Progress in Nutrition 2019; Vol. 21, Supplement 2: 190-202 DOI: 10.23751/pn.v21i2-S.6972

Original article

Dietary food groups' intake in association with salivary physico-chemical properties in adult females

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Summary. *Objective:* Limited data are available regarding the association between long-term consumption of dietary food groups other than sweets and sugars in association with saliva properties. The current study examined the association between different dietary food groups' intake and salivary viscosity, flow rate, pH and buffering capacity in adults**.** *Design:* Cross-sectional study. *Setting:* Yazd, Iran. *Subjects:* The present study recruited 450 female teachers who were randomly selected from elementary, guidance and high schools. Anthropometric and dietary food intake assessments were conducted and unstimulated saliva samples were also collected. Salivary pH, buffering capacity, flow rate, and viscosity were assessed. The salivary physicochemical properties were compared amongst the tertiles of the dietary food groups' intake. *Results:* In total, 431 female teachers aged 40.45±8.18 years were included. After controlling for all possible confounders, Higher intake of poultry, legumes, and nuts were significantly associated with higher saliva pH ($P<0.05$); while processed meats and high-fat dairy intake were negatively associated with salivary pH ($P<0.05$). Furthermore, red and processed meat intake was inversely associated with saliva flow rate ($P<0.05$). Higher fruits, poultry and nuts intake and lower processed meat intake were associated with higher buffering capacity ($P<0.05$). In addition, the average consumption of nuts was inversely associated with the chance of developing highly concentrated saliva ($P<0.05$). *Conclusion:* Adherence to a diet with lower red and processed meats, and higher plant-based foods might improve the saliva properties. Future prospective studies are recommended to confirm these results.

Key words: diet, food intake, saliva, oral health

Introdution

Saliva and salivary glands play important roles in maintaining oral health (1, 2). Saliva lubricates the oral cavity and helps in several functions such as speaking, eating, and swallowing and has also an important role in protection of teeth and oral mucosa from several diseases (3). It might help maintaining dental tissues' integrity and especially plays a vital role in the prevention of dental caries (4). Several characteristics of saliva like pH, buffering capacity, flow rate and consistency are associated with the risk of oral cavity diseases (2, 5, 6). Furthermore, Salivary buffering capacity is another biochemical feature of this fluid which shows the ability of saliva to buffer acids that are producing by bacteria (2, 5). The flow rate of saliva, is another character, which represents the amount of saliva produced by salivary glands (6). For instance, a recently published study in Japanese adults revealed that decreased salivary flow rate is associated with dental caries and periodontal health (7). Saliva can be fluid or viscous and each mood describes its consistency (2).

Diet might plays an important role in influencing the oral mucosa (8). Furthermore, it is suggested that dietary intake of foods and nutrients might be associated to oral diseases like dental caries and periodontal status by changing the saliva properities and content (9). However, although the majority of studies have considered the association between dietary intake and dental caries (10), data on the association between dietary intake and saliva properities are scarce. A number of studies have represented that dietary meal composition affects saliva flow rate in short term (11-13). In addition, we could find a limited number studies that have targeted the long term dietary intake in association with saliva properties. For instance, a study done by Johansson and Birkhed revealed that 12 months of adherence to a lactovegetarian diet might increase secretion rate, and buffering capacity of whole saliva and the secretion rate of parotid saliva (14). Furthermore, a study on 282 French adults showed that dietary fat intake is associated with salivary flow rate and proposed that dietary intake might be associated with salivary flow and/or composition (15). This study considered dietary nutrient intake in relation to saliva characteristics; however, it could not adjust the associations for several confounders other than energy intake, age and gender like socio-economic status, physical activity (15).

While documents on the relationship between saliva characteristics and usual dietary intake are inconsistent, we are not aware of any study trying to examine the association between dietary food groups rather than nutrients like dietary fat, carbohydrates, protein and etcetera with the aspects of the saliva in human adults. Finding the association between long term dietary intake and salivary properties might help researchers to better elucidate the possible mechanisms for the diet-oral disease associations and also examining dietary food intake might help researchers to provide informative guidelines for the community. Therefore, in the present study we tried to examine the association between different dietary food groups and the saliva flow rate, pH, buffering capacity, and viscosity in a sample of Iranian female teachers living in central Iran.

Materials and methods

Study design and sample size:

This cross-sectional study was conducted on 20- to 60-year-old female teachers working in primary schools of Yazd in central Iran. The current study was a part of a larger study which has been fully described elsewhere (16). The study protocol for the present study was developed according to declaration of Helsinki and the protocol was ethically approved by the Research Council of Shiraz University of Medical Sciences and essential permissions were obtained from the Yazd Province Educational Department.

In brief, using a randomized cluster sampling method, 450 teachers who were not following a specific diet were invited. Height, weight, waist circumference and blood pressure were measured. Information on marital status, medical history, as well as dietary food and supplement intake, socio-economic status and physical activity was obtained using self-administered questionnaires. All subjects then asked to gather in the health room for collecting the saliva sample at their schools. The inclusion criteria was to be a female teacher of selected schools then those who didn't have adequate data about dietary intake and didn't report reasonable amounts of daily energy intake (1500-4500 Kcal/day), and pregnant women were excluded. Written informed consent was obtained from the participants who were eligible to be entered to the study.

Anthropometric measurements

In all cases, anthropometric parameters (height, weight, waist circumference, and hip circumference), were measured by a nutritionist. Weight was measured using a digital scale (SECA, model 813) with an accuracy of 100 grams while the participant had minimum cloths on. Height was measured using a tape measure mounted on the wall with an accuracy of 0.5 cm while the participants were in the standing position and body mass index (BMI) was calculated by dividing weight (in kg) by height squared (in square meters). Waist circumference was also assessed using a tape measure with an accuracy of 0.5 cm at the narrowest area in its natural state at the end of exhalation (17).

Dietary assessment

Dietary intakes over the past year were evaluated by the use of a semi-quantitative food frequency questionnaire (FFQ). The questionnaire was a modified version of 168-item questionnaire of Tehran Lipid and Glucose Study (TLGS) (18). Ten local food items that were frequently consumed in the region were added to the original questionnaire. Therefore, the final questionnaire had 178 food items. The 168-item FFQ used in TLGS was designed to be open ended in its original form; therefore, it was modified to a multiple-choice questionnaire in for the present study. Participants answered two questions about each food item. First, they were asked about the frequency of food consumption (number of times per month, week or day the food was eaten) in the last year based on ten multiple choice frequency response categories varying from "never or less than once a month" to "10 or more times per day". Then they were asked about the average amount of food that was consumed each time. To increase precision and accuracy of the estimates, we attempted to give the portion size of foods as a unit with the same perception for all people. The amount of food eaten in each time was asked using questions with 5 predefined choices. The choices were different according to each food item.

Participants were also interviewed to answer a separate multiple-choice questionnaire about their supplement use. Finally, we computed daily intake of all food items and then converted to grams per day using household measures (19). Daily intake (g/day) of related food items were summed to create the following food groups: fruits, vegetables, whole grains, refined grains, poultry, eggs, fish, processed meats, red meats, low fat and high fat dairy, legumes, nuts, simple sugars, sweets and soft drinks. The study participants were then categorized into three intake levels or "tertiles" (low intake, medium intake and high intake) based on their consumption of each food item. Then the saliva properties of participants were compared according to the tertiles of the food groups' intake.

Economic status

Economic status was assessed using a 9 item self-administered questionnaire about the number of family members, husband's occupation, the head of household (husband/ herself/ other family members), house ownership (owner/tenant), house type (apartment/ house), number of bedrooms in the house, car ownership (yes/no), number of cars owned by the family, and family income per month. We assigned a score to each item and participants were categorized into low, middle, and high socio-economic status based on tertiles of the overall summed score.

Physical activity

Data on physical activity was obtained by using International Physical Activity Questionnaire (IPAQ) (short format). The information gathered from this questionnaire was converted to metabolic equivalent hours per week (MET-h/wk) and participants were placed in two categories (sedentary and active) (20).

Collecting saliva samples

Teachers were told to be present between 8:00 a.m. to 10:00 a.m. in the morning to collect their saliva. They had to brush their teeth at 8:00 without any toothpaste (as they might have contained saliva stimulator) and did not eat or drink for two hours before collecting the samples at 10:00 a.m (21). They were asked to hold their head down, not swallow, and split all their saliva in a collecting cap for 10 minutes.

Salivary assessment

The consistency of saliva was obtained by visual examination. Healthy saliva is watery and clear. If the production rate of saliva was low it become frothy, stringy, bubbly or very sticky (22). Therefore saliva samples were normal (watery) and high (sticky or bubbly) viscosity groups based on the visual examination.

The caps were weighted right away by a digital scale (Model: Precision Balance, M.T electronic balance, K-500BH 500g/0.01 g., made in Hong Kong) before and after saliva collection. This will allow the measurement of saliva obtained in ten minutes, and therefore, the calculation of saliva flow rate.

Salivary pH was also checked in the school right after collecting saliva using a pH meter (Model: AZ8686, made in Taiwan). After that 1ml of 0.1 N HCl was added to 1 ml of saliva for calculating the buffering capacity according to Erricson method (23). For assessing an accurate range of pH, a digital pH meter which shows up to two decimals was used.

Assessment of the other variables

Some other variables were also collected by administration of another self-administered questionnaire. The questionnaire included the following factors; age (20-50 years/ over 50 years), marital status (single/ married), participants' education (college/ Bachelor degree/ Master degree or higher), , menstruation status (yes/ no), oral contraceptives use (yes/no), history of cardiovascular diseases, type 2 diabetes or metabolic syndrome (yes/no), family history of diabetes (yes/no), lifestyle change in recent year (yes/no), vitamin D or multivitamin-mineral supplement use (yes/no) and the tooth brushing habit (lower than once a day/ once a day/twice a day/ more than twice a day).

Statistical analysis

The normal distribution of quantitative data was checked using Kolmogrove-Smirnove test. Saliva pH, flow rate and buffering capacity were compared across tertiles of dietary food groups' intake using analysis of covariance (ANCOVA) with Bonferroni correction in crude and two different multivariable models. In the first model, the association was adjusted for age and energy intake (kcal), and in the second model the body mass index (BMI), physical activity level (sedentary/active), menstruation status (yes/no), education level (college/bachelor's degree/master's degree), marriage status (single/married), economic status (low/middle/high), oral contraceptives use (yes/no), history of chronic diseases (yes/no), tooth brushing (lower than once a day/ once a day/twice a day/ more than twice a day) were further adjusted. To examine the trend of odds ratios for developing highly concentrated saliva across tertiles of nutrient patterns' score, we used logistic regression analysis in crude and multivariable adjusted models. The adjusted models were the same as models we used for adjustment in the ANCOVA. All statistical analyses were done using the Statistical Package for Social Sciences (SPSS, version 16.0 for Windows, 2006, SPSS, Inc, Chicago, IL). P values less than 0.05 were considered as statistically significant.

Results

Data were obtained for 431 female teachers which were eligible to be included in the current study. Mean age was 40.45±8.18 years. The general characteristics of the study participants are represented in Table 1.

Table 2 describes the saliva pH according to tertiles of the dietary food groups' intake. Subjects with higher consumption of poultry had a higher salivary pH compared to those with lower consumption of this food group (P=0.001) and the association remained significant after adjustment for possible confounders in models 1 and model 2 (P<0.001); the association also became significant for legumes (P=0.005 and P=0.002 for models 1 and 2, respectively). The participants who consumed the highest daily amount of nuts had also a higher salivary pH, however the association was not significant in the crude analysis (6.08±0.08 vs. 5.93±0.08, P=0.416). After considering the maximum number of confounders, we observed that the saliva pH in subjects with the highest nuts consumption was significantly higher compared to those with the least nuts intake (6.20±0.09 vs. 5.80±0.09, P=0.017). Our analysis also revealed that higher consumption of processed meat (P=0.002), high fat dairy (P=0.009) and sweets (P =0.006) is inversely associated with saliva pH in the crude analysis. After adjustment for other variables the association remained significant after adjustment for age and energy intake (P=0.005, P=0.001 and P=0.038, respectively). The adjustment for other potential confounders did not change the association for processed meat (P=0.009), high fat dairy (P=0.001); however, sweets intake was marginally associated with saliva pH in the second model (P=0.083).

The association between the intake of food groups and saliva flow rate is provided in Table 3. Consumption of vegetables (P=0.014), fish (P=0.049), red meats (P=0.004), processed meats (P=0.017) and high fat dairy (P=0.014) were inversely associated with saliva flow rate in the crude analysis. None of the associations found in the crude model remained significant after adjustment for the possible confounders in the first and the second model.

The results showed that participants with higher consumption of fruits (P=0.029), poultry (P=0.020) and nuts (P=0.008), had a significantly higher buffering capacity compared to those with lowest intake from these food groups and the association remained significant even after adjustment for the maximum possible confounders (P=0.011, P=0.005 and P=0.002, respectively) (Table 4). On the other hand, higher consumption of processed meat was inversely related to buffering capacity (P=0.007), however the observed association was remained significant in the second model (P=0.007).

The association between food groups' intake and likelihood of developing highly concentrated saliva is

Table 1. General characteristics of the study participants based on age group as well as total population

	Age group		
	Under 50 years	**50 years or more**	**Total Population**
Age (year)	38.25±6.601	53.29±3.30	40.45±8.18
BMI (Kg/m²)	27.67±4.70	28.55±4.41	27.8±4.66
Flow rate (ml/min)	0.70±0.40	0.71±0.38	0.70±0.39
Buffering capacity (pH reduction)	4.30±1.21	4.20±1.15	4.30±1.20
pH	6.00±1.00	6.14±0.93	6.02±0.99
Energy intake (Kcal/day)			
Viscosity			
Normal (%)	90.2	90.5	90.3
Low (%)	9.8	9.5	9.7
Marriage status			
Single (%)	8.2	14.5	9.1
Married (%)	91.8	85.5	90.9
Education			
College (%)	14.5	46.0	19.1
Bachelor's degree (%)	73.2	47.6	69.5
Master's degree or higher (%)	12.3	6.3	11.4
Economic status			
Low (%)	33.0	20.6	31.2
Medium (%)	31.6	39.7	32.8
High (%)	35.4	39.7	36.0
Menstruation			
Yes (%)	94.0	69.8	84.7
No (%)	6.0	30.2	15.3
OCP use			
Yes (%)	6.8	1.6	6.1
No (%)	93.2	98.4	93.9
Physical activity			
Sedentary (%)	74.3	82.3	75.5
Active (%)	25.7	17.7	24.5
Disease history			
Yes (%)	41.6	50.8	42.9
No (%)	58.4	49.2	57.1
Tooth Brushing habit			
Lower than once a day (%)	9.6	12.9	10.1
Once a day (%)	52.1	45.2	51.1
Twice a day (%)	32.6	35.5	33.0
More than twice a day (%)	5.8	6.5	5.9

[1]Values are represented as mean ± standard deviation (SD), otherwise indicated.

described in Table 5. The analysis showed that participants in the second tertile (middle intake) of nuts intake had a significantly lower chance for having a highly concentrated saliva (OR=0.39, 95% confidence interval (CI):0.17, 0.88) and the association remained significant even after adjustment for other confounding variables in model 2 (OR=0.36, 95% confidence interval (CI):0.15, 0.84). The other food groups were not associated with the likelihood for developing highly concentrated saliva (Table 5).

Table 2. Comparison of saliva pH based on teritiles of the dietary food groups' intake.

		Dietary food groups' intake			
		Tertile 1 (Low)	Tertile 2 (Medium)	Tertile 3 (High)	P value
Fruits					
	Crude	6.11±0.081	5.98±0.08	5.96±0.08	0.376
	Model 12	6.06±0.09	5.98±0.08	6.02±0.09	0.797
	Model 23	6.03±0.09	5.98±0.08	6.01±0.09	0.942
Vegetables					
	Crude	6.02±0.13	6.22±0.14	5.96±0.16	0.414
	Model 1	6.06±0.14	6.23±0.14	5.90±0.17	0.323
	Model 2	6.01±0.15	6.29±0.15	5.90±0.19	0.200
Whole grains					
	Crude	6.00±0.08	5.94±0.08	6.12±0.08	0.259
	Model 1	5.99±0.08	5.94±0.08	6.13±0.08	0.216
	Model 2	5.95±0.08	5.94±0.08	6.13±0.09	0.225
Refined grains					
	Crude	6.01±0.08	6.07±0.08	5.97±0.08	0.678
	Model 1	5.95±0.09	6.07±0.08	6.04±0.09	0.623
	Model 2	5.96±0.09	6.05±0.08	6.02±0.09	0.773
Poultry					
	Crude	5.82±0.08	5.98±0.08	6.24±0.08	0.001
	Model 1	5.79±0.08	5.98±0.08	6.28±0.08	<0.001
	Model 2	5.77±0.08	5.97±0.08	6.29±0.08	<0.001
Eggs					
	Crude	5.98±0.07	6.20±0.14	6.01±0.07	0.368
	Model 1	5.93±0.07	6.22±0.14	6.05±0.07	0.157
	Model 2	5.91±0.07	6.26±0.14	6.03±0.08	0.096
Fish					
	Crude	5.98±0.08	6.05±0.08	6.01±0.08	0.859
	Model 1	5.95±0.08	6.04±0.08	6.06±0.08	0.628
	Model 2	5.94±0.09	6.03±0.08	6.06±0.09	0.601
Processed meats					
	Crude	6.17±0.08	6.10±0.08	5.78±0.08	0.002
	Model 1	6.16±0.08	6.10±0.08	5.80±0.08	0.005
	Model 2	6.13±0.09	6.10±0.08	5.79±0.08	0.009
Red meats					
	Crude	6.01±0.08	6.14±0.08	5.90±0.08	0.121
	Model 1	5.96±0.08	6.14±0.08	5.95±0.09	0.198
	Model 2	5.99±0.09	6.14±0.08	5.90±0.09	0.153
Low fat dairy					
	Crude	5.96±0.15	6.19±0.14	6.05±0.15	0.502
	Model 1	5.97±0.15	6.19±0.14	6.04±0.15	0.540
	Model 2	5.95±0.16	6.19±0,14	6.06±0.16	0.532
High fat dairy					
	Crude	6.27±0.14	6.24±0.13	5.72±0.14	0.009
	Model 1	6.38±0.15	6.25±0.13	5.59±0.15	0.001
	Model 2	6.41±0.16	6.25±0.14	5.60±0.15	0.001
Legumes					
	Crude	5.89±0.08	6.00±0.08	6.25±0.08	0.060
	Model 1	5.83±0.08	6.00±0.08	6.22±0.08	0.005
	Model 2	5.79±0.09	5.99±0.08	6.23±0.09	0.002
Nuts					
	Crude	5.93±0.08	6.03±0.08	6.08±0.08	0.416
	Model 1	5.86±0.09	6.03±0.08	6.17±0.09	0.047
	Model 2	5.80±0.09	6.03±0.08	6.20±0.09	0.017

(Continued in the next page).

		Dietary food groups' intake			
		Tertile 1 (Low)	**Tertile 2 (Medium)**	**Tertile 3 (High)**	**P value**
Sugars					
	Crude	5.97±0.08	6.04±0.08	6.03±0.08	0.786
	Model 1	5.92±0.08	6.03±0.08	6.10±0.08	0.359
	Model 2	5.91±0.09	6.03±0.08	6.08±0.09	0.404
Sweets					
	Crude	6.08±0.08	6.16±0.08	5.81±0.08	0.006
	Model 1	6.05±0.09	6.16±0.08	5.85±0.09	0.038
	Model 2	6.03±0.09	6.14±0.08	5.86±0.09	0.083
Soft drinks					
	Crude	6.10±0.08	6.01±0.08	5.93±0.08	0.362
	Model 1	6.09±0.09	6.02±0.08	5.96±0.08	0.568
	Model 2	6.07±0.09	6.02±0.08	5.93±0.09	0.506

[1] *Values are shown as mean ± standard error of mean (SE). All comparisons were conducted using the analysis of covariance.*
[2] *Adjusted for age and total energy intake*
[3] *Adjusted for variables in model one plus body mass index (BMI), physical activity level (sedentary/active), menstruation status (yes/no), education (college/bachelor's degree/master's degree), marriage status (single/married), economic status (low/middle/high), oral contraceptives use (yes/no), history of chronic diseases (yes/no), tooth brushing (lower than once a day/ once a day/twice a day/ more than twice a day).*

Discussion

The present cross-sectional study on a total of 431 adult female teachers revealed that long-term consumption of poultry, legumes and nuts is positively associated with unstimulated salivary pH. This is while higher consumption of processed meats and high fat dairy was associated with reduced saliva pH levels. Furthermore, our analysis showed that red and processed meats intake is inversely associated with salivary flow rate. The present study also revealed that higher ingestion of fruits, poultry and nuts is associated with higher buffering capacity of saliva while a reverse association was shown for processed meats. In addition, average consumption of nuts was inversely associated with the chance of developing highly concentrated saliva.

To the best of our knowledge a limited number of studies have tried to investigate the association between long-term dietary intake of food groups in association with salivary physico-chemical properties and the majority of studies have tried to assess the relationship between dietary food intake and decayed, missed and filled (DMF) teeth or the gingival properties. In a study conducted by Bjornstad et al (24). on 50 healthy children from Greenland and 50 age and gender matched children from Sweden it was found that salivary flow rate and buffering effect were significantly higher in Greenlandic children. It was also shown that milk, fish/meat and fruit/vegetables were more frequently consumed by the Swedish children, while snacks, soft drinks and sweets had a higher consumption frequency on Greenland. They did not find any obvious correlation between consumption frequency of the tested food products and flow rate or buffer effect of saliva. However, a study on 15 adult subjects from northern Italy who had been following a vegan diet for a minimum of 18 months to a maximum of 20 years and a control group (15 subjects) with the same criteria of age, sex, and place of origin all following an omnivorous diet showed that those omnivorous participants had a significantly lower saliva pH compared to vegetarians (25). The findings of the study done by Laffaranchi et al (25) are in line with our results. In the present study we also revealed that higher consumption of nuts and legumes is associated with higher salivary pH and also higher consumption of fruits and nuts is positively associated with saliva buffering capacity.

The mechanism by which dietary food groups might affect physicochemical properties of saliva is not fully understood. It is mentioned that salivary pH might be associated with blood pH (26). It is also mentioned that diets based on animal protein are associated with increased low grade metabolic acidosis compared to plant based diets which are associated with reduced low grade acid production in the body (27). Lower salivary pH, buffering capacity and flow rate is associated with oral health (28), therefore the dietary food groups found in the present study as the predic-

Table 3. Comparison of saliva flow rate based on the teritiles of the dietary food groups' intake.

		Dietary food groups' intake			
		Tertile 1 (Low)	**Tertile 2 (Medium)**	**Tertile 3 (High)**	**P value**
Fruits					
	Crude	0.71±0.031	0.70±0.03	0.69±0.03	0.905
	Model 11	0.65±0.03	0.69±0.03	0.75±0.04	0.165
	Model 22	0.64±0.04	0.70±0.03	0.75±0.03	0.167
Vegetables					
	Crude	0.76±0.03	0.71±0.03	0.63±0.03	0.014
	Model 1	0.73±0.03	0.71±0.03	0.66±0.03	0.326
	Model 2	0.73±0.04	0.70±0.03	0.66±0.04	0.353
Whole grains					
	Crude	0.67±0.03	0.67±0.03	0.75±0.03	0.158
	Model 1	0.66±0.03	0.68±0.03	0.76±0.03	0.072
	Model 2	0.66±0.03	0.68±0.03	0.75±0.03	0.147
Refined grains					
	Crude	0.73±0.03	0.71±0.03	0.67±0.03	0.410
	Model 1	0.69±0.03	0.70±0.03	0.71±0.03	0.917
	Model 2	0.69±0.03	0.70±0.03	0.70±0.04	0.946
Poultry					
	Crude	0.70±0.03	0.72±0.03	0.68±0.03	0.803
	Model 1	0.68±0.03	0.72±0.03	0.70±0.03	0.703
	Model 2	0.67±0.03	0.72±0.03	0.70±0.03	0.632
Eggs					
	Crude	0.70±0.03	0.64±0.06	0.71±0.03	0.507
	Model 1	0.67±0.03	0.65±0.05	0.74±0.03	0.123
	Model 2	0.66±0.03	0.66±0.06	0.74±0.03	0.146
Fish					
	Crude	0.70±0.03	0.76±0.03	0.64±0.03	0.049
	Model 1	0.68±0.03	0.75±0.03	0.67±0.03	0.176
	Model 2	0.68±0.03	0.74±0.03	0.67±0.03	0.280
Processed meats					
	Crude	0.72±0.03	0.75±0.03	0.62±0.03	0.017
	Model 1	0.71±0.03	0.75±0.03	0.64±0.03	0.052
	Model 2	0.69±0.03	0.75±0.03	0.65±0.03	0.089
Red meats					
	Crude	0.72±0.03	0.76±0.03	0.61±0.03	0.004
	Model 1	0.70±0.03	0.76±0.03	0.65±0.03	0.063
	Model 2	0.71±0.03	0.74±0.03	0.63±0.03	0.071
Low fat dairy					
	Crude	0.76±0.03	0.68±0.03	0.66±0.03	0.107
	Model 1	0.73±0.03	0.67±0.03	0.70±0.03	0.528
	Model 2	0.72±0.03	0.68±0.03	0.69±0.03	0.602
High fat dairy					
	Crude	0.76±0.03	0.72±0.03	0.62±0.03	0.014
	Model 1	0.72±0.03	0.71±0.03	0.66±0.03	0.486
	Model 2	0.72±0.04	0.71±0.03	0.6±0.04	0.471
Legumes					
	Crude	0.71±0.03	0.67±0.03	0.71±0.03	0.564
	Model 1	0.68±0.03	0.67±0.03	0.74±0.03	0.260
	Model 2	0.67±0.03	0.67±0.03	0.75±0.03	0.135
Nuts					
	Crude	0.72±0.03	0.73±0.03	0.64±0.03	0.127
	Model 1	0.69±0.03	0.73±0.03	0.68±0.03	0.544
	Model 2	0.67±0.03	0.73±0.03	0.69±0.03	0.461

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		Dietary food groups' intake			
		Tertile 1 (Low)	**Tertile 2 (Medium)**	**Tertile 3 (High)**	
Sugars					
	Crude	0.73±0.03	0.69±0.03	0.68±0.03	0.612
	Model 1	0.70±0.03	0.68±0.03	0.71±0.03	0.755
	Model 2	0.68±0.03	0.70±0.03	0.71±0.03	0.818
Sweets					
	Crude	0.73±0.03	0.72±0.03	0.64±0.03	0.110
	Model 1	0.70±0.03	0.71±0.03	0.69±0.03	0.868
	Model 2	0.70±0.03	0.69±0.03	0.70±0.03	0.978
Soft drinks					
	Crude	0.73±0.03	0.67±0.03	0.70±0.03	0.350
	Model 1	0.72±0.03	0.67±0.03	0.72±0.03	0.395
	Model 2	0.72±0.03	0.66±0.03	0.71±0.03	0.434

[1]*Values are shown as mean ± standard error of mean (SE). All comparisons were conducted using the analysis of covariance.*

[2] *Adjusted for age and total energy intake*

[3]*Adjusted for variables in model one plus body mass index (BMI), physical activity level (sedentary/active), menstruation status (yes/no), education (college/bachelor's degree/master's degree), marriage status (single/married), economic status (low/middle/high), oral contraceptives use (yes/no), history of chronic diseases (yes/no), tooth brushing (lower than once a day/ once a day/twice a day/ more than twice a day).*

Table 4. Comparison of saliva buffering capacity based on teritiles of the dietary food groups' intake

		Dietary food groups' intake			
		Tertile 1 (Low)	**Tertile 2 (Medium)**	**Tertile 3 (High)**	**P value**
Fruits					
	Crude	4.14±0.101	4.23±0.10	4.50±0.10	0.029
	Model 12	4.04±0.11	4.21±0.10	4.60±0.11	0.003
	Model 23	4.06±0.11	4.22±0.10	4.58±0.11	0.011
Vegetables					
	Crude	4.26±0.15	4.39±0.16	4.29±0.18	0.835
	Model 1	4.30±0.15	4.40±0.16	4.23±0.20	0.790
	Model 2	4.32±0.16	4.47±0.16	4.13±0.20	0.421
Whole grains					
	Crude	4.32±0.1	4.24±0.1	4.30±0.1	0.814
	Model 1	4.32±0.10	4.24±0.10	4.30±0.10	0.821
	Model 2	4.32±0.10	4.24±0.10	4.30±0.10	0.847
Refined grains					
	Crude	4.37±0.1	4.31±0.1	4.19±0.1	0.433
	Model 1	4.38±0.11	4.31±0.10	4.18±0.11	0.447
	Model 2	4.38±0.11	4.28±0.10	4.21±0.11	0.610
Poultry					
	Crude	4.2±0.1	4.15±0.1	4.51±0.1	0.020
	Model 1	4.17±0.10	4.15±0.10	4.53±0.10	0.014
	Model 2	4.17±0.10	4.13±0.10	4.58±0.10	0.005
Eggs					
	Crude	4.2±0.09	4.55±0.17	4.32±0.09	0.149
	Model 1	4.17±0.09	4.56±0.17	4.34±0.09	0.118
	Model 2	4.16±0.10	4.50±0.17	4.34±0.10	0.096
Fish					
	Crude	4.2±0.1	4.35±0.1	4.31±0.1	0.557
	Model 1	4.19±0.10	4.34±0.10	4.33±0.10	0.514
	Model 2	4.21±0.11	4.36±0.10	4.30±0.11	0.608
Processed meats					
	Crude	4.42±0.10	4.42±0.10	4.03±0.10	0.007
	Model 1	4.42±0.10	4.42±0.10	4.03±0.10	0.007
	Model 2	4.41±0.11	4.41±0.10	4.04±0.10	0.016

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		Dietary food groups' intake			
		Tertile 1 (Low)	**Tertile 2 (Medium)**	**Tertile 3 (High)**	**P value**
Red meats					
	Crude	4.14±0.10	4.35±0.10	4.37±0.10	0.201
	Model 1	4.11±0.10	4.34±0.10	4.41±0.11	0.124
	Model 2	4.12±0.11	4.37±0.10	4.38±0.11	0.163
Low fat dairy					
	Crude	4.23±0.10	4.28±0.10	4.36±0.10	0.646
	Model 1	4.21±0.10	4.28±0.10	4.38±0.10	0.529
	Model 2	4.21±0.11	4.30±0.10	4.35±0.11	0.635
High fat dairy					
	Crude	4.39±0.10	4.34±0.10	4.13±0.10	0.166
	Model 1	4.40±0.11	4.40±0.10	4.11±0.11	0.150
	Model 2	4.42±0.11	4.35±0.10	4.10±0.11	0.116
Legumes					
	Crude	4.25±0.10	4.16±0.10	4.45±0.10	0.122
	Model 1	4.23±0.10	4.17±0.10	4.47±0.10	0.093
	Model 2	4.22±0.11	4.15±0.10	4.50±0.11	0.046
Nuts					
	Crude	4.06±0.10	4.30±0.10	4.5±0.10	0.008
	Model 1	4.00±0.10	4.30±0.10	4.56±0.10	0.002
	Model 2	3.40±0.11	4.30±0.10	4.57±0.11	0.002
Sugars					
	Crude	4.24±0.10	4.40±0.10	4.22±0.10	0.393
	Model 1	4.24±0.10	4.40±0.10	4.23±0.0	0.410
	Model 2	4.23±0.11	4.40±0.10	4.24±0.11	0.417
Sweets					
	Crude	4.4±0.10	4.36±0.10	4.10±0.10	0.076
	Model 1	4.42±0.10	4.36±0.10	4.08±0.11	0.065
	Model 2	4.40±0.11	4.37±0.10	4.12±0.11	0.175
Soft drinks					
	Crude	4.45±0.10	4.31±0.10	4.11±0.10	0.058
	Model 1	4.45±0.10	4.31±0.10	4.11±0.10	0.063
	Model 2	4.43±0.11	4.31±0.10	4.12±0.11	0.128

[1]Values are shown as mean ± standard error of mean (SE). All comparisons were conducted using the analysis of covariance.
[2]Adjusted for age and total energy intake
[3]Adjusted for variables in model one plus body mass index (BMI), physical activity level (sedentary/active), menstruation status (yes/no), education (college/bachelor's degree/master's degree), marriage status (single/married), economic status (low/middle/high), oral contraceptives use (yes/no), history of chronic diseases (yes/no), tooth brushing (lower than once a day/ once a day/twice a day/ more than twice a day).

tors of salivary physicochemical properties might also be associated with dental caries and oral health.

There are some limitations that should be considered while interpreting our results. Due to the cross-sectional nature of the current project, causality cannot be inferred and prospective observational studies are highly needed to confirm our findings. The saliva samples were collected once for each participant and one sample might not be a good indicator for long-term saliva status. In addition, although we have tried to control for several confounding variables in our analyses, residual confounding from unknown or unmeasured factors is inevitable. Although we used a validated FFQ for dietary assessment, some degree of measurement error and misclassification must be noted. It must also be kept in mind that the present study was done in a sample of female adults working in schools across the Yazd city; therefore, generalizing our findings to the Iranian adults must be considered with caution.

Conclusion

In conclusion the present study revealed that dietary food groups including poultry, legumes and nuts is positively associated with saliva pH; this is while

Table 5. The likelihood of developing highly concentrated saliva based on the teritiles of dietary food groups' intake

		Dietary food groups' intake			
		Tertile 1 (Low)	**Tertile 2 (Medium)**	**Tertile 3 (High)**	**P value**
Fruits					
	Crude	1 (reference)	1.56(0.72-3.37)1	0.99(0.43-2.29)	0.393
	Model 12	1 (reference)	1.62 (0.73-3.31)	1.09 (0.41-2.89)	0.393
	Model 23	1 (reference)	1.74 (0.77-3.93)	1.25 (0.46-3.40)	0.370
Vegetables					
	Crude	1 (reference)	0.78 (0.35-1.72)	0.99 (0.47-2.11)	0.783
	Model 1	1 (reference)	0.80 (0.36-1.81)	1.11 (0.47-2.60)	0.783
	Model 2	1 (reference)	0.91 (0.40-2.09)	1.20 (0.50-2.91)	0.810
Whole grains					
	Crude	1 (reference)	1.99 (0.89-4.44)	1.34 (0.57-3.16)	0.216
	Model 1	1 (reference)	2.01 (0.90-4.51)	1.38 (0.58-3.30)	0.216
	Model 2	1 (reference)	2.18 (0.96-4.94)	1.35 (0.56-3.25)	0.150
Refined grains					
	Crude	1 (reference)	0.85 (0.39-1.85)	0.92 (0.43-1.98)	0.916
	Model 1	1 (reference)	0.85 (0.38-1.88)	0.95 (0.40-2.22)	0.916
	Model 2	1 (reference)	0.86 (0.38-1.92)	0.96 (0.40-2.33)	0.920
Poultry					
	Crude	1 (reference)	1.02 (0.48-2.18)	0.77 (0.35-1.71)	0.745
	Model 1	1 (reference)	1.03 (0.48-2.21)	0.80 (0.35-1.80)	0.745
	Model 2	1 (reference)	1.06 (0.49-2.30)	0.80 (0.34-1.84)	0.780
Eggs					
	Crude	1 (reference)	1.03 (0.36-2.91)	0.99 (0.50-1.96)	0.998
	Model 1	1 (reference)	1.02 (0.36-2.94)	1.02 (0.50-2.10)	0.998
	Model 2	1 (reference)	0.96 (0.33-2.84)	0.99 (0.47-2.09)	0.998
Fish					
	Crude	1 (reference)	1.96 (0.90-4.27)	1.02 (0.43-2.44)	0.121
	Model 1	1 (reference)	1.96 (0.90-4.27)	1.04 (0.42-2.57)	0.121
	Model 2	1 (reference)	1.95 (0.88-4.31)	1.04 (0.41-2.60)	0.150
Processed meats					
	Crude	1 (reference)	0.52 (0.24-1.14)	0.58 (0.27-1.25)	0.186
	Model 1	1 (reference)	0.52 (0.24-1.15)	0.59 (0.27-1.27)	0.186
	Model 2	1 (reference)	0.53 (0.24-1.18)	0.56 (0.25-1.25)	0.210
Red meats					
	Crude	1 (reference)	0.49 (0.21-1.15)	0.93 (0.45-1.91)	0.217
	Model 1	1 (reference)	0.50 (0.21-1.18)	0.99 (0.44-2.20)	0.217
	Model 2	1 (reference)	0.49 (0.21-1.16)	0.94 (0.41-2.17)	0.220
Low fat dairy					
	Crude	1 (reference)	0.65 (0.30-1.46)	0.93 (0.44-1.96)	0.550
	Model 1	1 (reference)	0.67 (0.29-1.51)	0.97 (0.43-2.15)	0.550
	Model 2	1 (reference)	0.64 (0.38-1.45)	0.96 (0.42-2.17)	0.500
High fat dairy					
	Crude	1 (reference)	0.79 (0.36-1.70)	0.79 (0.36-1.70)	0.776
	Model 1	1 (reference)	0.79 (0.36-1.74)	0.79 (0.33-1.91)	0.776
	Model 2	1 (reference)	0.75 (0.34-1.68)	0.72 (0.29-1.78)	0.720
Legumes					
	Crude	1 (reference)	0.64 (0.28-1.47)	1.14 (0.55-2.39)	0.355
	Model 1	1 (reference)	0.66 (0.28-1.54)	1.21 (0.55-2.65)	0.355
	Model 2	1 (reference)	0.67 (0.28-1.57)	1.24 (0.55-2.78)	0.355
Nuts					
	Crude	1 (reference)	0.39 (0.17-0.88)	0.53 (0.25-1.12)	0.043
	Model 1	1 (reference)	0.37 (0.16-0.84)	0.49 (0.21-1.12)	0.043
	Model 2	1 (reference)	0.36 (0.15-0.84)	0.51 (0.22-1.18)	0.050

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		Dietary food groups' intake			
		Tertile 1 (Low)	Tertile 2 (Medium)	Tertile 3 (High)	P value
Sugars					
	Crude	1 (reference)	0.63 (0.30-1.36)	0.63 (0.30-1.36)	0.374
	Model 1	1 (reference)	0.63 (0.29-1.37)	0.62 (0.27-1.42)	0.374
	Model 2	1 (reference)	0.6 (0.27-1.31)	0.61 (0.26-1.41)	0.350
Sweets					
	Crude	1 (reference)	0.71 (0.31-1.60)	1.07 (0.51-2.25)	0.571
	Model 1	1 (reference)	0.73 (0.32-1.67)	1.18 (0.52-2.72)	0.571
	Model 2	1 (reference)	0.68 (0.30-1.57)	1.15 (0.49-2.69)	0.470
Soft drinks					
	Crude	1 (reference)	1.40 (0.61-3.20)	1.57 (0.69-3.60)	0.550
	Model 1	1 (reference)	1.42 (0.62-3.24)	1.64 (0.71-3.80)	0.559
	Model 2	1 (reference)	1.40 (0.60-3.27)	1.65 (0.69-3.92)	0.520

[1] *Values are shown as odds ratio and its corresponding 95% confidence interval (CI). The odds ratios were derived using the logistic regression analysis.*
[2] *Adjusted for age and total energy intake*
[3] *Adjusted for variables in model one plus body mass index (BMI), physical activity level (sedentary/active), menstruation status (yes/no), education (college/bachelor's degree/master's degree), marriage status (single/married), economic status (low/middle/high), oral contraceptives use (yes/no), history of chronic diseases (yes/no), tooth brushing (lower than once a day/ once a day/twice a day/ more than twice a day).*

higher consumption of processed meats and high fat dairy is associated with more acidic saliva. The current study also showed that red and processed meats intake is inversely associated with salivary flow rate. Higher fruits, poultry and nuts intake was also related to higher buffering capacity of saliva while the connection was reverse for the processed meats. In addition, participants with the average consumption of nuts had a lower chance of developing highly concentrated saliva. Future large scale prospective studies are highly recommended to confirm our results.

Acknowledgements

The current study was derived from a PhD thesis by A.H.Y. which was conducted under supervision of AG and advisory of AN, MV, and JZ.

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