Analysis of Dental Caries Experience and Total Sugar Consumption as per the National Health and Nutrition Examination Survey (NHANES)

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Abstract

Dental caries is one of the most prevalent chronic oral diseases. Dietary habits, oral hygiene, and accessibility to preventive interventions, notably fluoridated water, are critical elements of the causative pie in the multifactorial onset of dental caries. This paper investigates if the total sugar consumption in grams or percentage of total daily energy intake changes the likelihood of developing dental caries after adjusting for the water source, gender, family income, and race.

The prevalence of dental caries experience, the mean incidence of tooth decay experience, and the proportion of energy consumed from sweets were all calculated using data from the National Health and Nutrition Examination Surveys (NHANES) for the years 2011–2012 and 2015–2016, along with the corresponding weights. Logistic regressions with many variables and levels were employed for the analysis. Odds ratios with 95% confidence intervals were presented.

In 2011-2012, 69.03% and 2015-16, 69.93% of the US population had at least one caries experience. When stratified by age, dental caries experience was most prevalent amongst adolescents at 70.64% at 11-20 years in 2011-12 and 70.28% at 2-5 years 2015-16. The mean daily sugar consumption was 115.34 grams and 103.32 grams in 2011-12, respectively; 23.96% and 22.08% of mean daily energy consumption from sugar were observed in both years. In 2011–2012, Americans consumed 23.3% of their daily energy from sugars on average and 21.02% in 2015-16. The Chi-square test was not significant for categories of sugar consumption and caries experience. The overall amount of sugar consumed in grammes and the amount consumed as a proportion of total daily calorie intake changed in neither year, and neither did the likelihood of developing dental caries.

The findings mentioned above confirm earlier research that net sugar consumption does not affect experience with caries; rather, the dietary aspect of the causative pie of caries experience has to be thoroughly researched in light of contemporary developments in dental public health.

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Introduction

The US Surgeon General's Dental Health Report, which emphasized how one's oral health mirrors their general health and well-being, was published at the beginning of the twenty-first century. From sealant programs to water fluoridation, through public health initiatives, the profession of dentistry has been at the forefront of reducing the burden of dental disease on the community. Nevertheless, dental disease amongst permanent teeth is the most prevalent worldwide, affecting 2.5 billion people (34.1% for all ages).

Dental caries is a multifactorial, with dietary habits as a cornerstone of disease onset. The breakdown of cariogenic food types decreases saliva's pH by the energized oral microbiome as the ignition for the caries

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process[1,2]. Over time in the presence of poor oral hygiene and absence of fluoride treatment or sealants, this caries process often concludes in dental disease[3].

Refined carbohydrates and sugars are typically considered among cariogenic food types, which decrease the pH around teeth, making them susceptible to caries. Burt and Pai discovered a weak correlation between the incidence of tooth decay and sugar consumption in their systematic review in 2001. The review concluded that the association between sugar consumption and caries risk might not be as substantial as in the current era due to fluoride exposure[4]. The scientists also asserted that while limiting sugar intake is reasonable, it might not be the most crucial preventive approach at this time. In order to lower dental caries, research in the British Journal suggests cutting sugar intake to 3%[5]. This paper aims to measure the association between dental caries experience and the percentage of total daily calories consumed from sugar in the NHANES dataset 2011-2012 and 2015-16.

Materials and methods

Data Source: For the years 2011–2012 and 2015–16, data were gathered from the National Health and Nutrition Examination Survey (NHANES).NHANES is a population-based survey in which the participants are selected using a random sampling method, representing the noninstitutionalized US population.

Study population: 8774 participants in the 2015–16 dataset and 8956 participants in the 2011–12 dataset were all aged 0 or older.

Variable Classification: Based on Occupant characteristics & demographics.

1. Age was analyzed both as a continuous and categorical variable as an actual variable age was categorized into six categories with Category I: ages 0-13 years, Category II: 13 – 20 years as the second category, Category III: 20-35 years, Category IV: 35-55 years, Category V: 55-65 years and Category VI: > 65 years.
2. Gender was characterized as male or female as provided in (NHANES).
3. Race was characterized as Mexican American, Other Hispanic, Non-Hispanic Black, Non-Hispanic White and Other Race.
4. Dental Caries experience was dichotomized as 1) Presence of caries experience and 2) Absence of caries experience. The total number of decayed, missing owing to dental disease, filled, replaced with a prosthesis (partial or fixed), and missing due to dental disease was used to compute the caries experience. A sum greater than or equal to 1 was categorized as the presence of dental caries experience, and less than one was categorized as the absence of caries. The variables; OHX02CTC to OHX31CTC) from the oral health examination dataset were used to calculate the above information.
5. Dietary Variables: The dietary variables were retrieved from the dietary intake data of NHANES, which is a 24-hour dietary recall of the types and amounts of foods and beverages (including all types of water) consumed. The initial dietary recall interview was conducted face-to-face at the Mobile Examination Center, and the second interview was conducted over the phone 3 to 10 days later.

Children aged six and under were interviewed by a proxy; those aged six to eight had the proxy and a kid present to help with reporting; those aged nine to eleven had a child and an adult able to help, and those aged twelve or over responded on their own.

The variables briefly described below are retrieved from NHANES, Total Sugar consumption in grams; retrieved total nutrient intake files file of the dietary component of NHANES, Source of water; Community supply, Well or rain cistern, Spring, tap water, retrieved from the total nutrient intake file of the dietary component of NHANES, Total energy consumed; retrieved from the total nutrient intake records of the dietary component of NHANES, Percentage of daily calories from sugar was derived from the total nutrient intake data of the dietary component of the NHANES and calculated in SAS using the method total sugar consumption in grammes *4 / Total energy consumed *100, comparing the food consumed yesterday to usual. A portion of the population's data from the analysis was used to determine whether the food was consumed the previous day.

SugarP: After extracting the percentage of daily calories consumed from sugar, a categorical variable called SugarP was constructed. The categories, which were designed to categorise the relationship between the percentage of calories that were consumed

as sugars, were 0 = 0 - 17%, 1 = 17 - 24%, 2 = 24 - 30%, and 3 = 30%.

Statistical analysis: Multilevel logistic regressions were used to investigate the relationships between dental caries experience and total sugar consumption as categorical variables representing the percentage of daily calories consumed. In order to produce odds ratios with 95% confidence intervals, SAS Survey Logistics was utilized. The participants' 24-hour dietary intake, as reported in the dietary component of the NHANES survey, was depictive of their typical intake of nutrients, according to subpopulation analysis of weighted data performed for them. Ratios both with and without adjustments were reported. Age, gender, colour, poverty income ratio, and water source were all incorporated in the final models. The entire analysis was done in SAS 9.4.

Results

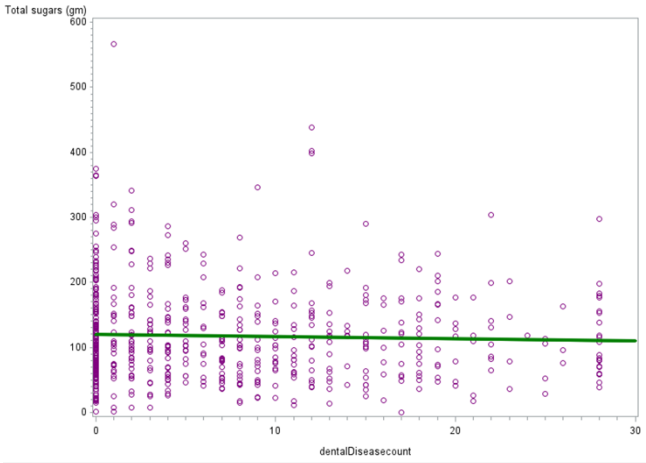
8956 adults between the ages of 0 and 150 made up the study population in 2011–12, and 8774 adults did so in 2015–16. In the weighted population, the prevalence of dental caries was 69.03% in 2011–12 and 69.93% in 2015–16. In 2011-12, young adolescents and adults (11-20 years) had the most caries prevalence, 70.64%. In 2015-16, two to five years old's had the most caries prevalence at 70.28%.[Table 1]

Age	Caries Experience(+)	Caries Experience(-)
0-2 years	68.17%	31.82%
2-5 years	68.82%	31.18%
6-10 years	70.34%	29.66%
11-20 years	70.64%	29.36%
21-30 years	69.32%	30.68%
31-50 years	69.41%	30.58%
> 50 years	67.57%	32.43%

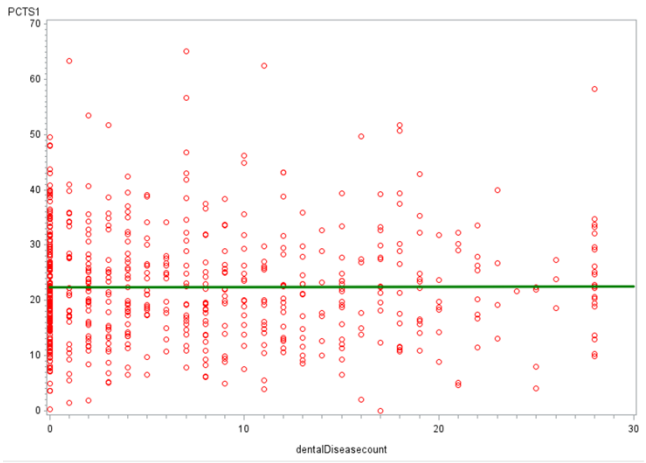
Table 1. Caries experience with respect to age.

Since the prevalence of the periodontal disease is historically rare for infants, children and adults up to 35 years of age, a Subpopulation analysis of dental caries experience amongst all ages from 0 up to 35 years of age was done. This showed that all ages up to 35 had a 69.74% prevalence of caries experiences.

The average score on the DMFT was 7.24 (95%CL 7.24,7,76). The score was lowest for Non-Hispanic White (7.24) and highest for Other Race (7.78), followed by Mexican American(7.77), Non-Hispanic Black (7.54) and Other Hispanics (7.41). [Table 2, 3]



Graph 1. Graphical representation of relationship between caries experience as continuous variable (dental disease count) and total sugar consumption in grams from a subsample (1300) weighted population.



Graph 2. Graphical representation of relationship between caries experience as continuous variable (dental disease count) and percentage of daily calories consumed from sugar from a subsample (1300) weighted population.

The total daily caloric intake from sugar changed from 7.24 to 7.84 calories, with overlapping confidence limits, making the mean DMFT among people 0 to 35 years old negligible. The data plotted with subsampling did not show a linear link between the number of dental diseases and daily calorie intake of sugar[Graph

1, 2]. When using logistic regression to analyze changes in sugar intake as a percentage of daily calories consumed from sugar and dental caries experience for values of percentage of daily calories consumed from sugar as a categorical variable, the adjusted Odds ratios (0.96 1.39), (0.93 1.4), (0.87 1.23) and unadjusted Odds ratios (0.75 1.20), (0.81 1.15), and (0.84 1.29) were not significant[Table 4].

Discussion

Since the oral cavity is the gateway to the human body's nutritional needs, it is assumed that dietary habits play an essential role in maintaining the integrity of the complex and soft tissues of the oral cavity. In contrast to the periodontium, which is more affected by systemic nutritional effects than local impacts, there is evidence that the hard tissues of the oral cavity (teeth) are more affected by local side effects connected to eating habits. As demonstrated by Stephen and Millet and supported by several investigations that found no acidogenic activity of foods containing carbohydrates when no plaque was allowed to develop utilizing ph telemetry, the local side effects of dietary patterns are altered by the thickness of plaque[6].

Comparative studies on Turkish and Moroccan immigrant children in the Netherlands indicated more excellent caries rates in them than in native children, despite eating less cariogenic foods and more vegetables[7,8]. Studies on the proportion of caries-free 7-year-olds in Basel, Switzerland, showed a rise from 2-3% (due to a limited supply of sugar) to 15% after World War Two. Nevertheless, the percentage of 7-year-old children without cavities rose to 65% thanks to the development of fluoride tablets, toothpaste, and improved awareness and education campaigns despite the significant rise in sugar consumption after World War II[9,10].

Our findings in this study, which looked at changes in the likelihood of developing dental caries or changes in the likelihood that dental caries will be severe, about changes in the amount of total sugar consumed as a share of daily calories from sugar, support prior research that has shown a weak correlation between total sugar consumption and developing dental caries. One of the main limitations of our study was not analyzing the frequency of sugar consumption and thickness of plaque. The landmark Vipeholm study of the 1950s first revealed the distinction between the frequency of sugar intake and the total amount of sugar consumed and its effect on the incidence of caries. An increase in the incidence of caries was observed with increased frequency of sugar intake rather than total sugar intake in the Vipeholm study. The critiques of the Vipeholm study include external validation as the study was conducted in a mental asylum with inmates not controlled for plaque thickness or oral hygiene[11,12]. No change in the correlation between dental caries experience and total sugar consumption may have been caused by the widespread use of fluoride-containing toothpaste and improved brushing practices, which resulted in nearly no plaque in children and better hygiene in adults[13-16].

Conclusions

To better understand the relationships between dental caries and dietary sugars, additional research must be conducted to assess plaque thickness and frequency of total sugar intake. Furthermore, recall bias in recalling dietary sugars and missing teeth from dental caries or periodontal disease were limitations of this study. The present study conducted a subpopulation analysis up to the age of 35 and discovered similar non-significant results because the incidence of periodontal disease is only present in people under the age of 35. The paper mentioned above reiterates the systematic review was concluding remarks from Burt and Pai in 2001[4]. Dental caries experience is unaffected by total sugar consumption in grammes or the number of daily calories from sugar.

Declaration of Interest

The authors report no conflict of interest.

SUGARP - Daily cal from sugar				
	Caries Experience(+)	Caries Experience(-)	OR (95%CI)	p-value
SugarP 0 (0-17%)	57393775(19.56%)	25637952(8.74%)	Ref group	
SugarP 1 (17-24%)	60801364(20.72%)	23620067(8.05%)	0.96 1.39	0.14
SugarP 2 (24-30%)	42396484(14.45%)	16647745(5.67%)	0.93 1.40	0.19
SugarP 3 (>30%)	46950756(16.00%)	19926160(6.79%)	0.87 1.27	0.57
RACE				
Mexican American	18837476(6.69%)	7956499(2.82%)	0.79, 1.25	0.96
Other Hispanic	14059548(4.99%)	5537555(1.96%)	1.001, 1.34	0.04
Non-Hispanic White	120362186(42.77%)	56987522(20.25%)		
Non-Hispanic Black	24827005(8.8%)	10276708(3.65%)	0.85, 1.30	0.62
Other Race	16113871(5.72%)	6477454(2.3%)	0.88 1.394	0.37
POVERTYX				
1	74996209(25.42%)	31535281(10.68%)	0.856 1.152	0.9
2	49928511(16.92%)	20217986(6.8%)	0.878 1.239	0.6
3	83757590(28.39%)	34605389(11.7%)	Ref group	

Table 2. Caries experience with adjusted Odds Ratio for Race, Gender and Povertyx.

Variable		N	Mean	Std Error of Mean	95% CL for Mean	
DMFT		8169	7.50	0.123469	7.24224099	7.76323610
Domain Analysis: Race/Hispanic origin						
Race/Hispanic origin	Variable	N	Mean	Std Error of Mean	95% CL for Mean	
Mexican American	DMFT	1111	7.77	0.249758	7.25	8.30
Other Hispanic	DMFT	889	7.41	0.288870	6.80	8.02
Non-Hispanic White	DMFT	2496	7.24	0.308375	6.58	7.88
Non Hispanic Black	DMFT	2270	7.55	0.292534	6.93	8.16
Other Race	DMFT	1403	7.78	0.312174	7.12	8.44
DMFT for different categories of percentage of total daily calories from sugar						
Sugarp	Variable	N	Mean	Std Error of Mean	95% CL for Mean	
0	DMFT	2015	7.33	0.232906	6.83	7.82
1	DMFT	2239	7.94	0.207476	7.50	8.38
2	DMFT	1724	7.34	0.260614	6.79	7.89
3	DMFT	2065	7.33	0.328636	6.64	8.03
DMFT for ages 0 to 35 years based on total daily calories consumed from sugar						
Sugarp	Variable	N	Mean	Std Error of Mean	95% CL for Mean	
0	DMFT	1140	7.59	0.307657	6.95	8.24
1	DMFT	1267	7.84	0.282099	7.24	8.43
2	DMFT	976	7.48	0.455605	6.52	8.44
3	DMFT	1127	7.24	0.262174	6.68	7.79

Table 3. Analysis of dental disease as continuous variable.

Effect	Severity	Point Estimate	95% Wald Confidence Limits	
SugarP 1 vs 0	1	1.169	1.013	1.350
SugarP 1 vs 0	2	0.964	0.741	1.254
SugarP 1 vs 0	3	1.315	1.019	1.698
SugarP 2 vs 0	1	1.215	0.922	1.600
SugarP 2 vs 0	2	1.079	0.808	1.441
SugarP 2 vs 0	3	1.061	0.832	1.354
SugarP 3 vs 0	1	1.152	0.945	1.403
SugarP 3 vs 0	2	0.880	0.651	1.188
Sugarp 3 vs 0	3	1.044	0.766	1.424
Female vs Male	1	0.980	0.813	1.182
Female vs Male	2	1.073	0.822	1.401
Female vs Male	3	0.897	0.711	1.132
Mexican American vs Non Hispanic White	1	0.899	0.720	1.123
Mexican American vs Non Hispanic White	2	0.948	0.678	1.325
Mexican American vs Non Hispanic White	3	1.252	0.909	1.725
Other Hispanic vs Non Hispanic White	1	1.229	0.993	1.521
Other Hispanic vs Non Hispanic White	2	1.061	0.729	1.545
Other Hispanic vs Non Hispanic White	3	1.196	0.977	1.465
Non Hispanic Black vs Non Hispanic White	1	0.987	0.750	1.299
Non Hispanic Black vs Non Hispanic White	2	1.144	0.777	1.682
Non Hispanic Black vs Non Hispanic White	3	1.117	0.803	1.554
Other Race vs Non Hispanic White	1	1.034	0.797	1.342
Other Race vs Non Hispanic White	2	1.147	0.767	1.716
Other Race vs Non Hispanic White	3	1.249	0.924	1.687
Water Source	1	1.000	1.000	1.000
Water Source	2	1.000	1.000	1.000
Water Source	3	1.000	1.000	1.000
PovertyX 1 vs 3	1	0.925	0.812	1.054
PovertyX 1 vs 3	2	1.122	0.867	1.450
PovertyX 1 vs 3	3	0.917	0.751	1.119
PovertyX 2 vs 3	1	1.080	0.844	1.382
PovertyX 2 vs 3	2	1.065	0.815	1.391
PovertyX 2 vs 3	3	0.913	0.709	1.175

Table 4. Odds Ratio Estimates.

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