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Dry Mouth and Dietary Quality Among Older Adults in North Carolina

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Abstract

Objectives—To quantify: (1) prevalence of dry mouth; (2) association of dry mouth with beverage intake and dietary quality; and (3) association of dry mouth with self-reported dietary accommodations to oral health deficits.

Design—Cross-sectional study; data from self-reports.

Participants—A multi-stage cluster sampling design was used to recruit 622 participants aged 60+ from rural North Carolina counties with substantial African American and American Indian populations.

Measurements—Data included the 11-item Xerostomia Inventory (XI); higher scores connote greater impact from dry mouth; a food frequency questionnaire (converted into Health Eating Index-2005 scores); and survey items on foods modified before consumption or avoided due to oral health problems.

Results—Dry mouth was associated with being female, lower education, and income below the poverty level. Although overall beverage consumption did not vary with dry mouth, consumption of certain sugar-sweetened beverages was positively associated with dry mouth. Overall dietary quality did not differ with dry mouth, but more severe dry mouth was associated with lower intake of whole grains and higher intakes of total fruits. Dry mouth was strongly associated with self-reported modification and avoidance of foods. Those in the highest tertile of dry mouth were more likely to modify several foods compared to the lowest tertile, and were more likely to avoid three or more foods.

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Conclusion—Older adults appear to modify foods or selectively avoid foods in response to perceived dry mouth. Despite these behaviors, dry mouth does not result in reduced dietary quality.

Keywords

xerostomia; rural; nutrition; oral health

INTRODUCTION

The subjective feeling of dry mouth, xerostomia, is a commonly reported condition among older adults. The estimated prevalence of dry mouth ranges from 20% to 40% in community dwelling older adults,[1–4] with higher prevalence reported among women than men.[5,6] Aging per se is not associated with dry mouth. However, use of prescription medications is strongly associated with dry mouth, with the polypharmacy characteristic of older adults being a leading cause.[5,7,8]

Dry mouth can have negative consequences for quality of life. A variety of studies, ranging from nursing home populations in Sweden,[9] to community-dwelling home care recipients in Norway,[10] to older Canadian adults in a range of care settings,[11] to community-dwelling elders in Florida[1] found dry mouth and its consequences to be associated with poorer overall and specific measures of oral health-related quality of life (OHRQoL).

Because of the impact of dry mouth on perceived swallowing ability, it is likely that the condition has an impact on food consumption behaviors. Most clinical recommendations for counseling dry mouth patients cite the dietary impact (e.g., Walls and Steele[12]), but evidence for this is limited and incomplete. In patient populations with severe dry mouth due to Sjogren's syndrome or head and neck cancer treatment, certain foods are reported to be avoided[13] and nutrient intakes are impacted.[14] Avoidance of hard to swallow foods, and increased consumption of liquids in response to dry mouth, have been reported in the general elderly population, as well.[1,2,15] However, no comprehensive evaluations of the association of dry mouth and dietary quality exist. No studies have considered the role of self-management of food preparation and consumption by persons with dry mouth as a factor in dietary quality.

Studies of community dwelling older adults demonstrate that they adopt self-management behaviors to compensate or adjust for functional limitations affecting routine activities of daily living like eating.[16,17] As these limitations occur gradually over time, older adults are not always conscious of their actions to manage health deficits or of the varied impacts such actions may have on their overall well-being. We have shown that older adults use a variety of means to accommodate eating with oral health deficits, particularly deficits such as tooth loss and oral pain.[18] These behaviors include avoiding foods that pose challenges for chewing, that may interfere with removable prostheses, and that could cause additional pain due to sensitivity. They also include modifying foods by changing their size, shape, and consistency to make them easier or more comfortable to eat.[19] These changes are associated with dietary quality; in general, food avoidance reduces dietary quality, while food modification increases it.[20]

In this paper we examine the effects of dry mouth in a multi-ethnic population of older adults with a wide range of oral health statuses. Our objectives are to: (1) measure the prevalence and distribution of dry mouth; (2) quantify the association of dry mouth with beverage intake and dietary quality; and (3) examine the association of food avoidance and food modification with dry mouth.

METHODS

Sampling Plan and Recruitment

Between January 2006 and March 2008, the Rural Nutrition and Oral Health (RUN-OH) Study conducted a population-based, cross-sectional survey of the dietary intake of an ethnically diverse (African American, American Indian, and white) population of older adults in two rural North Carolina counties. In these counties, over 99% of elderly residents are African American, American Indian and white (www.factfinder.census.gov). Details of sampling and recruitment are presented elsewhere.[21]

Individuals were considered eligible if they were 60 years or older, spoke English, were able to give informed consent, and were physically able to complete the interview. Of 5,445 selected dwellings, 39 were not screened, 4,647 were screened but did not include an eligible participant, and 859 included an eligible participant, yielding a screening rate of 99.3%. The eligible residents in 635 of the 859 eligible dwelling units completed the interview; 224 refused to participate, for a response rate of 73.9%. These analyses include the 622 for whom complete data for the xerostomia measure were available.

Data Collection and Measures

All data collection procedures were approved by the university's Institutional Review Board. The data were collected in face-to-face interviews at participants' homes, lasting 1.5 to 2.5 hours. The 413 participants who had at least one tooth were asked to undergo an in-home oral examination. Among these, 362 completed the oral examination, for a participation rate of 87.6%. Oral examinations were conducted by dental hygienists who performed tooth counts. Two hygienists conducted all study assessments. They underwent an initial one-day training and one-day calibration with a research dentist using volunteers who were representative of the study population. Calibration was repeated annually. The research dentist conducted five replicate examinations with each hygienist, and performed an ongoing review of data collection forms to check for correct logic, legal values, and data ranges.

Data collection included the 11-item Xerostomia Index (XI) developed and validated by Thomson and colleagues to assess severity of symptoms associated with dry mouth.[4,22] Responses for each item consist of a Likert-type scale with scores ranging from 1 to 5 (never, hardly ever, sometimes, fairly often, and very often). Total scores were calculated by summing responses, resulting in a range from 11 to 55. Higher XI scores indicate more severe xerostomia. Scores were divided into tertiles for analysis. Scores in Tertile 1 ranged from 11 to 16, Tertile 2, from 17 to 24, and Tertile 3, from 25 to 49. As a check on construct validity,[4] a single question (how often does your mouth feel dry?) with Likert-type responses (never, occasionally, frequently, always) was also included in the study questionnaire separate from the eleven XI items. Persons who responded "frequently" and "always" to this question were considered to have reported having xerostomia.[23]

For participants with teeth, tooth counts were obtained from the oral examination. If the participant refused the oral examination (n=51), self-reported number of teeth obtained at the survey was used. The correlation of self-report and examination in those who had both was 0.92 ($p<0.0001$).

Dietary data were collected using the 1998 version of the Block Food Frequency Questionnaire (FFQ) (NutritionQuest Block 98.2; www.NutritionQuest.com), which assesses usual intake of 110 foods. Participants were asked about typical frequency and portion sizes of foods eaten within the past year. Questions were read to participants. Cue cards with response categories were used if necessary. Interviewers completed 8 hours of

training and 6 hours of practice interviews. Ten percent of interviews were verified by telephone. To maintain quality, one interview every month was audio-recorded for each interviewer and reviewed by a research staff member, who provided written feedback.

The food frequency data were used to calculate the Healthy Eating Index-2005 (HEI-2005), which is a measure of dietary quality. The conversion of dietary measures to HEI-2005 scores can be found in more detail.[24] Briefly, the HEI-2005 contains 12 components.[25] These include cup equivalent (eq)/1000 kcals of Total Fruit, Whole Fruit, Total Vegetables, Dark Green and Orange Vegetables and Legumes (after Meat and Bean component reach maximum values), and Milk (dairy products including soy milk). Meat and Beans (eggs, nuts, and soy foods excluding drinks), Total Grains, and Whole Grains are calculated in oz eq/1000 kcals. The amounts of Oils (non-hydrogenated fats found in mayonnaise, margarine, salad dressing, nuts and seeds, and fish) and Sodium, measured in g/1000 kcals, and the percent calories from Saturated fat and Solid Fat, Alcohol, and Added Sugar (SoFAAS) comprise remaining components. The Total HEI score ranges from 0 to 100, with a higher score indicating better dietary quality. The Total HEI score is the sum of scores for all components; the contribution (weighting) of each component to the total score varies. A maximum score of 5 was given for meeting or exceeding recommended intake of Total Fruit, Whole Fruit, Total Vegetable, Dark Green and Orange Vegetables and Legumes, Total Grains, or Whole Grains. A maximum score of 10 was assigned for meeting or exceeding recommended amounts of Milk, Meat and Beans, and Oils and when Saturated Fat and Sodium were *equal to or less* than recommended intake. The recommended percent of energy contributed by SoFAAS was assigned a score of 20 if it was equal to or less than the recommendations.

Completed FFQs were scanned by NutritionQuest. In addition to standard output variables of daily intake of micro- and macronutrients and USDA servings of food groups, gram amounts and calories of each questionnaire item were provided by NutritionQuest for the calculation of HEI-2005 component scores. The USDA Food Search Tool 3.0 (www.ars.usda.gov/foodsearch) provided additional information to calculate HEI-2005 components, such as grams per cup or ounce, amounts of fat, or added sugar in certain reference foods.

Demographic data included sex, ethnicity, age, education, and income. Ethnicity was self-reported and categorized as African American, American Indian, or white. Educational attainment categories were: (1) eighth grade or less; (2) grades 9, 10 or 11; or (3) grade 12 or higher. Income was dichotomized as either above or below the poverty line using current-year federal poverty guidelines according to household size.[26]

Data were collected on current and lifetime use of smoked and smokeless tobacco. Weight and height were measured using a digital scale and portable stadiometer. Body mass index (BMI) was calculated as kg/m^2.

Food avoidance measures were developed based on data obtained over ten years of qualitative and quantitative nutrition research in the study population,[26–31] as well as a small pilot study. Respondents were read a list of foods and asked if they avoided the food because of the condition of their teeth, mouth, or dentures. The list included common foods consumed in the population that require different types and intensities of biting or chewing (e.g., baked or stewed chicken vs. grilled or fried pork chops, what is commonly referred to in this population as “hard fried meat”) or present different problems for teeth or dentures (e.g., whole apples with skin, anterior biting; grilled or fried meats, posterior grinding; berries and nuts, seeds and small pieces that become lodged in teeth or under dentures; sticky candy, food that can adhere to dental work). These measures are further described

elsewhere.[19] Because the distribution was skewed, a categorical variable was created for 0 foods avoided, 1–2 foods avoided, and 3–14 foods avoided.

For food modification, respondents were asked whether or not they prepared foods in a special way because of the condition of their teeth, mouth, or dentures. The foods included apples; steak, pork chops, or roasts; beans such as limas or black-eyed peas; carrots; and cooked greens. For each, preparation methods common in the area were queried. For example, for apples, respondents were asked if they prepared them by peeling, slicing thin, chopping into small pieces, scraping with a spoon, or cooking. Respondents could indicate more than one modification technique for each food. Measures were created indicating whether any modification method was used or no modification method used. Details of these modification measures are described in another report.[19] Two categories were created for the number of foods modified: 0–3 foods and 4–5 foods.

Statistical Analysis

All analyses incorporated the multistage cluster sampling design and have been described elsewhere.[21] Weighted sample sizes are reported. Rao-Scott Chi-Square tests were used to compare categorical demographic and health characteristics by XI tertiles, and linear regressions were used to compare continuous variables, such as age and BMI. Analysis of variance (ANOVA) was performed to compare liquid intake between XI tertiles. Logistic regression models were used to estimate percent meeting recommendation for HEI-2005 score and its components after adjusting for age, sex, ethnicity, education, poverty status and number of teeth. Comparisons of food modification and avoidance practices by XI tertiles were made based on odds ratios between tertiles modeled through logistic regression analyses, adjusting for age, sex, ethnicity, education, poverty status and number of teeth. Internal consistency of XI was assessed using Cronbach's alpha. Construct validity was evaluated by examining the association between the responses to the single dry-mouth question and the mean XI scores. ANOVA was used to test the statistical significance of the observed association. All statistical analyses used the Statistical Analysis Software (version 9.2, SAS Institute Inc, Cary, NC). Significance level was set at $p<0.05$.

RESULTS

The sample was 54.4% female (Table 1). Slightly less than half the respondents were white (47.8%) and the remainder African American (21.3%) or American Indian (30.9%). Over half (55.7%) had less than a high school education, and 32.1% reported household incomes below the federal poverty line. About a fifth (19.7%) were current smokers, and 16.0% chewed tobacco.

Prevalence of xerostomia based on persons responding "frequently" or "always" to a single question ("How often does your mouth feel dry?") was 25.5%. The mean (± SE) of XI was 21.8 (± 0.5). Cronbach's alpha indicated high internal consistency ($\alpha=0.82$). Evidence for construct validity was high: mean XI varied significantly with responses to the single question on frequency of dry mouth, from never (16.7 ± 0.6), to occasionally (21.6 ± 0.5), to frequently (27.5 ± 1.1), to always (31.2 ± 1.2) ($p<0.0001$).

The total XI score (as indicated by tertiles) was significantly higher for women ($p=.0051$) and for those with lower education ($p=.0332$) and lower income ($p=.0016$) (Table 1). There were no differences in age ($p=.6802$) or BMI ($p=.9479$) by XI tertile.

There were no differences in total liquid intakes or categories of liquids (juice, milk, sweet drinks, water) by tertiles of xerostomia (Table 2). Two specific sweetened drinks (Sunny Delight®, Kool-Aid®) were associated with higher XI scores, but they constitute only a

small proportion of the sweetened drinks consumed. The second tertile of XI had a higher intake of sweetened iced tea than the first. This relationship was not present for the third tertile.

Overall, few in this population met the recommendations for satisfactory dietary quality. As indicated in Table 3, for example, the proportion of study participants with unadjusted total HEI scores at or above the recommended score of 80 ranged between 4.0% and 5.5% across the XI tertiles. Scores for HEI components were higher, but for only one component score (Solid Fat, Alcohol and Added Sugars) did at least half of the sample meet the recommendation. When adjusted for age, sex, ethnicity, education, poverty status, and number of teeth, those with more severe xerostomia were significantly more likely to meet recommendations for total fruit (which includes fruit juices), and significantly less likely to consume recommended amounts of whole grain products. However, no significant differences were reported for any other food category.

Those with XI scores in the highest tertile were 6.71 (CI 4.07, 11.07) times more likely than those in the lowest tertile to report modifying four or five foods (Table 4). Those with XI scores in the second tertile were 1.92 (1.11, 3.29) times more likely than those in the first tertile to modify four or five foods. Similar associations were found with modifying specific foods: carrots, apples, steak/pork chops/roast, cooked greens, and beans and other legumes.

Associations between XI and avoiding foods were less consistent. Those in the third tertile of XI were 5.97 (2.92, 12.22) times more likely to avoid one or two foods than those in the first tertile. Several foods showed similar tendencies to be avoided by those in the highest, compared to the lowest, tertile of XI, including raw carrots, whole apples, popcorn, lettuce, corn, whole nuts, and grilled or fried meats.

DISCUSSION

Our results suggest that older adults' perceived dry mouth has little overall impact on dietary quality. These findings support the idea that community dwelling older adults respond to health symptoms by changing their behavior so that they can still accomplish the tasks of daily living, such as eating, in spite of dry mouth, an indicator of declining health status.[16,17,36]

The prevalence of dry mouth is similar to that found in other studies of older adults.[23,32] The Xerostomia Index appears to have adequate internal consistency and construct validity in this rural North Carolina population. The higher XI for females is consistent with other studies.[5,6] Although the significantly worse dry mouth observed here for low educational attainment and low income has not been reported elsewhere, it could reflect socioeconomic differences in health status or socioeconomic differences in tendency to report symptoms.

Consuming liquids is routinely recommended as a way to relieve dry mouth symptoms, suggesting that persons with more severe symptoms of dry mouth should have greater liquid consumption that those with fewer symptoms. Persons with dry mouth are more likely to report sipping liquids in response to dry mouth.[33] Nevertheless, there are few published dietary intake data to support this. In this study, there were no significant differences for total liquids or any of the major categories of beverages (juice, sweetened drinks, water, milk or alcohol). There were several significant differences when individual beverages were examined, with those with more severe dry mouth consuming more of these sugar-sweetened, non-carbonated liquids. While this may help alleviate dry mouth symptoms and the study-wide average consumption of these was quite low, it raises concerns about consumption of energy-dense (high calorie relative to other nutrient content) beverages by some individuals that may displace other, more nutrient-dense foods and beverages. In

addition, frequent consumption of sugar-sweetened beverages may promote dental disease, which is already exacerbated in persons with dry mouth.[8,34]

Despite the wide range of XI scores, there were few differences in dietary quality associated with them. Those that did appear, lower whole grain and higher total fruit (which includes both fruit and fruit juice), probably reflect differences in the willingness to consume dry foods, such as breads and crackers, and preferences for more liquid foods, such as fruit juices or perhaps canned fruit. Despite the widespread reporting that persons with dry mouth are reluctant to eat dry breadstuffs (e.g., toast, crackers), few previous studies have examined this. Sheiham and colleagues[15] found that, while both dentate and edentulous older adults with dry mouth were more likely to report difficulty eating bread, toast, and crisps than their counterparts without dry mouth, the differences between those with and without dry mouth were not significant. Their results for fruit consumption also did not support the assumption of greater consumption associated with dry mouth. Comparing nutrient intakes of women with dry mouth due to Sjogren's syndrome with healthy controls, Cermak and colleagues[14] failed to find differences in dietary fiber, carbohydrates, or vitamins that would reflect reduced consumption of breadstuffs and increased consumption of fruits by those with dry mouth.

Our finding of limited impact of dry mouth on dietary quality is, thus, not consistent with the conventional wisdom that persons with dry mouth make food choices that reduce their dietary quality. This may be due to two factors. First, our data on food consumption and dietary quality come from analyses of foods in the total diet reported by older individuals, not simply reports of whether foods were difficult to eat. The latter is largely subjective and may not be reflected in dietary intake. Converting foods to nutrients (e.g., Cermak et al.[14]) also removes the specific foods from the analysis, making it difficult to assess food or food group consumption. Second, part of the explanation of this may lie in examining how such persons self-manage their dry mouth. Previous research examining such behaviors focused primarily on food avoidance, asking respondents only about foods known to be problematic (e.g., Loesche et al.[33]) and asking specifically if foods are avoided due to dry mouth. Because dry mouth rarely occurs as an isolated symptom, older adults may attribute their food avoidance to other oral deficits (e.g., ill-fitting dentures or oral pain) rather than dry mouth.

We have attempted to understand the variety of ways in which older adults manage eating in the context of poor oral health. Anastassiadou and Heath[35] suggest that older adults with oral health problems modify foods, and Walls and Steele[12] hypothesize that these older adults may practice "overpreparation" of foods (e.g., overcooking or removing skin). Based on ethnographic work in this population, we identified possible food avoidance and food modification practices that older adults use to accommodate oral health problems.[19] Using that information in this study, we find some food avoidance related to dry mouth, but a stronger and more consistent relationship of modifying foods to allow consumption.

Based on these results, we suggest that older adults' perceived dry mouth is associated with somewhat greater consumption of particular sugared beverages, but little overall impact on dietary quality. The maintenance of dietary quality comparable to that of persons without dry mouth is likely achieved by self-managing the diet. We highlight self-management practices of food avoidance and food modification, but there are probably other practices that would be revealed by more detailed analysis of food-related behaviors (e.g., substitution of comparable foods for those avoided). These findings are consistent with our previous work on dietary self-management [36] that views community-dwelling older adults as active self-managers of their health status, consciously or not, altering their behavior to maintain usual patterns of function even in the context of declining health. Such findings are also

consistent with the broader health self-management literature.[16,17] It may be that in situations where older adults cannot manipulate their food (e.g., nursing homes), dietary quality in the context of dry mouth declines.

These results should be interpreted in light of study limitations. Data were cross-sectional, so causal relationships between dry mouth and diet cannot be firmly established. Data on chronic disease conditions (e.g., glycemic control in diabetes) and on medication use were not available. The sample consists of older adults in one particular region of the US, so results may not be applicable to other regions. This study focuses on perceived dry mouth, not actual saliva flow. Studies that have measured both saliva flow and subjectively assess dry mouth frequently find inconsistencies.[32.37] Nevertheless, the data come from a large, population-based sample of older adults that is diverse in sex, ethnicity, and social class composition. Few existing studies of dry mouth have sizable African American or American Indian samples. The present study includes extensive dietary assessment that does not rely on respondents' subjective association of dry mouth and diet, and it assesses multiple dietary self-management behaviors.

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Table 1

Demographic and Health Characteristics, Total and by Xerostomia Index (tertiles)

Characteristic	Overall		Tertile 1		Tertile 2		Tertile 3		P value
	N	%	N	%	N	%	N	%	
Total	622	(100.0)	186	(30.0)	224	(36.0)	211	(34.0)	
Sex									0.005
Female	338	(54.4)	83	(44.3)	124	(55.4)	132	(62.4)	
Male	283	(45.6)	104	(55.7)	100	(44.6)	79	(37.6)	
Ethnic									0.802
White	297	(47.8)	96	(51.5)	100	(44.8)	101	(47.8)	
African American	132	(21.3)	32	(17.2)	54	(24.2)	46	(21.8)	
American Indian	192	(30.9)	58	(31.3)	69	(31.0)	64	(30.4)	
Education									0.033
≤ Grade 8	206	(33.1)	48	(25.8)	73	(32.5)	85	(40.1)	
Grades 9, 10, 11	141	(22.6)	34	(18.0)	53	(23.6)	54	(25.6)	
≥ Grades 12	276	(44.3)	105	(56.2)	98	(43.9)	72	(34.3)	
Income									0.002
Below Poverty Line	200	(32.1)	41	(22.1)	68	(30.5)	90	(42.8)	
At or Above Poverty Line	422	(67.9)	145	(77.9)	156	(69.5)	121	(57.2)	
Current Smoker									0.168
Yes	123	(19.7)	49	(26.0)	35	(15.6)	39	(18.6)	
No	499	(80.3)	138	(74.0)	189	(84.4)	172	(81.4)	
Current Tobacco									0.224
Chewer									
Yes	100	(16.0)	24	(12.7)	33	(14.9)	43	(20.2)	
No	522	(84.0)	163	(87.3)	191	(85.1)	169	(79.8)	

Table 2

Liquid Intake (ml) by Xerostomia Index tertiles.

Drink Type	Xerostomia Index			P value
	Tertile 1 Mean (SE)	Tertile 2 Mean (SE)	Tertile 3 Mean (SE)	
Total liquid	1774 (57.21)	1794	1813 (64.62)	0.822
Total juice[1]	82.95 (17.90)	97.93	86.49 (9.90)	0.348
Orange juice	35.08 (5.53)	53.26 (7.49)	45.11 (6.39)	0.114
Orange juice with calcium	17.26 (5.07)	25.35 (7.74)	24.55 (6.16)	0.548
Tomato juice	30.61 (12.66)	19.33 (5.39)	16.84 (3.27)	0.434
Total sweetened drinks[2]	489.9 (45.52)	486.1	463.7 (37.26)	0.893
Real fruit juice (inc. lemonade)	63.29 (10.85)	53.01 (9.08)	53.19 (9.12)	0.647
Sunny Delight®	17.85 (5.14)	23.07 (5.08)	51.90 (13.02)	0.045
Kool-Aid®	14.15(4.15)	40.68	32.13 (7.65)	0.022
Regular soft drinks	212.9 (35.09)	161.3	234.8 (26.74)	0.122
Sweetened iced tea	244.9 (31.82)	261.1	144.8 (18.90)	0.001
Total water[3]	1013 (35.84)	1033	1101 (55.34)	0.423
Coffee	333.0 (38.25)	345.4	349.4 (33.81)	0.926
Water	679.7 (28.54)	687.5	751.2 (37.61)	0.325
Total milk	66.53 (12.19)	88.13	78.65 (10.84)	0.577
Total alcohol	58.52 (20.61)	35.77	30.80 (11.38)	0.449

Table 3

Association between Xerostomia[1] and Dietary Quality (HEI-2005)[2]

	Unadjusted % meeting Recommendation				Adjusted % meeting recommendation[3]			
	Tertile 1	**Tertile 2**	**Tertile 3**	**P value**	**Tertile 1**	**Tertile 2**	**Tertile 3**	**P value**
Total HEI score ≥80	4.8	5.5	4.0	0.816	1.5	1.7	1.7	0.959
Total fruit ≥0.8 cup eq/1000 kcal	16.9	18.5	24.4	0.157	12.2	11.8	21.5	0.017
Whole fruit ≥0.4 cup eq/1000 kcal	28.6	30.5	32.7	0.782	24.2	24.8	30.5	0.479
Total vegetable ≥1.1 cup eq/1000 kcal	20.7	17.3	17.2	0.736	19.1	15.6	15.4	0.692
Dark green vegetable ≥0.4 cup eq/1000 kcal	40.2	37.0	31.9	0.296	38.1	33.7	29.5	0.412
Total grains ≥3.0 oz/1000 kcal	26.2	27.9	32.1	0.509	29.0	29.9	33.7	0.708
Whole grains ≥1.5 oz/1000 kcal	23.5	11.7	15.7	0.011	19.2	8.7	17.6	0.001
Milk ≥1.3 cup eq/1000 kcal	5.4	4.0	4.6	0.874	3.3	2.2	1.9	0.577
Meat and beans ≥2.5 oz/1000 kcal	34.9	37.6	25.6	0.110	31.4	36.5	26.0	0.267
Oils ≥12 g eq/1000 kcal	14.2	15.0	10.4	0.715	7.0	7.6	6.0	0.876
Saturated fat ≤7% of energy	2.1	0.4	3.4	0.044	1.3	0.2	1.9	0.035
Sodium ≤700 mg/1000 kcal	0.3	0.0	0.0	<.0001	0.0	0.0	0.0	--
SoFAAS ≤20% of energy	52.0	53.5	54.3	0.933	47.9	50.1	53.3	0.754

[1] Xerostomia used as tertiles

[2] HEI uses % above recommendation

[3] Adjusted for age, sex, ethnicity, education, poverty status and number of teeth.

Table 4

Comparison of Food Modification and Avoidance Practices, by Xerostomia Index Tertiles[1]

Food modification or avoidance practice[2]	Xerostomia tertile 3 vs. 1 OR (95% CI)	Xerostomia tertile 2 vs. 1 OR (95% CI)	P-value
Modify 4 or 5 foods	6.71 (4.07, 11.07)	1.92 (1.11, 3.29)	<.0001
Modify carrots	2.10 (1.05, 4.20)	1.25 (0.60, 2.60)	0.028
Modify apples	4.42 (2.48, 7.86)	1.88 (1.18, 2.99)	<.0001
Modify meat	4.83 (2.74, 8.52)	2.39 (1.39, 4.14)	<.0001
Modify greens	4.87 (3.08, 7.68)	2.56 (1.50, 4.37)	<.0001
Modify beans and legumes	5.28 (2.97, 9.38)	1.69 (0.91, 3.11)	<.0001
Avoid 1–2 vs. avoid 0 foods	1.33 (0.62, 2.87)	0.79 (0.45, 1.40)	<.0001
Avoid 3–14 vs. avoid 0 foods	5.97 (2.92, 12.22)	1.46 (0.70, 3.04)	
Avoid carrots	2.66 (1.58, 4.48)	1.39 (0.73, 2.68)	0.001
Avoid apples	2.81 (1.61, 4.91)	1.14 (0.62, 2.07)	<.0001
Avoid popcorn	3.60 (1.63, 7.95)	1.57 (0.72, 3.44)	0.001
Avoid berries	2.27 (0.80, 6.44)	1.79 (0.80, 3.99)	0.272
Avoid tomatoes	5.67 (1.03, 31.24)	4.85 (0.67, 34.91)	0.126
Avoid lettuce	5.78 (1.80, 18.62)	2.27 (0.80, 6.50)	0.012
Avoid corn	6.79 (2.58, 17.90)	2.91 (1.32, 6.41)	0.001
Avoid nuts	4.90 (2.51, 9.54)	1.63 (0.72, 3.70)	<.0001
Avoid pork chops	4.42 (1.78, 10.94)	1.65 (0.55, 4.94)	<.0001
Avoid steak	6.32 (1.94, 20.63)	2.11 (0.58, 7.66)	<.0001
Avoid fried chicken	5.34 (1.58, 18.02)	1.77 (0.43, 7.39)	0.002
Avoid candy	1.98 (0.96, 4.08)	0.87 (0.51, 1.47)	0.001

[1] Adjusted for age, gender, ethnicity, education, poverty and number of teeth.

[2] Items for avoiding hamburgers/ground beef, baked chicken, and fish or shrimp were excluded because few persons (<7) reported the practices