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Abstract

Objectives: To investigate the prevalence and severity of tooth wear (TW) and its relationship with consumption of beverages among adults in the United States.

Methods: The National Health and Nutrition Examinations Survey data for 2003-2004 was analyzed. TW was defined as "wear on at least one surface of at least one examined tooth." Drink/juice consumption was ascertained via a Food Frequency Questionnaire processed with Diet*Calc software to obtain the average daily consumption frequency for all queried drinks and juice categories including milk. Survey-weighted descriptive and multivariable analyses with interaction terms were performed.

Results: Our study sample consisted of 3,773 adults (aged 20 and above). Eighty percent of the subjects had evidence of TW, and soft drinks were the most consumed beverage. Significant interactions between the effects of age, gender, and race/ethnicity on TW were found ($P < 0.001$). After adjustment for demographic factors, consumption of fruit drinks was found to be significantly associated with the severity [odds ratio (OR) = 1.32 and 1.42], but not prevalence of TW. However, this trend was reversed for grape juice consumption (OR = 0.34, 0.41).

Conclusions: This study demonstrates that a substantial proportion of adults had evidence of TW, which was affected by demographic factors in a complex way. Fruit drinks consumption in adults was associated with the severity of TW, but not with the prevalence of TW after adjusting for demographics. These findings are important for the development of appropriate treatment guidelines, public policy, and programs aimed at reducing TW in adults.

Introduction

In general, tooth wear (TW) is an irreversible condition that manifests as loss of dental hard tissue resulting in changes in the outer anatomical appearance of a tooth. The recognized types of TW are: erosion, abrasion, and attrition. Irrespective of whether a subject is a child or an adult, it may sometimes be difficult to ascertain the causative agent or the combination of causative factors responsible for TW.[1] In addition, the diagnosis, treatment, and measurement of TW in large population groups continues to be a challenge for clinicians and researchers.[2,3] However, the TW index developed by Smith & Knight with modifications continues to be widely used in local and national surveys around the world.[4,5]

McGuire *et al*. reported that approximately 46 percent of American children aged 13-19 years had evidence of erosive TW in at least one tooth.[6] Compared with Whites, African Americans had significantly lower rates of erosive TW.[6] In addition, it has been reported that erosive TW increases with age. With an increase of 1

Journal of Public Health Dentistry, Vol 75, No. 4 (Fall 2015): pg. 274-281. DOI.

year in age, the odds of a child having erosive TW increases by 1.3 times.[6] Nunn reported an increase in erosive TW due to increased availability and consumption of soft drinks and fruit juices in adolescents based on anecdotal evidence.[7] These studies have, to date focused primarily on the epidemiology of erosive TW in children, with limited attention from researchers and clinicians on TW in adults from both developed and developing countries.

Although researchers have published mixed results on the relationship between the erosive potential of juices/drinks and the prevalence and severity of TW in children, research is scant on identifying potential beverage predictors of TW in adults. There is therefore a need to provide generalizable information from a nationally representative sample to help improve clinicians' understanding of the dietary and treatment implications of TW in adults. The primary aim of this study was to examine the prevalence and severity of TW as well as to investigate whether an association exists between the consumption of juices, drinks, milk, demographic factors, and TW in adults living in the United States.

Materials and methods

The most recent data on TW available in the National Health and Nutrition Examinations Survey (NHANES) were analyzed. The NHANES 2003-2004 data on TW is the only publicly available national data across the lifespan for different population groups in the United States. NHANES collects data from civilian, noninstitutionalized population living in the 50 United States and the District of Columbia. Participants in the 2003-2004 database were selected based on a stratified, multistage, probability sampling design. Non-Hispanic Blacks, Mexican-Americans, persons aged 12-19 years and 60 years or older were oversampled to achieve more precise estimates for these groups.[8] Trained and calibrated examiners used the modified Smith and Knight Tooth Wear Index from a 1998 United Kingdom Adult Health Survey conducted by the Social Survey Division of the Office of National Statistics, United Kingdom, to measure TW.[8] TW was evaluated and scored visually by trained examiners who assessed the lingual, facial, and incisal surfaces of all 12 anterior teeth and the occlusal surfaces of the maxillary and mandibular first molars.[8] According to Dye *et al*., the

percent agreement for interexaminer reliability across all tooth sites for the TW sessions was 87.7 percent and the kappa was 0.80.[8] Person-level prevalence of TW was quantified as the presence of marked wear on any surface in the enamel or dentine of examined teeth. Person-level severity of TW was quantified as the highest TW score of the person (mild = highest score of 1; moderate = *highest score of 2*; *severe = highest score of 3*).

TW scoring system (Dye *et al*. 2008)[8]

Score	Description of tooth wear
0	*Sound natural tooth surface. Any wear is restricted to the enamel and does not extend into the dentin (all surfaces).*
1	*Loss of enamel just exposing the dentin (all surfaces).*
2	*Loss of enamel exposing the dentin in more than an estimated one third of the individual surface area (buccal, lingual surfaces). Loss of enamel and extensive loss of dentin, but not exposing secondary dentin or pulp. On occlusal/incisal surfaces, exposed dentin facets with a buccal-lingual dimension of 2 mm or greater at the widest point will be seen (incisal and occlusal surfaces).*
3	*Complete loss of enamel on a surface, pulp exposure, or exposure of secondary dentin where the pulp used to be. Frank pulp exposure is most unlikely (buccal, lingual surfaces). Pulp exposure or exposure of secondary dentin (incisal, occlusal surfaces).*

In addition, NHANES collected data on beverage consumption over a 12-month period through a food frequency questionnaire that was processed using the Diet*Calc software (Diet*Calc Analysis Program, Version 1.4.3., National Cancer Institute, Applied Research Program) to obtain daily frequencies. This resulted in intake frequency values from 0 (never) to 7 (6 or more times a day) for milk (as a beverage), tomato/vegetable juice, orange/grapefruit juice, apple juice, grape juice, other fruit juice, fruit drinks (such as Hi-C and lemonade), soda in the summer, and soda during the rest of the year. In addition, our choice of the different beverage categories included in this analysis was based on what was available in the NHANES database. The seasonal soda measurement was combined using a weighted average (1/4 weight for summer) to reflect average annual consumption. Race/ethnicity was combined into racial subdivisions (White, Black, Other) among non-Hispanic respondents only. The study was approved by the Marquette University Institutional Review Board.

Statistical analysis

The general analysis approach followed the NHANES analytical guidelines in adjusting for the survey design. The analysis was performed using SAS 9.2 (SAS Institute, Cary, NC, USA), and the SURVEYFREQ, SURVEYLOGISTIC, and SURVEYREG procedures were used as appropriate. Rao-Scott chi-square tests were performed to investigate bivariate associations between prevalence/severity of TW and demographic variables: gender, age, race/ethnicity, family income, and education level. Survey-weighted *t*-tests were performed to compare the daily beverage consumption between populations with and without TW. Survey-weighted one-way analysis of variance analyses were performed to compare the daily beverage consumption between different severities of TW.

Because the proportional odds assumption in the multivariate ordinal logistic regression was not fulfilled (score test, $P < 0.001$), three separate weighted multivariable binary logistic regressions were performed to evaluate the effects of different beverage consumption on the prevalence and severity of TW. These multivariable logistic regressions were conducted with an adjustment for age, gender, and race/ethnicity; their interactions (age × gender, gender × race/ethnicity, age × race/ethnicity, and age × gender × race/ethnicity); family income; and education level. A two-sided 5 percent significance level was used for all analyses.

Results

Our study sample consisted of 3,773 adults (20 years to 65 and above), 79.8 percent had evidence of TW, 64.4 percent had mild TW (highest TW score of 1), 10.2 percent had moderate TW (highest score of 2), and 5.2 percent had severe TW (highest score of 3). Table 1 shows the prevalence and severity of TW by demographic factors. Significant differences were found in the percentages of TW for age (lowest in 20-24 years old, 62.8 percent, $P < 0.001$), gender (lowest in female, 75.9 percent, $P < 0.001$), and race/ethnicity (lowest in non-Hispanic Black, 65.0 percent, $P < 0.001$) for prevalence of TW. In terms of the relationship between the severity of TW and demographic factors, significant differences in severity of TW were found between

Journal of Public Health Dentistry, Vol 75, No. 4 (Fall 2015): pg. 274-281. DOI.

age groups ($P < 0.001$), race/ethnicity ($P < 0.001$), gender ($P < 0.001$), and education level ($P = 0.003$). As age increased, so did percentages of moderate and severe TW, and the reverse was the case in the group without TW. Percentages of females with moderate and severe TW (5.2 percent and 1.6 percent) were lower than those of males (13.2 percent and 4.6 percent), whereas the percentage of females without TW (24.1 percent) was higher than that of males (14.9 percent). Percentages of non-Hispanic Blacks with moderate and severe TW (4.8 percent and 1.3 percent) were lower than those of non-Hispanic Whites (9.1 percent and 3.0 percent). The percentage of non-Hispanic Blacks without TW was the highest (35.0 percent) among all racial/ethnic groups. College graduates or those with higher education levels had lower percentages of moderate and severe TW (7.7 percent and 2.7 percent) than those with less than grade 12 or grade 12 levels with no diploma (10.3 percent and 6.0 percent).

Table 1. Prevalence and Severity of Tooth Wear by Demographic Variables

		Prevalence			Severity			
Characteristics	***n***	**Without TW % Score 0 (SE)**	**With TW % Score 1-3 (SE)**	***P*-value**	**% Score 1 (SE)**	**% Score 2 (SE)**	**% Score 3 (SE)**	***P*-valuea**
Age years ($n = 3,773$)				<0.001				<0.001b
20-24	430	37.2 (6.8)	62.8 (6.8)		60.4 (6.9)	2.3 (0.5)	0	
25-34	753	27.0 (5.0)	73.0 (5.0)		69.1 (5.2)	2.9 (0.7)	0.9 (0.5)	
35-44	663	17.7 (4.5)	82.3 (4.5)		72.5 (4.0)	8.4 (1.1)	1.4 (0.5)	
45-54	608	14.5 (2.8)	85.5 (2.8)		70.7 (3.0)	12.5 (1.5)	2.3 (0.8)	
55-64	494	11.0 (3.4)	89.0 (3.4)		70.8 (3.1)	12.8 (2.3)	5.4 (1.3)	
65 or above	825	12.6 (1.5)	87.4 (1.5)		59.7 (1.8)	16.6 (1.6)	11.1 (1.4)	
Gender ($n = 3,773$)				<0.001				<0.001

[a]*P*-value for chi-square test comparing the subjects across severity scores 0-3.

[b]The *P*-value of chi-square test cannot be obtained since there was one empty cell for highest tooth wear score of 3 in the 20- to 24-year-old group. This *P*-value was obtained by a multinomial logistic regression predicting severity from age.

Characteristics	*n*	Prevalence			Severity			
		Without TW % Score 0 (SE)	With TW % Score 1-3 (SE)	*P*-value	% Score 1 (SE)	% Score 2 (SE)	% Score 3 (SE)	*P*-valuea
Male	1,832	14.9 (3.0)	85.1 (3.0)		67.3 (2.5)	13.2 (1.1)	4.6 (0.3)	
Female	1,941	24.1 (4.3)	75.9 (4.3)		69.1 (4.1)	5.2 (0.7)	1.6 (0.4)	
Race/ethnicity (*n* = 3,773)				<0.001				<0.001
Hispanic	895	13.9 (3.2)	86.1 (3.2)		69.9 (2.7)	11.9 (1.1)	4.3 (1.0)	
Non-Hispanic White	1,950	18.6 (3.7)	81.4 (3.7)		69.3 (3.3)	9.1 (1.0)	3.0 (0.3)	
Non-Hispanic Black	772	35.0 (6.8)	65.0 (6.8)		58.9 (6.4)	4.8 (0.7)	1.3 (0.3)	
Other	156	13.0 (5.3)	87.0 (5.3)		70.1 (4.9)	11.3 (3.4)	5.5 (2.4)	
Education (*n* = 3,771)				0.138				0.003
≤Grade 12/ Grade 12 with no diploma	971	18.8 (2.7)	81.2 (2.7)		64.9 (2.8)	10.3 (1.3)	6.0 (0.7)	
High school grad/GED or equivalent	946	16.8 (3.5)	83.2 (3.5)		69.8 (3.0)	10.4 (1.5)	3.1 (0.8)	
Some college or AA degree	1,083	21.8 (4.6)	78.2 (4.6)		67.8 (4.4)	8.5 (0.6)	1.9 (0.4)	
College graduate or above	771	20.2 (3.8)	79.8 (3.8)		69.4 (3.6)	7.7 (1.3)	2.7 (0.6)	
Annual family income (*n* = 3,584)				0.350				0.079
$0-$9,999	384	25.7 (5.2)	74.3 (5.2)		65.0 (4.5)	6.2 (1.1)	3.1 (1.3)	
$10,000-$19,999	694	19.0 (3.5)	81.0 (3.5)		65.2 (4.2)	11.7 (1.4)	4.0 (0.9)	
$20,000-34,999	808	21.5 (4.3)	78.5 (4.3)		65.1 (4.1)	10.1 (1.0)	3.4 (0.6)	
$35,000-$54,999	674	18.4 (3.9)	81.6 (3.9)		67.8 (4.4)	9.4 (1.6)	4.3 (1.1)	
$55,000-$74,999	367	18.0 (4.1)	82.0 (4.1)		73.4 (4.4)	7.3 (1.8)	1.3 (0.5)	
$75,000 or above	657	18.6 (4.3)	81.4 (4.3)		71.0 (4.4)	8.2 (1.1)	2.2 (0.6)	

Figure 1 shows the distribution of TW by age, gender, and race/ethnicity. There was significant interaction effect by age, gender, and race/ethnicity in the prevalence and severity of TW (data not shown). For all racial/ethnic groups (except other), an increasing trend of prevalence of TW was observed with increasing age. Females had significantly lower prevalence of TW among non-Hispanic Blacks and non-Hispanic Whites aged 20-54 years old ($P < 0.05$). Within the racial/ethnic, gender, and age groups, non-Hispanic Blacks had the lowest prevalence of TW (except among males aged 65 or above in the "Other" racial/ethnic group) (data not shown). It was observed that the percentages of moderate and severe TW were much lower in females in all racial/ethnic groups. In addition, the percentages of groups with moderate and severe TW increased faster with age in Hispanic than in non-Hispanic Whites and the increasing trend in non-Hispanic Blacks was the slowest (data not shown). The level 3 interaction (age × gender × race/ethnicity) was found to be significant in the multivariable binary logistic regression with the demographics and their interactions ($P < 0.001$, data not reported).

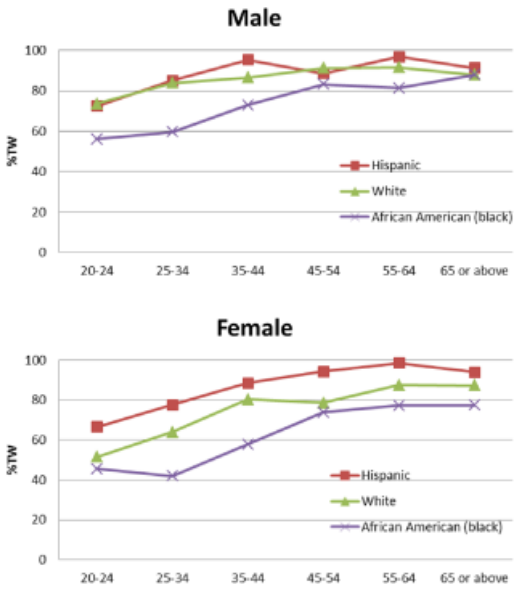

Figure 1. Distribution of tooth wear by age, gender, and race/ethnicity ($n = 3,773$).

Beverage consumption data were available for approximately 2,900 adults. Table 2 shows the bivariate results of the consumption of different beverages with prevalence and severity of TW. Overall, the most consumed (1.11 times per day) beverage by participants was

soft drinks, and grape juice was the least (0.08 times a day). Although not statistically significant, the most consumed beverage was soft drinks (1.08 and 1.20) among groups with and without TW, whereas milk was the second highest consumed (0.58 and 0.50, $P = 0.022$) among the group.

Table 2. Bivariate Relationship between Prevalence, Severity, and the Consumption of Different Beverages and Tooth Wear

Beverage	*n*[a]	Overall mean daily frequency of consumption (SE)	Mean daily frequency of consumption (SE)						
			Prevalence			Severity			
			Without TW Score 0	With TW Score 1-3	*P*-valueb	Score 1	Score 2	Score 3	*P*-valuec
Apple juice	2,925	0.13 (0.01)	0.14 (0.02)	0.13 (0.01)	0.606	0.13 (0.02)	0.09 (0.02)	0.17 (0.07)	0.160
Fruit drinks	2,887	0.31 (0.03)	0.39 (0.05)	0.29 (0.02)	0.046	0.28 (0.03)	0.31 (0.06)	0.35 (0.07)	0.049
Grape juice	2,929	0.08 (0.01)	0.09 (0.01)	0.08 (0.01)	0.371	0.08 (0.01)	0.05 (0.01)	0.05 (0.01)	0.001
Milk	2,912	0.56 (0.03)	0.50 (0.04)	0.58 (0.03)	0.022	0.57 (0.04)	0.59 (0.04)	0.66 (0.09)	0.071
Orange/grapefruit juice	2,919	0.39 (0.02)	0.40 (0.04)	0.38 (0.02)	0.638	0.37 (0.02)	0.43 (0.04)	0.48 (0.11)	0.572
Other juice	2,927	0.16 (0.01)	0.16 (0.02)	0.17 (0.02)	0.898	0.17 (0.02)	0.13 (0.03)	0.22 (0.08)	0.389
Soft drinks	2,745	1.11 (0.07)	1.20 (0.13)	1.08 (0.06)	0.323	1.11 (0.07)	0.95 (0.05)	0.97 (0.12)	0.231
Tomato/vegetable juice	2,917	0.09 (0.01)	0.07 (0.01)	0.09 (0.01)	0.016	0.09 (0.01)	0.07 (0.01)	0.28 (0.04)	0.023

1. [a]Number of subjects with reported juice consumption frequency.
2. [b]*P*-value for *t*-test comparing the subjects with and without TW.
3. [c]*P*-value for ANOVA comparing the subjects across severity scores 0-3.

In terms of TW severity, there were significant differences in the consumption of fruit drinks, grape juice, and tomato/vegetable juice ($P < 0.05$). A U-shaped pattern was observed, showing that consumption of fruit drinks was more frequent among those with no TW and severe TW (respectively, 0.39 and 0.35 time daily) compared with those with moderate and mild TW (respectively, 0.28 and 0.31 time daily). Severity of TW decreased with consumption of grape juice from 0.09 to 0.05 times a day. Consumption of tomato/vegetable juice was more frequent among those with severe TW (consumed 0.28 times daily) compared with those with moderate, mild, and no TW (respectively, 0.07, 0.09 and 0.09 time daily).

Journal of Public Health Dentistry, Vol 75, No. 4 (Fall 2015): pg. 274-281. DOI.

Because there were only 156 subjects in the "other" race/ethnicity group, weighted multivariable binary logistic regression analysis investigating the effects of different beverage consumption on the presence of TW was performed with only three major race/ethnicity groups (Hispanic, non-Hispanic White, and non-Hispanic Black). After adjusting for demographic factors and their interaction effects, the significant predictors at the bivariate level were no longer associated with the prevalence of TW at 5 percent significance level (Table 3).

Table 3. Weighted Bivariate and Multivariable Logistic Regression for Factors Associated with Consumption of Different Beverages on the Prevalence and Severity of Tooth Wear (without Other Race/Ethnicity) (n = 2,408)

Beverage	**Prevalence**			**Severity**					
	Score 0a versus 1,2,3			**Score 0,1a versus 2,3**			**Score 0,1,2a versus 3**		
	Unadjusted odds ratio (95% CI)	**Adjusted odds ratio (95% CI)**	***P*-value[b]**	**Unadjusted odds ratio (95% CI)**	**Adjusted odds ratio (95% CI)**	***P*-value[b]**	**Unadjusted odds ratio (95% CI)**	**Adjusted odds ratio (95% CI)**	***P*-value[b]**
Apple juice	0.93 (0.79, 1.09)	1.11 (0.82, 1.48)	0.506	0.90 (0.63, 1.27)	0.90 (0.54, 1.50)	0.676	1.21 (0.90, 1.63)	1.27 (0.72, 2.23)	0.411
Fruit drinks	**0.86 (0.76, 0.98)**	1.02 (0.91, 1.14)	0.786	1.05 (0.88, 1.26)	**1.32 (1.09, 1.61)**	**0.005**	1.11 (0.91, 1.35)	**1.42 (1.10, 1.84)**	0.008
Grape juice	0.92 (0.77, 1.10)	1.00 (0.68, 1.46)	0.993	**0.40 (0.17, 0.94)**	**0.34 (0.15, 0.76)**	**0.008**	0.60 (0.29, 1.24)	**0.41 (0.21, 0.82)**	0.011
Orange/grape juice	0.94 (0.82, 1.06)	0.90 (0.75, 1.08)	0.244	1.07 (0.92, 1.25)	1.19 (0.93, 1.51)	0.173	1.11 (0.85, 1.46)	0.91 (0.73, 1.13)	0.376
Tomato/vegetable juice	1.18 (0.84, 1.66)	1.04 (0.75, 1.45)	0.813	1.10 (0.82, 1.48)	0.85 (0.52, 1.39)	0.510	**1.44 (1.10, 1.88)**	1.24 (0.93, 1.65)	0.141
Other juice	0.98 (0.85, 1.13)	1.18 (0.99, 1.42)	0.070	0.95 (0.78, 1.17)	1.00 (0.68, 1.46)	0.999	1.14 (0.88, 1.48)	1.01 (0.63, 1.60)	0.977
Milk	**1.13 (1.03, 1.23)**	1.09 (0.99, 1.21)	0.091	1.03 (0.93, 1.14)	1.00 (0.87, 1.14)	0.950	1.07 (0.91, 1.27)	0.98 (0.83, 1.17)	0.857

1. [a]Adjusted for age-group, gender, race/ethnicity, and all their interactions, family income, and education level.
2. [b]*P*-values for the adjusted logistic regression models.

Beverage	Prevalence			Severity					
	Score 0a versus 1,2,3			Score 0,1a versus 2,3			Score 0,1,2a versus 3		
	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	*P*-value b	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	*P*-value b	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	*P*-value b
Soft drinks	0.95 (0.86, 1.05)	0.97 (0.86, 1.09)	0.610	0.90 (0.81, 1.00)	0.95 (0.84, 1.06)	0.327	0.93 (0.80, 1.09)	1.04 (0.91, 1.19)	0.596

Table 3 also shows the results from the multivariate logistic regression analysis on the relationship between the severity of TW and consumption of different beverages after the adjustment for demographic factors and interaction effects. Consumption of fruit drinks and grape juice remained significant predictors associated with severity of TW ($P < 0.05$). For every one more fruit drink consumed a day, the odds of participants having moderate or severe TW relative to no or mild TW was 32 percent more [odds ratio (OR) = 1.32, 95 percent confidence interval (CI): 1.09-1.61], whereas the odds of participants having severe TW relative to all other TW categories was 42 percent more (OR = 1.42, 95 percent CI: 1.10-1.84). On the other hand, the trend was reversed with grape juice consumption. The odds of having moderate or severe TW were 66 percent lower for every unit increase in grape juice consumption a day (OR = 0.34) and similarly 59 percent lower for the odds of severe TW (OR = 0.41, 95 percent CI: 0.21-0.82).

Discussion

This study expands the literature on the documentation of the growing public health concern regarding TW and provides prevalence and severity data as well as associated factors related to TW in adults in the United States. The study shows that a substantial proportion of adults living in the United States had some evidence of TW, with a mild form of TW being the most common in terms of the severity. Bartlett *et al*. in a study of TW among young adults from seven European countries based on the Basic Erosive Wear Examination (BEWE) reported that 26 percent had evidence of TW limited to enamel (score 2) and 3.3 percent had evidence of TW into dentine (score 3).[9] However, BEWE is designed for the examination of a few

teeth and for monitoring the severity and progression of erosive TW in a dental practice and somewhat unsuitable for epidemiological studies.

Another study conducted by Xhonga-Oja and Valdmanis using a convenience sample of dental school patients in Los Angeles and Boston reported that the prevalence of dental erosion among adults was 25 percent.[10] Our finding on the prevalence of TW is in contrast with the few published reports that are based on convenience and nationally representative samples of adults from different countries. However, our data provide additional documentation on the prevalence, severity, and the relationship between demographic factors and TW among adults in the United States.

Most studies conducted in children have identified significant predictors related to the prevalence and severity of TW and dental erosion. However, the relationship between extrinsic factors is complex and difficult to interpret because of the interaction effect displayed by the different variables included in the different analyses.[11] Reporting and interpretation of our findings regarding the identification of significant predictors related to prevalence and severity of TW was complex because of the significant interaction effects between age, gender, and race/ethnicity. In our study, TW prevalence and severity increased with age. These findings were fairly consistent with previous studies in children and adults based on convenience, longitudinal studies, and national representative samples from both developing and developed countries.[12-17] Although our dataset did not contain information on diet, brushing habits, bruxism, and enamel composition, it is important to recognize the role of these factors in the prevalence and severity of TW.[11] Lussi *et al*. reported that the effect of tooth brushing is somewhat dependent on the bristle stiffness,[12] but more studies are required to reinforce this finding.

Another interesting finding was that gender was significantly associated with prevalence and severity of TW in adults, a result that is consistent with some previous studies on dental erosion and TW conducted in children, adolescents, and young adults.[1,18-21] However, it remains unclear whether this relationship is influenced by biological or behavioral factors, or indeed both.[22] In addition, compared with non-Hispanic Whites, non-Hispanic Blacks had lower prevalence of TW, a

finding consistent with that found in children based on the same NHANES data.[6]

With increased consumption of beverages in North America among adults, there is a need to explore the relationship between consumption of beverages and the occurrence/progression of TW and dental erosion. However, previous studies have reported mixed results from clinicians, laboratory scientists, and epidemiological researchers. In this study, drinks/fruit juice and soft drinks were the most consumed beverages by adults. The consumption of fruit drinks was significantly associated with the severity of TW. This finding is in contrast with prior studies in children and adults.[2,9,18] In addition, some studies have indicated that the erosive potential of fruit drinks are related to the acidity and frequency of intake. However, NHANES data did not contain this information for our evaluation.[9,22,23] Although not statistically significant, our study demonstrates that the largest absolute difference in mean soft drink consumption between subjects with and without TW was based on severity. In addition, there were only weak to moderate correlations between the consumption of different juices/drinks. The consumption of grape juice was significantly associated with the severity of TW. Although this might be an unusual finding, it is important for future studies to determine the underlying pathological mechanisms.

In our study, milk was the second highest consumed product on average in the list of beverage information collected. Aidi *et al*. reported that erosive TW was less likely to progress in subjects who consumed milk.[24] In our study, the prevalence of TW was significantly associated with the mean consumption of milk among subjects with and without TW, but not with the severity of TW at the bivariate level. After adjusting for available covariates, the relationship with prevalence of TW became almost nonexistent. This is particularly interesting given that milk protein has been documented to contribute to the protective effect of the salivary pellicle. In addition, it is documented that the fluoride present in milk forms fluorohydroxyapatite or fluorapatite and has a protective effect on the tooth surface. However, future studies are required to identify mechanisms of the possible protective effect of milk in TW from longitudinal studies especially in adults.[25]

To the best of our knowledge, this is the first study to report on the prevalence and severity of TW and its relationship with drink/juice consumption in a large, nationally representative sample of US adults. However, our study is subject to some limitations. First, the data analyzed is based on self-reports and subject to random and systematic reporting errors as well as coding errors. Second, NHANES is a cross-sectional study, which makes it impossible to ascertain a cause–effect relationship, but is robust enough to identify potential risk factors associated with TW. In addition we are unable to adjust for all potential covariates such as gastroesophageal reflux in our analysis because it was not collected. Third, the study only examined current consumption of drinks/juice and not total consumption by subjects since tooth eruption. Therefore, we are unable to account for all previous consumption that could have potentially affected our results. Nevertheless, studies have documented that estimates derived from food frequency questionnaires closely match those from 24-hour dietary recalls or food records.[26,27] Fourth, the TW index used in the study consist of scores that do not take into consideration the age of the patient or other criteria for identifying pathological forms of wear.[28] Finally, we recognize that our findings should be interpreted with caution due to differences in study population, type of indices used to record TW, and the level of training and calibration of examiners used for data collection. Our study highlights and suggests that TW is prevalent and severe within the United States and warrants further consideration by clinicians and researchers. If left unchecked, this problem could affect prevalence and severity of TW in adults. In addition, our study analyzed a nationally representative sample of adults identified for providing national estimates for monitoring health outcomes and disease burden in the United States. Our study demonstrates that a substantial proportion of adults shows evidence of TW by demographic factors in a complex way. Fruit drinks consumption in adults was associated with severity of TW but not with the prevalence of TW after adjusting for demographics.

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