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## Permanent tooth loss and sugar-sweetened beverage intake in U.S. young adults

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### Abstract

**Objective:** In young adults, sugar-sweetened beverage (SSB) intake is associated with dental caries, which in turn is a major contributor to tooth loss. The independent role of SSB intake on tooth loss, however, has not been well-described. This cross-sectional study examined associations between tooth loss and SSB intake among U.S. young adults.

**Methods:** The outcome was number of permanent teeth lost because of dental caries or periodontal disease (0, 1–5, 6 teeth). Data from the 2012 Behavioral Risk Factor Surveillance System were used. The 22,526 adults aged 18–39 years completed the Sugar Drink Module. The exposure variable was daily frequency of SSB intake. We used multinomial logistic regression to examine the adjusted associations between tooth loss and daily SSB consumption (0, >0 to <1, 1–2, >2 times/day).

**Results:** Approximately, 26% of young adults reported losing at least one permanent tooth. Tooth loss was positively associated with SSB intake frequency; the odds of losing 1–5 teeth were higher among adults drinking SSBs >0–<1 times/day (OR = 1.44, 95%CI = 1.16–1.79), 1–2 times/day (OR = 1.58, 95%CI = 1.25–1.99), and >2 times/day (OR = 1.97, 95%CI = 1.51–2.58) than non-SSB consumers. The odds of losing 6 teeth were higher among adults drinking SSBs 1–2 times/day (OR = 2.20, 95%CI = 1.15–4.22) and >2 times/day (OR = 2.81, 95%CI = 1.37–5.76) than non-SSB consumers.

**Conclusions:** Frequency of SSB consumption was positively associated with tooth loss among young adults even when the average SSB intake was less than one time per day. This study suggests that efforts to reduce SSB intake among young adults may help to decrease the risk of tooth loss.

### Keywords

tooth loss; dental caries; oral health; dietary sugars; young adult; behavioral risk factor surveillance system

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## Introduction

Oral health is essential to overall health and well-being. Poor oral health can lead to pain and tooth loss; evidence of links to chronic diseases like diabetes and heart disease is mounting (1). Poor oral health is costly as well. Estimated total expenses of dental services, based on data from Medical Expenditure Panel Survey, was \$83 billion among the U.S. civilian noninstitutionalized population in 2010 (2).

Loss of permanent teeth is a key surveillance indicator used to monitor overall oral health at the population level (3). Data from the Behavioral Risk Factor Surveillance System (BRFSS) data suggest the median prevalence of losing any permanent teeth among U.S. adults aged 18 years has declined from 50.2% in 1999 to 43.6% in 2010, but tooth loss still is common, and disparities among certain groups remain (4). Higher prevalence of tooth loss was found among older adults, black adults, current smokers, and those adults earning lower-income and having lower educational attainment than their counterparts (4,5).

Sugar-sweetened beverages (SSBs) are drinks such as regular soda, fruit drinks, sports drinks, and energy drinks that have been flavored with added sugars (6); in adults living in the United States, SSBs are the most common sources of added dietary sugars (7). Young adults have been shown to consume larger amounts of SSBs than middle-aged or older adults (8,9). SSBs adds very little if any or no nutritional value to the body (10). The association between frequent SSB intake and adverse health outcomes such as obesity, type 2 diabetes, cardiovascular disease, and kidney disease has been reported (11–13).

Dental caries (tooth decay) and periodontal disease (gum disease) are two main causes of tooth loss among adults (14–16). Studies in Nepal, the United Kingdom, and Iran indicated that the most common reasons for tooth loss were dental caries among young adults and periodontal disease among older adults (14–16). Sugars are implicated in the etiology of dental caries. A few studies reported a positive association between SSB consumption and dental caries among adults (17) and young children (18), and a recent systematic review reported positive association between sugars intake and dental caries (19). It should be noted that the majority of previous studies about sugars intake and dental caries were conducted in children while only a few studies were conducted in adults, mainly among those aged 30 years and older (19). Researchers found that substantial tooth loss can be associated with lower intake of fruits, vegetables, and other nutrient-rich foods (20,21). Information is lacking, however, on sugars intake's independent role in the loss of permanent teeth among young adults in the United States.

A better understanding of the relationship between tooth loss and frequent SSB consumption could help public health practitioners enhance efforts to prevent tooth loss and improve oral health among young adults. In this cross-sectional study, we aimed to describe the prevalence of permanent tooth loss due to dental caries or periodontal disease by frequency of SSB consumption among young (18–39 years) adults in the United States. We also examined the association between permanent tooth loss and frequency of SSB consumption after controlling for socio-demographic characteristics and several risk factors.

## Methods

### Study design and participants

We used 2012 BRFSS data. The BRFSS, established by the Centers for Disease Control and Prevention (CDC) in 1984, is a state-based, random-digit-dialed telephone survey of the noninstitutionalized U.S. population aged 18 years and older. It monitors health risk, use of preventive services, and behaviors associated with morbidity and mortality primarily related to chronic disease. Detailed description of the survey method is available elsewhere (22), and all data sets and yearly questionnaires are available at [www.cdc.gov/brfss](http://www.cdc.gov/brfss). In 2012, 18 states (California, Delaware, Georgia, Hawaii, Iowa, Kansas, Maryland, Minnesota, Mississippi, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New York, Oklahoma, South Dakota, and Tennessee) administered an optional BRFSS Sugar Drink Module. For the current study, we restricted our analyses to young adults aged 18 to 39 years. Although 23,447 young adults completed the Sugar Drink Module, we excluded participants with missing data on tooth loss ( $n = 126$ ), past-year dental visit ( $n = 139$ ), smoking ( $n = 70$ ), and diabetes history ( $n = 586$ ), leaving a final analytic sample of 22,526 young adults in 18 states.

### Variables

The outcome variable was permanent tooth loss due to dental caries (tooth decay) or periodontal disease (gum disease). One question asked survey participants about the number of permanent teeth they had lost: “How many of your permanent teeth have been removed because of tooth decay or gum disease? Include teeth lost to infection, but do not include teeth lost for other reasons, such as injury or orthodontics. (If wisdom teeth are removed because of tooth decay or gum disease, they should be included in the count for lost teeth.)” From the predefined 4 response categories (0, 1–5, 6 or more but not all, and all), we created 3 categories as 0 (loss of no teeth), 1–5 (loss of 1–5 teeth), and 6 (loss of six or more teeth). The main exposure variable was frequency of SSB intake. There were two questions about SSB consumption: “During the past 30 days, how often did you drink regular soda or pop that contains sugars? Do not include diet soda or diet pop” and “During the past 30 days, how often did you drink sweetened fruit drinks, such as Kool-Aid, cranberry juice cocktail, and lemonade? Include fruit drinks you made at home and added sugars to.” Respondents reported either the daily, weekly, or monthly intake frequency. Weekly or monthly intake was converted to daily intake by dividing weekly intake by 7 and monthly intake by 30. Then, we summed the consumption of regular soda and fruit drinks to calculate total daily SSB intake. The frequency of total SSB intake was categorized as 0, >0 to <1, 1 to 2, and >2 times/day.

Covariates were sex (18–25, 26–32, 33–39 years), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic others), annual household income ( $\$0 < \$25,000$ ,  $\$25,000 < \$49,999$ ,  $\$50,000 < \$74,999$ ,  $\$75,000$ , unknown), education (<high school diploma, high school diploma, some college, college graduate), and marital status (never married, single, married/couple). We also adjusted for past-year dental visit (yes or no) (any visit to a dentist or dental clinic, including dental specialists), because having regular dental visits has been associated with reduced risk of tooth loss (23). Lastly, dental



when we further controlled for alcohol intake during the past month, the key findings remained the same.

## Discussion

We observed that 1 in 4 young adults in the United States reported having lost at least one permanent tooth due to dental caries or periodontal disease, and almost 2 out of 5 young adults reported drinking SSBs at least once a day. In adjusted analyses, young adults drinking SSBs more often were likely to have greater odds of losing permanent teeth. Even for those who drink SSBs on average less than one time per day, their odds of losing 1 to 5 teeth were still likely to be higher than non-SSB drinkers.

In this study, we were not able to differentiate between tooth loss due to dental caries versus periodontal disease. But, based on previous studies that found dental caries to be the major cause of tooth loss among young adults (14–16), we limited our analyses among young adults. For example, Upadhyaya and Humagain reported that for 21 to 30 years of age, the highest proportion of tooth extraction was due to caries, for those 51 to 60 years of age, it was due to periodontal disease in Nepal (14). Hull et al. also reported that caries was the main reason for tooth extraction in patients under 50 years of age, whereas periodontal disease was the factor responsible in the over-50 age group (15). Furthermore, findings from the 2009–2012 National Health and Nutrition Examination Survey (NHANES) suggest that the prevalence of severe periodontitis was higher in older adults: 2.2% among individuals aged 30–34 years versus 11% in adults aged 65 years (26).

In previous studies, findings regarding the relationships between the amount or frequency of sugars intake (including SSBs) and dental caries have been inconsistent; the majority of these studies have been conducted among children or adolescents (18,19,27,28). A cross-sectional study reported no association between dental caries and frequency of sugars intake among 236 school children (27). A systematic review supported a relationship between the amount of sugars consumed and dental caries among children and adults (19). Árnadóttir et al. indicated an association between sugars intake frequency (rather than amount of sugars intake) and caries among 150 Icelandic teenagers (28). Although the development of dental caries represents a multifactorial disease, and the relationship between sugars intake and caries may not be straightforward, sugar is known to be a fermentable carbohydrate and can be cariogenic through its fermentation by oral bacteria producing acid, which can dissolve the tooth enamel (29).

In the NHANES III study (1988–1994), Lula et al. reported that high intake of added sugars is likely to be related to a greater prevalence of periodontal disease in adults aged 18–25 years (30). The authors suggested that hyperglycemia resulting from increased sugars intake is associated with systematic inflammation, which is further related to periodontal disease. Whether or not sugars intake actually plays a role in periodontal disease, the mechanisms for such association have not been well-established (30).

Researchers have documented higher SSB consumption among young adults than older adults (6–9). More than 40% of U.S. adults aged 18–24 years drank SSBs daily, whereas

19% of adults aged 55 and older did so (9). However, there is limited evidence on the independent association between SSB consumption and tooth loss among young adults. While our study helps to fill this knowledge gap and suggested that increased SSB intake is likely to be associated with greater odds of tooth loss, further research is needed to examine associations between sugars intake from other foods (e.g., solid foods) and tooth loss because properties of sugars intake from SSBs or solid foods can be very different.

We observed that certain populations face significant disparities in their oral health, a finding that was consistent with that of a previous study (5,31). We also observed that women, older adults, those with lower-incomes and educational attainment, adults who were single, individuals with no past-year dental visit, participants with diabetes, and current or former smokers had increased prevalence of having lost at least some of their permanent teeth. Although the prevalence of permanent tooth loss in U.S. adults is decreasing, it is still a common health problem and can substantially reduce one's quality of life and daily functioning throughout their remaining life.

This study is subject to some limitations. First, BRFSS collects self-reported data, which are subject to report or recall bias. Second, we assumed the amount of SSB consumption during the past 30 days represented the participants' overall habitual behavior. Although there is limited information on longitudinal associations of SSB intake between adolescence and adulthood, previous studies showed significant longitudinal associations of SSB intake between infancy and young childhood (32) as well as between young childhood and adolescence (33). Similarly, even though the past-year dental visit was considered a surrogate variable of dental health behavior, it may not necessarily represent other behaviors related to dental health, such as oral hygiene, intake of fluoridated water, and use of fluoride products. In addition, an individual may have visited a dentist to have a tooth extracted or to be treated for cavities, which may confound the relationships between SSB and tooth loss found in this study. Third, regular soda and fruit drinks were the only SSBs counted in the survey. Thus, other types of SSBs, such as sweetened coffee or tea drinks and sports drinks, were not included in the study. Fourth, findings in this study were based on data collected from only 18 states participating in the BRFSS Sugar Drink Module; therefore, we cannot generalize the results to the entire young adult population in the United States. Fifth, there is a recognized association between long-term use of methamphetamine and severe dental caries, and the majority of users are young adults (34,35), but BRFSS did not ask participants about such recreational drug use. Therefore, our study may not rule out the potential confounding effect of methamphetamine use. Sixth, lack of information on other dietary intake (such as starchy food) is a limitation that may not be ignored. Seventh, some of the studies we cited are 20 years old or were conducted in countries with varying cultures, diets, and other factors, so application to today's U.S. population may be of limited value (14–16). Nevertheless, the lack of recent studies in applicable settings does underscore the need for such research to be conducted. Lastly, BRFSS is cross-sectional data. the causal relationship between SSB intake and tooth loss cannot be determined in this study.

In conclusion, we observed individuals drinking increased frequency of SSBs were likely to have increased odds of tooth loss among young adults aged 18–39 years in the United States. The association was likely to be preserved even when the average frequency of daily SSB

intake was low—less than one time per day. Permanent tooth loss has life-long effects. Young adults should be aware of adverse health consequences of frequent SSB intake including oral disease and tooth loss in addition to obesity and type 2 diabetes. Efforts to reduce SSB consumption can be more efficacious when implemented early in childhood, because dietary behaviors such as frequent SSB intake may begin earlier in one's lifetime (32).

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## References

1. Review of the oral disease-systemic disease link. Part 1: heart disease, diabetes. *Canadian Journal of Dental Hygiene*. 2006 Nov-Dec; 40(6):288–342.
2. Oral health; preventing cavities, gum disease, tooth loss, and oral cancers at a glance 2011 Available from: <https://stacks.cdc.gov/view/cdc/11862>
3. Healthy People. Washington, DC: U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion 2020 Available from: <http://www.healthypeople.gov>
4. The BRFSS Prevalence & Trends Data Atlanta: Centers for Disease Control and Prevention Available from: <http://www.cdc.gov/brfss/brfssprevalence/>
5. Dye B, Thornton-Evans G, Li X, Iafolla T. Dental caries and tooth loss in adults in the United States, 2011–2012. *NCHS Data Brief*. 2015;197:1–8.
6. U.S. Department of Agriculture, U.S. Department of Health and Human Services Dietary guidelines for Americans, 2010. 7th ed. Washington, DC: U.S. Government Printing Office; 2010 Available from: <http://health.gov/dietaryguidelines/dga2010/dietaryguidelines2010.pdf>
7. Drewnowski A, Rehm CD. Consumption of added sugars among US children and adults by food purchase location and food source. *Am J Clin Nutr*. 2014;100(3):901–7. [PubMed: 25030785]
8. Kit BK, Fakhouri TH, Park S, Nielsen SJ, Ogden CL. Trends in sugar-sweetened beverage consumption among youth and adults in the United States: 1999–2010. *Am J Clin Nutr*. 2013; 98(1):180–8. [PubMed: 23676424]
9. Park S, Xu F, Town M, Blanck HM. Prevalence of sugar-sweetened beverage intake among adults—23 States and the District of Columbia, 2013. *MMWR Morb Mortal Wkly Rep*. 2016;65(7):169–74. [PubMed: 26914018]
10. U.S. Department of Agriculture. Agricultural Research Service. USDA National Nutrient Database for Standard Reference, Release 28 Nutrient Data Laboratory. Washington, DC: U.S. Department of Agriculture Available from: <http://ndb.nal.usda.gov/>
11. Duffey KJ, Gordon-Larsen P, Steffen LM, Jacobs DR, Jr, Popkin BM. Drinking caloric beverages increases the risk of adverse cardiometabolic outcomes in the Coronary Artery Risk Development in Young Adults (CARDIA) Study. *Am J Clin Nutr*. 2010;92(4):954–9. [PubMed: 20702604]
12. Bombback AS, Derebail VK, Shoham DA, Anderson CA, Steffen LM, Rosamond WD, Kshirsagar AV. Sugar-sweetened soda consumption, hyperuricemia, and kidney disease. *Kidney Int*. 2010;77(7):609–16. [PubMed: 20032963]
13. de Koning L, Malik VS, Rimm EB, Willett WC, Hu FB. Sugar-sweetened and artificially sweetened beverage consumption and risk of type 2 diabetes in men. *Am J Clin Nutr*. 2011;93(6): 1321–7. [PubMed: 21430119]
14. Upadhyaya C, Humagain M. The pattern of tooth loss due to dental caries and periodontal disease among patients attending dental department (OPD), Dhulikhel Hospital, Kathmandu University Teaching Hospital (KUTH), Nepal. *Kathmandu Univ Med J*. 2009;7(25):59–62.
15. Hull PS, Worthington HV, Clerehugh V, Tsirba R, Davies RM, Clarkson JE. The reasons for tooth extractions in adults and their validation. *J Dent*. 1997;25(3–4):233–7. [PubMed: 9175351]
16. Jafarian M, Etebarian A. Reasons for extraction of permanent teeth in general dental practices in Tehran, Iran. *Med Princ Pract*. 2013;22(3):239–44. [PubMed: 23295210]

17. Bernabé E, Vehkalahti MM, Sheiham A, Aromaa A, Suominen AL. Sugar-sweetened beverages and dental caries in adults: a 4-year prospective study. *J Dent.* 2014;42(8):952–8. [PubMed: 24813370]
18. Park S, Lin M, Onufrak S, Li R. Association of sugar-sweetened beverage intake during infancy with dental caries in 6-year-olds. *Clin Nutr Res.* 2015;4(1):9–17. [PubMed: 25713788]
19. Moynihan PJ, Kelly SA. Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. *J Dent Res.* 2014;93(1):8–18. [PubMed: 24323509]
20. Hung HC, Colditz G, Joshipura KJ. The association between tooth loss and the self-reported intake of selected CVD-related nutrients and foods among US women. *Community Dent Oral Epidemiol.* 2005;33(3):167–73. [PubMed: 15853839]
21. Nowjack-Raymer RE, Sheiham A. Association of edentulism and diet and nutrition in US adults. *J Dent Res.* 2003;82(2): 123–6. [PubMed: 12562885]
22. Mokdad AH, Stroup DF, Giles WH. Behavioral Risk Factor Surveillance Team. Public health surveillance for behavioral risk factors in a changing environment. Recommendations from the Behavioral Risk Factor Surveillance team. *MMWR Recomm Rep.* 2003;52:1–12.
23. Renvert S, Persson RE, Persson GR. A history of frequent dental care reduces the risk of tooth loss but not periodontitis in older subjects. *Swed Dent J.* 2011;35(2): 69–75. [PubMed: 21827016]
24. Campus G, Cagetti MG, Senna A, Blasi G, Mascolo A, Demarchi P, Strohmer L. Does smoking increase risk for caries? a cross-sectional study in an Italian military academy. *Caries Res.* 2011;45(1):40–6. [PubMed: 21228593]
25. Miralles L, Silvestre FJ, Hernández-Mijares A, Bautista D, Llambes F, Grau D. Dental caries in type 1 diabetics: influence of systemic factors of the disease upon the development of dental caries. *Med Oral Patol Oral Cir Bucal.* 2006;11(3):E256–60. [PubMed: 16648764]
26. Eke PI, Dye BA, Wei L, Slade GD, Thornton-Evans GO, Borgnakke WS, Taylor GW, Page RC, Beck JD, Genco RJ. Update on prevalence of periodontitis in adults in the United States: NHANES 2009 to 2012. *J Periodontol.* 2015;86(5): 611–22. [PubMed: 25688694]
27. Garcia-Closas R, Garcia-Closas M, Serra-Majem L. A cross sectional study of dental caries, intake of confectionary and foods rich in starch and sugars, and salivary counts of *Streptococcus mutans* in children in Spain. *Am J Clin Nutr.* 1997;66:1257–63. [PubMed: 9356546]
28. Árnadóttir IB, Rozier RG, Saemundsson SR, Sigurjons H, Holbrook WP. Approximal caries and sugar consumption in Icelandic teenagers. *Community Dent Oral Epidemiol.* 1998; 26:115–21. [PubMed: 9645405]
29. Marshall TA. Preventing dental caries associated with sugar-sweetened beverages. *J Am Dent Assoc.* 2013;144(10):1148–52. [PubMed: 24080931]
30. Lula EC, Ribeiro CC, Hugo FN, Alves CM, Silva AA. Added sugars and periodontal disease in young adults: an analysis of NHANES III data. *Am J Clin Nutr.* 2014;100:1182–7. [PubMed: 25240081]
31. National Institute of Dental and Craniofacial Research. Tooth Loss in Adults (Age 20 to 64). Bethesda, MD: National Institutes of Health Available from: <http://www.nidcr.nih.gov/DataStatistics/FindDataByTopic/ToothLoss/ToothLossAdults20to64.htm>
32. Park S, Pan L, Sherry B, Li R. The association of sugar-sweetened beverage intake during infancy with sugar-sweetened beverage intake at 6 years of age. *Pediatrics.* 2014; 134(suppl 1):S56–62. [PubMed: 25183757]
33. Fiorito LM, Marini M, Mitchell DC, Smiciklas-Wright H, Birch LL. Girls' early sweetened carbonated beverage intake predicts different patterns of beverage and nutrient intake across childhood and adolescence. *J Am Diet Assoc.* 2010; 110(4):543–50. [PubMed: 20338280]
34. Durell TM, Kroutil LA, Crits-Christoph P, Barchha N, Van Brunt DL. Prevalence of nonmedical methamphetamine use in the United States. *Subst Abuse Treat Prev Policy.* 2008;25: 3–19.
35. Shaner JW. Caries associated with methamphetamine abuse. *J Mich Dent Assoc.* 2002;84(9):42–7.

Characteristics of Study Population Overall and by Number of Permanent Tooth Loss Among U.S. Young Adults Aged 18 to 39 Years in 18 States, BRFSS, 2012

Table 1

Characteristics	No. of tooth loss, %(SE)				P <sup>†</sup>
	All n (%*)	None	1-5	6 or more	
Total sample	22526(100)	74.4 (0.6)	22.7 (0.6)	2.9 (0.2)	<0.001
SSB <sup>‡</sup> intake					
0 times/d	3529(14.6)	79.9 (1.5)	17.8(1.4)	2.3 (0.7)	
>0 to <1 times/d	10876(47.8)	77.8 (0.9)	20.5 (0.9)	1.8(0.2)	
1 to 2 times/d	5266 (23.8)	70.8(1.3)	25.1 (1.3)	4.1 (0.5)	
>2 times/d	2855 (13.7)	63.1 (1.9)	31.4(1.8)	5.5 (0.8)	
Sex					0.043
Male	10158 (50.4)	74.6(1.0)	23.1 (0.9)	2.3 (0.3)	
Female	12368(49.6)	74.2 (0.8)	22.3 (0.8)	3.5 (0.4)	
Age (y)					<0.001
18-25	6398 (38.4)	85.0 (0.9)	14.1 (0.9)	0.9 (0.2)	
26-32	7569(31.4)	71.2 (1.2)	25.6 (1.1)	3.3 (0.5)	
33-39	8559 (30.3)	64.4 (1.1)	30.6 (1.1)	5.0 (0.5)	
Race/Ethnicity					<0.001
White, non-Hispanic	14836 (53.0)	77.7 (0.7)	18.9 (0.7)	3.4 (0.3)	
Black, non-Hispanic	2186(15.3)	66.0(1.9)	31.1 (1.9)	2.9 (0.5)	
Hispanic	3217 (11.3)	74.1 (1.9)	24.3 (1.9)	1.7(0.3)	
Others, non-Hispanic	2287 (20.5)	72.4(1.6)	25.3 (1.6)	2.3 (0.6)	
Annual household income					<0.001
\$0 - <\$25,000	6032 (31.4)	66.8(1.2)	28.4(1.2)	4.8 (0.5)	
\$25,000 - <\$50,000	5252 (21.2)	72.6(1.3)	24.4(1.3)	3.0 (0.5)	
\$50,000 - <\$75,000	3350 (12.0)	79.9 (1.6)	18.8 (1.5)	1.4(0.3)	
>\$75,000	5533 (22.6)	81.8 (1.2)	17.4 (1.2)	0.8 (0.2)	
Unknown	2359 (12.8)	77.9 (1.7)	18.9 (1.7)	3.2 (0.6)	
Education					<0.001
< High school	1691 (15.0)	56.6 (2.2)	36.5 (2.2)	6.9(1.1)	

Characteristics	All n (%)*	No. of tooth loss, %(SE)			P <sup>†</sup>
		None	1-5	6 or more	
High school	5890 (28.0)	72.4(1.2)	24.5 (1.1)	3.1 (0.3)	
Some college	6888 (32.8)	77.2 (1.0)	20.7 (1.0)	2.1 (0.3)	
College graduate	8057 (24.2)	84.0 (0.9)	14.8(0.3)	1.2 (0.2)	
Marital status					<0.001
Never married	10366 (60.2)	77.4 (0.8)	20.3 (0.8)	2.4 (0.3)	
Single	2000 (6.8)	56.7 (2.4)	35.4 (2.4)	7.9(1.0)	
Married/couple	10160(33.0)	72.6 (0.9)	24.5 (0.9)	2.8 (0.4)	
Recent dental visit					<0.001
Yes	14984(64.4)	76.1 (0.7)	21.4(0.7)	2.5 (0.3)	
No	7542 (35.6)	71.4 (1.1)	25.0 (1.1)	3.6 (0.4)	
Diabetes					<0.001
Yes	500 (2.2)	51.9 (4.6)	41.8 (4.7)	6.3(1.7)	
No	22026 (97.8)	74.9 (0.6)	22.3 (0.6)	2.8 (0.2)	
Smoking status					<0.001
Current smoker	4925 (21.0)	60.3 (1.5)	32.2(1.5)	7.4 (0.8)	
Former smoker	3634(14.0)	70.6(1.7)	26.3 (1.7)	3.0 (0.5)	
Never	13967 (65.0)	79.8 (0.7)	18.8(0.7)	1.4(0.2)	

BRFSS, Behavioral Risk Factor Surveillance System; n, sample size; SE, standard error; P, P value.

\* Unweighted sample size and weighted percent are presented.

<sup>†</sup>Based on Chi-square test.

<sup>‡</sup>SSB includes regular soda and sweetened fruit drinks.

**Table 2**  
Multinomial Logistic Regression of Permanent Tooth Loss\* by Frequency of SSB Intake Among U.S. Young Adults Aged 18 to 39 Years in 18 States, BRFSS, 2012

	1-5 tooth loss			6 or more tooth loss		
	OR	95% CI	P	OR	95% CI	P
SSB intake	ref			ref		
0 times/d						
>0 to <1 times/d	1.44	1.16-1.79	0.001	1.24	0.66-2.33	0.506
1 to 2 times/d	1.58	1.25-1.99	<0.001	2.20	1.15-4.22	0.017
>2 times/d	1.97	1.51-2.58	<0.001	2.81	1.37-5.76	0.005
Sex						
Male	0.95	0.83-1.1	0.528	0.57	0.41-0.79	0.001
Female	ref			ref		
Age (y)						
18-25	0.30	0.24-0.37	<0.001	0.09	0.06-0.14	<0.001
26-32	0.66	0.56-0.78	<0.001	0.40	0.28-0.57	<0.001
33-39	ref			ref		
Race/ethnicity						
White, NH	ref			ref		
Black, NH	1.75	1.42-2.15	<0.001	0.74	0.48-1.15	0.185
Hispanic	1.00	0.82-1.23	0.981	0.39	0.21-0.69	0.001
Other, NH	1.58	1.24-2.02	<0.001	0.63	0.4-0.98	0.040
Annual household income						
\$0-<\$25,000	1.48	1.15-1.91	0.002	5.82	2.95-11.46	<0.001
\$25,000 - <\$50,000	1.27	1-1.62	0.050	3.56	1.91-6.63	<0.001
\$50,000 - <\$75,000	0.98	0.75-1.28	0.893	1.57	0.79-3.12	0.194
>\$75,000	ref			ref		
Education						
Unknown	1.14	0.84-1.55	0.403	5.16	2.52-10.59	<0.001
<high school	3.37	2.59-4.38	<0.001	4.64	2.54-8.46	<0.001
= high school	2.02	1.65-2.48	<0.001	1.90	1.19-3.03	0.007
Some college	1.68	1.38-2.03	<0.001	1.37	0.86-2.17	0.186
College graduate	ref			ref		
Marital status						
Never married	0.92	0.76-1.1	0.354	0.99	0.65-1.5	0.951
Single	1.24	0.98-1.56	0.075	1.58	1-2.49	0.048
Married/couple	ref			ref		
Recent dental visit						
Yes	1.16	0.99-1.36	0.073	1.29	0.92-1.83	0.145

	1-5 tooth loss			6 or more tooth loss		
	OR	95% CI	P	OR	95% CI	P
Diabetes	ref			ref		
	1.94	1.31-2.86	0.001	1.94	1-3.75	0.048
Smoking status	ref			ref		
	1.73	1.46-2.06	<0.001	3.82	2.68-5.44	<0.001
	1.38	1.11-1.71	0.003	1.89	1.24-2.89	0.003
	ref			ref		

BRFSS, Behavioral Risk Factor Surveillance System; OR, odds ratio; CI, confidence interval; P, P value; ref, reference.

\* Reference category of tooth loss was no tooth loss.