75th	OR (95% CI)
Acidic and erosive food						
Acidic drink (mL/day) [a]	36	0.67 (0.31–1.46)	97	1.00 (0.50–1.98)	197	0.83 (0.38–1.81)
Acidic non-fruit food (g/day) [b]	0	–	3	0.96 (0.48–1.91)	14	0.725 (0.33–1.57)
Acidic fruit (g/day) [c]	14	0.97 (0.44–2.16)	50	0.86 (0.45–1.76)	148	1.03 (0.47–2.26)
Non-erosive drink						
Tea or coffee (mL/day)	0	–	43	1.15 (0.58–2.30)	150	0.43 [d] (0.21–0.90)
Milk (mL/day)	0	–	17	1.95 (0.97–3.94)	107	0.46 [d] (0.22–0.94)

[a] Acidic drinks included natural fruit juice, diluted fruit juice, cordial drinks, carbonated drinks (low-calorie and non-low-calorie), soda drinks, sports drinks, sparkling drinks, alcoholic drinks, fruit cocktail drinks, and honey drinks. [b] Acidic foods included ketchup, pickles (sour, fruits, vegetables), citrus fruit-flavoured ice-cream, vinegar-containing foods, baked beans, fruit jam, sour candies, dried fruits (prunes, apricots), and raisins. [c] Acidic fruits included apple, grape, kiwi, mango, orange, lemon, mandarin orange, pineapple, star fruit, mangosteen, pear, plum, prune, strawberry, guava, and tomato. [d] Results were significant with $P < 0.05$.

Table 7: Binary logistic regression model for the amount of non-erosive drinks consumed

Parameter	Crude OR	95% CI	Adjusted OR [a]	95% CI
Tea or coffee (≥ 150/< 150 mL per day)	0.43	0.21–0.90	0.42 [b]	0.19–0.95
Milk (≥ 107/< 107 mL per day)	0.46	0.22–0.94	0.47	0.22–1.01

[a] OR adjusted for ethnicity, gender, receipt of dietary advice, and frequency of milk consumption. [b] Result was significant with $P < 0.05$.

acidic fruits consumed was not associated with the occurrence of tooth erosion. This finding is consistent with previous studies (34–36). Associations between fruit consumption and tooth erosion were reported only in studies when consumption was excessive. In case-control studies, a considerable risk of erosion has been reported when citrus foods were eaten more than twice per day (10,34). Less than half of the subjects in the present study consumed fruits 4 to 5 times per day, with a median intake of 56 g among subjects with erosion and 46 g among subjects without tooth erosion. Fruit juices are more likely to initiate tooth erosion compared with fruits themselves (37). However, we did not find a significant association between fruit juices and tooth erosion in this study ($P = 0.268$), which may be because the majority of subjects reported low fruit juice and acidic food intake.

In the present study, we found that the occurrence of tooth erosion was lower among subjects who reported greater milk consumption. One study (31) indicated that children and adults with erosion drank milk significantly less than children with no erosion. Laboratory studies have demonstrated that milk is protective against tooth erosion due to its high concentration of calcium. The calcium and phosphate in foods may have a protective effect against erosion on tooth enamel. Calcium is crucial for dental health because it helps to maintain the teeth's mineral composition in the process of demineralisation and remineralisation, which depends on dietary factors, pH, and the oral environment (2,38). Cow's milk has been demonstrated to strengthen tooth enamel by re-hardening it after exposure to acidic drinks

(4). Milk consumption among all subjects in this study was low, with a median daily consumption of 4 mL/day among subjects with tooth erosion and 46 mL/day among subjects without tooth erosion. Low consumption of milk by the subjects in this study is in agreement with data from the national survey among adults in Malaysia in 2006; the survey reports that the average milk consumption among adults was 0.14 servings per day, compared with the recommendation of 1 to 2 servings per day (39). Only 17.1% of adults in this population consumed milk 1.4 times daily (39). According to the Recommended Nutrient Intake Malaysia, adults aged 19 to 65 years should consume 800 mg of calcium per day, and the Malaysian Dietary Guidelines recommend 1–3 glasses of milk as part of a balanced diet (40). The association between the risk of having tooth erosion and milk consumption was not significant when other confounding factors were taken into account. This may be because milk consumption was low among our participants.

The present study found that tea and coffee consumption greater than 150 mL/day was associated with a reduction in the risk of tooth erosion to 42% after other confounding factors were taken into consideration. We asked the subjects in this study to recall the frequency and amount of tea and coffee consumption, but we did not specifically ask them to recall these beverages separately. We also did not ask the participants to specify whether they added milk, sugar, or both to their coffee/tea. It is possible that some subjects in this study added milk to their coffee or tea, which may have provided a protective effect. In addition, it has been reported that tea has a complex composition, and its consumption has been recognised as having some beneficial dental effects because of its appreciable fluoride content (41–43). Although tea is acidic, with a pH of 4.9, it only reduces 1 pH unit on the tooth surface, and resting pH levels are restored within approximately 2 minutes after drinking (44). Despite the possible advantages of tea, excessive consumption may lead to problems of staining of the dentition. In addition, among groups at risk of iron deficiency, such as young infants and the elderly, excessive consumption of tea should be avoided to prevent possible effects on intestinal mineral absorption. We could not find any evidence to indicate any potential protective effects of drinking coffee on tooth erosion. Further studies are highly recommended to test and clarify this finding.

The present study found that the frequency of yogurt consumption was not associated with tooth erosion. Yogurt reportedly contains high amounts of calcium and phosphate, but it is also an acidic food (16). A laboratory study (45) indicated that yogurt has no erosive potential on enamel, although it can induce the deposition of hydroxyapatite and fluorapatite, components of tooth enamel.

Subjects who reported that they had not received dietary information about healthy eating were significantly more likely to have tooth erosion compared with their counterparts. More than two-thirds of subjects reported that their most recent dental check-up was more than 6 months before the study was conducted, which indicates that dental healthcare awareness should be promoted. In this study, subjects reported that parents, relatives/friends, and television/magazines were the primary sources of dietary advice related to dental health. This indicates that dental health promotion should be channelled through parents and media to reach out to this age group. Dentists, nutritionists, and dieticians should play an important role in promoting healthy eating to maintain dental health.

Our study did not specify whether acidic foods and drinks were consumed as a meal or as a snack. Acidic foods and drinks are recommended to be consumed with meals to reduce the risk of tooth erosion, as saliva flow is high during meal time (38). In addition, the consumption of acidic drinks with swishing, holding, sipping, or using a straw was not specifically addressed in the questionnaire, which may have been very useful to study (46). This study was conducted at one of the universities in Malaysia; thus, the results of this study may not be representative of the tooth erosion occurrence and dietary patterns of the general population, due to educational status, individual preferences, and lifestyle differences. This study should be replicated using a larger sample size including subjects from a wider age range and across multiple ethnic groups. Despite these limitations, outcomes from this study have highlighted several points. First, a high occurrence of tooth erosion among young adults at the university should be addressed through oral health promotion. Second, the study supports the importance of the dietary aspect in managing tooth erosion; thus, feasible means of integrating dietary education into the dental setting and mainstream media warrants further investigation. Finally, our study demonstrates the complexity of the interaction between diet and tooth erosion in humans, as well as the need for further epidemiological studies with large, random populations.

Conclusion

This study demonstrates that subjects who consumed milk more frequently and those who had received dietary information were less likely to have tooth erosion than those who had not. The amount of tea/coffee consumed was independently associated with a reduction in the risk of tooth erosion, and this finding warrants further investigation in the future. A high occurrence of tooth erosion among university students in this study indicates that a proper health promotion programme should be implemented in schools, at the university level and in the media to increase awareness of tooth erosion and the importance of dental check-ups and healthy eating, which may help to combat tooth erosion.

Authors' Contributions

Conception and design: ZAM, NAY
Provision of study materials: BYHY, YWS
Collection and assembly of the data: LMT, NHMA, SS, JYP, BYHY, YWS
Analysis and interpretation of the data: ZAM, LMT, NHMA, SS, JYP, NHI, NAY
Statistical expertise: NHI
Drafting of the article: ZAM, LMT, NHMA, SS, JYP
Critical revision and final approval of the article: ZAM, NAY
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