# Association between Periodontal Disease and the Intake of Carbohydrate, Fat and Total Calories in Humans

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# Abstract:

Background: There is increasing evidence in the literature about the association between diet and periodontal disease. Due to the proposed effect of diet on oral and systemic environments, we hypothesized that there is an association between periodontal disease and carbohydrate, fat and total caloric intake.

Methods: Data from the National Health and Nutrition Examination Survey (NHANES) 2009-2010 was used. After the application of inclusion and exclusion criteria, 2636 individuals were included in the sample. The outcome variable was periodontitis, defined as the presence of at least one site with both attachment loss ≥3mm and probing depth ≥4mm. Exposure variables were: percentage of calories in diet from carbohydrate, percentage of calories in diet from fat, and total caloric intake. The 2010 Dietary Guidelines for Americans were used to categorize carbohydrate and fat into 3 categories each. Caloric requirement for each subject was estimated using Harris-Benedict equation and individual's reported level of physical activity. Actual caloric intake was compared with the estimated caloric requirement in order to classify participants into: reduced, average and excess caloric intake.

The following covariates were selected as potential confounders: smoking, diabetes, age, sex, race/ethnicity, education, socioeconomic level, waist circumference and whether a subject has had previous periodontal treatment or not. Descriptive statistics, bivariate analysis and logistic regression models were used for data analyses.

Results: The prevalence of periodontitis in the sample was 39.1%. A statistical significance was detected between the outcome variable and all the covariates. No statistical significance was found between any of the exposure variables and periodontitis.

Conclusions: the results of this study showed no statistically significant association between periodontal disease and carbohydrate, fat and total caloric intake. More studies are needed to further investigate such association.

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## Introduction:

Periodontitis is an inflammatory disease that leads to break down of the tooth-supporting apparatus through destruction of the periodontal ligament which is attached to the bundle bone and the cementum; alveolar bone resorption and apical migration of the junctional epithelium. Gingivitis is defined as inflammation of the superficial periodontal tissue that does not lead to periodontal attachment loss. The primary etiologic factor for both diseases is bacterial biofilm that involves colonization by periodontal pathogens. [1] While the gingivitis lesion is reversible and does not cause loss of periodontal support once the etiologic factor(s) is/are removed, the periodontitis lesion is irreversible. These periodontitis lesions progress with loss of attachment and supporting bone, gingival recession, increasing tooth mobility and eventual tooth loss.[1]

Periodontitis is one of the most common chronic diseases in human adults. Eke *et al.* used the data from the National Health and Nutrition Examination Survey (NHANES) 2009-2010 data, to estimate the prevalence of periodontitis in the United States. [2] Data from that study estimated that 47.2% of the US population aged 30 years or older had some degree of periodontal disease, with 30% and 8.5% of all the subjects having moderate and severe periodontitis, respectively.[2] The remaining subjects (8.7%) would have slight periodontitis. [2] Special attention has to be given to the findings of this study, as the data set used by Eke *et al.* represents the first NHANES data in which a full-mouth periodontal examination was performed, versus random partial-mouth examination in the previous NHANES. [3] Several reports in the past have concluded that partial mouth exam in NHANES would lead to underestimation of the prevalence of periodontal disease .[3,4,5]

Several systemic, local and environmental factors have been associated with periodontits.[6] As with most chronic disorders, studying the association between periodontitis and risk factors/indicators, represents a huge challenge due to the overlap between different confounders and the time required to produce a measurable disease outcome. Ethical concerns add to the difficulty of studying such an association. The best study design to examine any association would be a randomized clinical trial (RCT) on human subjects, where an investigator has control over the study design. It would be unethical to leave some patients with periodontal disease untreated. In addition, once an exposure (e.g. treatment modality) is proved to be effective, a study has to be terminated, as it would be unacceptable to deprive the other groups of the benefit of treatment. Feasible study designs to investigate periodontal disease would be cross sectional studies, cohort studies and only limited RCTs.

Albander has studied the risk factors of periodontal disease.[6] Increasing age has been associated with increased periodontal break down.[6] It is not clear, however, whether this is merely due to the 'passage of time' or due to other changes at the host level that increase the risk for periodontal disease. Studies have shown that men have a higher risk of periodontal disease than women.[6] Individuals with high socioeconomic status tend to have a lower risk for periodontal disease when compared to those with a low socioeconomic status. [6] Smoking, diabetes, poor oral hygiene, genetics, obesity, level of physical activity diet and many other factors have been shown in the literature to be associated with periodontitis.[6-10] Strength of association varies. For instance

smoking and diabetes are proven to be strong risk factors for periodontal diseases while the relationship with diet is still controversial. [6-10]

Periodontal disease results from the interaction between the bacterial challenge and the host response. There is substantial evidence that the host immune response, through the release of pro-inflammatory mediators, such as: tumor necrosis factor-α (TNF-α), Interleukin-1 (IL-1), IL-6, IL-8 and Prostaglandin $E_2$ ($PGE_2$), causes most of the tissue destruction in periodontitis.[11] Nevertheless, the pathogenesis of periodontitis is not yet completely fully understood. Gingivitis is widely accepted as a prerequisite for periodontitis, only a few gingivitis sites develop into periodontitis.[12] Looking from this prospective, one can understand the importance of studying the association between periodontal disease and the potential risk factors.

Obesity and poor quality diet have been associated with periodontitis in cross sectional, and a few longitudinal, studies. [9,10, 13,14] Obesity has also been associated with elevated levels of inflammatory mediators that may play a role in the pathogenesis of periodontitis.[8] In a recent prospective study, Gorman *et al.* concluded that there is a positive association between adiposity changes (gains in body weight, waist circumference, and arm fat) and periodontal disease when 893 non-diabetic male subjects were followed up to four decades. [13] In addition, Jimenez et al. followed 36,910 healthy men, as a part of the Health Professionals Follow-Up Study and found a positive association between self-reported periodontal disease and adiposity measures which included body mass index (BMI) , waist circumference (WC) and waist-to-hip ratio (WHR).[14]

When looking at the human diet, one can easily appreciate the huge variation of what people eat. Professional dietary recommendations are revised and changed over relatively short periods of time. The United States Department of Agriculture (USDA) released the "Food Wheel" in 1984 as a guide for adequate and moderate nutrition. Eight years later, the USDA developed the "Food Guide Pyramid", which was later updated in 2005 when "MyPyramid Food Guidance system" was introduced. Recently, in 2011, the USDA announced the "MyPlate" guide (more information can be found on the website: www.choosemyplate.gov). [15]

Studying human nutrition is extremely complicated. There is a great variation among persons and among communities. This presents a huge challenge on how to record dietary intake. Furthermore, diet can be looked at from several perspectives (e.g. total intake, macronutrients, key elements, food groups, etc.). How dietary information is recorded is another challenge. Bias, recall problems, high cost and compliance issues are among these difficulties.[16,17]

A number of methods are available for researchers who are interested in measuring dietary intake. The most common methods are: diet record (diary), 24-hour recall and food frequency questionnaires (FFQ). Diet record involves participants self-reporting their daily dietary intake in detail for a day or more (most commonly 3-7 days). In order to enhance accuracy, training and instructions are provided to the participants. The 24-hour recall method is conducted by trained interviewers to obtain detailed information about diet that was consumed in a 24-hour period. Although accurate information can be gained this way, it can be costly. In FFQs, questionnaires are sent to the participants to self-report their average, overall consumption of food over a

period of time, which is typically weeks or months. Less attention is given to details with this method versus the other two methods. FFQs are very useful in tracking long-term dietary patterns when conducting cohort studies.[16-18]

As mentioned earlier, the relationship between periodontal diseases and diet is controversial. Although many reports have succeeded in establishing an association between various elements of diet, oral health, and periodontal diseases, others have failed to confirm such an association .[7-10,16] Several factors can contribute to such conflict in the literature. Different studies have targeted different dietary elements. When designing a study it is crucial to take into consideration that the relationship between most nutrients and diseases is not linear [16,17] In other words, a study design must ensure the presence of enough subjects who fit into either the 'deficient' or 'excess' groups vs. the 'optimal' group. [17] Another important point is the difference in study designs among various studies. Confounding factors add to these difficulties. [17]

Most of the studies investigating the relationship between diet and the periodontal status in humans looked at Vitamin D and Calcium intake. Many found an improved periodontal health when these nutritional supplements are taken. [19-23] Only a few reports looked at other aspects of dietary intake. Al-Zahrani *et al.* [24] have found a positive association between poor dietary habits and the degree of calculus deposition on the teeth. In another study they reported that individuals with poor diets are three times more likely to develop periodontitis.[8,] It is worth mentioning, however, that Al-Zahrani *et al*. used the original healthy eating index (HEI), which is a measure of the overall dietary quality that the USDA developed the 1995. [8,9]

Yoshihara *et al.* conducted a longitudinal study that followed 600 individuals aged 70 years for 6 years. They found a negative association between vegetable intake and periodontal disease. [25]

As a part of the Health Professional Follow-up Study, Merchant et al. concluded that the risk of developing periodontitis was reduced with increasing whole-grain intake .[26] In another prospective study, Schwartz et al. followed 625 men for an average of 15 years.[27] This study was a part of the Veterans Affairs Dental Longitudinal Study.[27] The study concluded that higher dietary fiber content reduced progression of periodontal disease in men who were ≥65 years old (n=204).[27]

Several mechanisms by which diet can affect periodontal status are mentioned in the literature. Earlier studies suggest a direct effect of the food content on the bacterial oral environment.[28] For example, simple sugars may provide nutrition to some of the biofilm organisms, while fibrous food content might have a cleansing effect.[29,30]

Following consumption of meals, there is a transient state of systemic inflammation that is associated with oxidative stress and the release of reactive oxygen species; this is exaggerated with meals that are heavy in fat and/or refined carbohydrate.[31,32] In addition, high caloric diets that are rich in carbohydrate and fat are associated with obesity and increased adipose tissue storage.[31,32] Several *in vitro* and *in vivo* studies have shown the increased capability of adipose tissue to produce key pro inflammatory mediators such as TNF-α, IL-1 and IL-6.[31,33] In addition, increased insulin production as a result of carbohydrate ingestion contributes to increased fat

tissue storage. [31] There is increased evidence in the literature that links increased levels of pro-inflammatory mediators and insulin resistance.[34]

A high fat diet has been associated with a change of intestinal flora into a more gram-negative bacterial flora .[34] An association between this shift in microbiota and the oral environment has been suggested in the literature.[34,35] In fact, Blasco-Baque *et al.*[35] found a positive association between a fat enriched diet and the prevalence of periodontal pathogens such as *Fusobacterium nucleatum* and *Prevotella intermedia.* Their results also indicated increased gingival inflammation and alveolar bone loss. [35]

Caloric restriction has been associated with a reduction in systemic chronic inflammation. Interestingly, Reynolds et al. studied the association between dietary caloric restriction and periodontal diseases in rhesus monkeys.[36] The experimental group received a 30% caloric reduction in diet, compared to the control group, for 13 to 17 years.[34] They concluded that caloric restriction reduced the risk for inflammatory periodontal disease only in male subjects. [36]

Due to the strong evidence available that indicates vast involvement of the host immune system in the development and progression of periodontal disease, [11] it is possible that dietary elements essential for the immune system (such as protein intake) may have some effect on the risk of developing periodontal disease .[37]

Based on our current knowledge, varying levels of evidence suggest an association between dietary intake and periodontal disease. Based on the limited data available, this association may be due to the direct and indirect effect of nutrients on the oral

flora, oral environment, immune status and systemic inflammation. Hence, we hypothesized that there is positive association between total caloric, carbohydrate and fat, and periodontal disease. To the authors' knowledge, no study has looked at the effect of carbohydrate, fat and total caloric intake on the periodontal status in human subjects. The aim of the present study was to assess if there was an association between periodontal disease and certain dietary aspects (total caloric, carbohydrate and fat intake) using a nationally representative US sample (NHANES data).

## Aim and Hypothesis:

**Aim:** to determine if there was an association between specific aspects of diet (total caloric, carbohydrate and fat intake) and periodontal disease in humans.

**Hypothesis:** There is a positive association between:

- Periodontal disease and total caloric intake
- Periodontal disease and percentage of calories from carbohydrate
- Periodontal disease and percentage of calories from fat

## **Research Design and Methods**:

This study used data from NHANES 2009-2010.[38] NHANES is a cross sectional survey that involves a sample representative of the United States population. In NHANES, calibrated examiners performed the periodontal examination. For participants who were ≥ 30 years old, probing depth (PD), recession, clinical attachment loss (CAL) and gingival bleeding were recorded on six sites per tooth (mid-facial, mid-lingual, mesio-facial, mesio-lingual, disto-facial and disto-lingual) for all the teeth excluding third molars. Individuals with contributory medical history findings were excluded from the examination. Dietary data for a 24-hour period was collected by personal interview. Three to 10 days later, a further 24-hour period data set was collected by a phone interview. Only subjects who completed both interviews were included in the study. Dietary data were averaged, using the two 24-hour surveys.

Independent variables in this study were:

- Total caloric intake
- Percentage of calories from carbohydrate
- Percentage of calories from fat

Periodontitis was defined based on the presence of at least one site with both a PD of ≥4 mm and CAL of ≥3 mm. This definition has been used in previous NHANES studies; in order to include only what most likely are true periodontitis lesions. [7,8,10]

Data were adjusted for the following potential confounders: smoking, diabetes, age, sex, race/ethnicity, education, socioeconomic level, waist circumference (WC) and whether a subject has had periodontal treatment before or not.

Participants' smoking status was defined as either current, former or never smoker. Education was classified as less than, equal to or more than 12 years of education. Individuals in NHANES 2009-2010 were categorized according to their race as follows:

- Non-Hispanic White
- Non-Hispanic Black
- Mexican-American
- Other Race-including Multi-Racial.
- Other Hispanic

Participants with a history of diabetes were considered diabetics, with the exception of females with a history of gestational diabetes.

The 2010 Dietary Guidelines for Americans [39] were used in order to define categories for percentages of calories from both carbohydrate and fat, as follows:

- Percentage of calories acquired from carbohydrate:
    - Less than 45% is a low carbohydrate diet
    - Between 45-65% is an average carbohydrate diet
    - Greater than 65% is a high carbohydrate diet.

- Percentage of calories acquired from fat:
    - Less than 20% is a low fat diet,
    - Between 20-35% is an average fat diet
    - Greater than 35% is a high fat diet.

In order to categorize subjects according to their total caloric intake, the Harris-Benedict equation (reevaluated by Roza and Shizgal) [40] which is a formula used to determine an individual's basal metabolic rate (BMR) using his/her weight, height, and age was used. The resulting BMR value is multiplied by a factor that is determined by the level of physical activity. The result is the recommended average daily caloric requirement in order to maintain the current body weight of the individual.

In our study, we used the Harris-Benedict equation to determine the average daily caloric requirement.[40] If a subject consumed 25% more calories than their average daily requirement, they were considered 'excess caloric intake'. If they consumed less than 75% of their average requirement, they were be considered 'reduced caloric intake'.

Periodontal examination was complete for 4086 individuals. After exclusion of edentulous participants, the sample size decreased to 3743. Having included only subjects who succeeded to complete both 24-hour dietary interviews, 506 individuals were excluded from the sample. Subjects without complete body measurements were also excluded, dropping the sample size to 2644. Physical activity was calculated in this study using information that was collected during the interviews about the

number of days and minutes of vigorous-intensity work, the number of days and minutes of vigorous recreational activities, the number of days and minutes of moderate-intensity work, the number of days and minutes of moderate recreational activities and the number of sedentary activity (details in the data management section). Only subjects with recordable physical activity using this method were included in the sample i.e. 2636 individual.

**Power Calculation**

Prior to starting the study, power calculation was performed using nQuery Advisor (Version 7.0, Statistical Solutions, Los Angeles, CA). A sample of at least 300 subjects with periodontal disease and 300 subjects without periodontal disease (which is the least anticipated sample size following application of inclusion and exclusion criteria) is adequate to obtain a type I error rate of 5% and a power of 80% assuming an effect size of $\Delta^2 = 0.02$ or greater.

**Statistical Analysis**

Bivariate analysis between the independent and dependent variables was conducted using Chi square test.

Five logistic regression models were created in order to further examine the relationship between the dependent and independent variables when other covariates were added. The models were as follows:

Model 1: the association between periodontal disease and the following factors: smoking, diabetes, age categories, gender, race/ethnicity, education, ratio of family income to poverty, WC and whether a subject has had periodontal treatment or not.

Model 2: the association between periodontal disease and the following factors: percentage of calories from carbohydrate, smoking, diabetes, age categories, gender, race/ethnicity, education, ratio of family income to poverty, WC and whether a subject has had periodontal treatment or not.

Model 3: the association between periodontal disease and the following factors: percentage of calories from fat, smoking, diabetes, age categories, gender, race/ethnicity, education, ratio of family income to poverty, WC and whether a subject has had periodontal treatment or not.

Model 4: the association between periodontal disease and the following factors: total caloric intake, smoking, diabetes, age categories, gender, race/ethnicity, education, ratio of family income to poverty, WC and whether a subject has had periodontal treatment before or not.

Model 5: the association between periodontal disease and the following factors: percentage of calories from carbohydrate,  percentage of calories from fat, total caloric intake, smoking, diabetes, age categories, gender, race/ethnicity, education, ratio of family income to poverty, WC and whether a subject has had periodontal treatment or not.

## Data Management:

Data management and analysis were conducted using SAS (Version 9.3, SAS Institute, Cary, NC).

The following files were downloaded from the NHANES website, http://www.cdc.gov/nchs/nhanes.htm 2009-2010 data: [38]

**DEMO_F.xpt** (Demographic Variables and Sample Weights)

**DR1TOT_F.xpt** (Total Nutrient Intakes -- First Day)

**DR2TOT_F.xpt** (Total Nutrient Intakes – Second Day)

**BMX_F.xpt** (Body Measures)

**OHXPER_F.xpt** (Oral Health – Periodontal)

**OHXDEN_F.xpt** (Oral Health – Dentition)

**OHQ_F.xpt** (Oral Health)

**DIQ_F.xpt** (Diabetes)

**PAQ_F.xpt** (Physical Activity)

**SMQ_F.xpt** (Smoking - Cigarette Use)

Files were sorted, and then merged by the variable: **SEQN** (respondent sequence number).

Periodontitis was defined as the presence of at least one site with both a probing depth (PD) of ≥4 mm and clinical attachment loss (CAL) of ≥3 mm. Each tooth present in the mouth (excluding 3rd molars) had 6 variables that had the PD values. Those variables were extracted form the file **OHXPER_F.xpt.** Variables names are in appendix1.

Similar to PD values, each tooth present in the mouth (excluding 3rd molars) had 6 variables that had the CAL values. Those variables were extracted from the file **OHXPER_F.xpt.** Variables names are in appendix 2.

A new variable was created for each site using an "IF" statement i.e. if a site has a LA value >=3 AND a PD value >=4, the value for the new variable would be 1; otherwise the value would 0. For each participant, the new variable values were summed up. If the sum value was >= 1, the participant was categorized as having periodontitis. This was done by creating a variable that had a value of 1 if a subject had periodontitis and a value of 0 if the subject did not have periodontitis.

In order to get the number of permanent teeth present, excluding third molars, the following variables were extracted from the file **OHXDEN_F.xpt:**
**OHX02TC, OHX03TC, OHX04TC, OHX05TC, OHX06TC, OHX07TC, OHX08TC, OHX09TC, OHX10TC, OHX11TC, OHX12TC, OHX13TC, OHX14TC, OHX15TC, OHX18TC, OHX19TC, OHX20TC, OHX21TC, OHX22TC, OHX23TC, OHX24TC, OHX25TC, OHX26TC, OHX27TC, OHX28TC, OHX29TC, OHX30TC, OHX31TC.**
A value of 1 for any of the previous variables indicated the presence of a permanent tooth in that particular site. A new variable for each tooth site was created using an "IF" statement. If the value for any site =1, the new variable's value would be 1. Otherwise, the value of the new variable would be 0. The number of teeth for each individual was obtained by adding the values of the new variable for all the sites.

For the dietary data, each participant's total energy intake was present in the files **DR1TOT_F.xpt** and **DR2TOT_F.xpt .** The variables names were **DR1TKCAL** and **DR2TKCAL**. A new variable was created that contains the sum of the two previous variables divided by 2 i.e. the average total energy in k-calories.

Regarding the percentage of calories from carbohydrate, the following steps were done.

First, the values of the two variable **DR1TCARB** and **DR2TCARB** – (total carbohydrate in grams) were averaged. This value was then multiplied by 4 in order to get the amount of calories a participant gets from carbohydrate.

After that, another variable was created as follows:

- If the value from the first step is < 0.45 of the value of the average total energy (∑**DR1TKCAL DR2TKCAL/2)**, the new variable will be given the value of 1. (low carbohydrate diet)
- If the value from first step is between >=0.45 and <=0.65 of the value of the average total energy (∑**DR1TKCAL DR2TKCAL/2)**, the new variable will be given the value of 2 (average carbohydrate diet)
- If the value from first step is > 0.65 of the value of the average total energy (∑**DR1TKCAL DR2TKCAL/2)** , the new variable will be given the value of 3 (high carbohydrate diet)

Similar steps were done to determine the percentage of calories from fat; as follows: first, the values of the two variable DR1TTFAT and DR2TTFAT - (total fat in grams.) This value was then multiplied by 9 in order to get the amount of calories a participant gets from fat.

After that, another variable was created as follows:

- If the value from first step is < 0.20 of the value of the average total energy (∑**DR1TKCAL DR2TKCAL/2)**, the new variable will be given the value of 1. (low fat diet)
- If the value from first step is >=0.20 and <=0.35 of the value of the average total energy (∑**DR1TKCAL DR2TKCAL/2)**, the new variable will be given the value of 2 (average fat diet)
- If the value from first step is > 0.35 of the value of the average total energy (∑**DR1TKCAL DR2TKCAL/2)**, the new variable will be given the value of 3 (high fat diet)

More complex steps had to be done in order to study the effect of total caloric intake. First, a new variable called **BMR** (basal metabolic rate) was created and calculated using the formula:

88.362 + (13.397 x weight in kg) + (4.799 x height in cm) - (5.677 x age in years) for male participants (value of 1 for in the variable **RIAGENDR** – Gender)

if a participant had a value of 2 for the variable **RIAGENDR** – Gender (female participant) the following formula 447.593 + (9.247 x weight in kg) + (3.098 x height in cm) - (4.330 x age in years) was used.

The following variables were used for this calculation:

**BMXWT** - Weight (kg)

**BMXHT** - Standing Height (cm)

**RIDAGEYR** - Age at Screening Adjudicated - Recode

After that, another variable was created that represented the average caloric requirement for each participant. This variable was calculated by multiplying the

**BMR** value by an activity factor that depends on the individual's of level of physical activity (values of 1.2, 1.375, 1.55, 1.725 and 1.9).[41-43]

In order to determine a participant's level of activity, the following variable were used:

**PAQ610 -** Days vigorous work

**PAD615 -** Minutes vigorous-intensity work

**PAQ655 -** Days vigorous recreational activities

**PAD660 -** Minutes vigorous recreational activities

**PAQ625 -** Number of days moderate work

**PAD630 -** Minutes moderate-intensity work

**PAQ670 -** Days moderate recreational activities

**PAD675 -** Minutes moderate recreational activities

**PAD680 -** Minutes sedentary activities

Those variables are in the file **PAQ_F.xpt** (Physical Activity).

For each subject,

- The value of the variable **PAQ610** was multiplied by the value of the variable **PAD615** to determine weekly minutes of vigorous work
- The value of the variable **PAQ655** was multiplied by the value of the variable **PAD660** to determine weekly minutes of vigorous recreational activities.
- The value of **PAQ625** was multiplied by the value of the variable **PAQ630** to determine the weekly minutes of moderate work.
- The value of the variable **PAQ670** was multiplied by the value of the variable **PAD675** to determine weekly minutes of moderate recreational activities.

For each subject, the values of the weekly minutes of moderate activity and the weekly minutes of moderate recreational activities were divided by 2 and added to the values of weekly minutes of vigorous work and weekly minutes of vigorous recreational activities.

This was done in order to adjust for the difference between the types of activities (moderate vs. vigorous) and to create a single variable that represented the adjusted physical activity for each individual.[44,45]

Individuals who had any value > 0 for the variable **PAD680**-minutes sedentary activity, and had a zero adjust physical activity, were considered sedentary and their BMR value was multiplied by the activity factor of 1.2.

Participants with adjusted physical activity >0 were categorized into quartiles, as follows:

- Individuals with physical activity value that were in the lowest quartile, had their **BMR** value multiplied by the activity factor of 1.375.
- Individuals with physical activity value that were in the second quartile, had their **BMR** value multiplied by the activity factor of 1.55.
- Individuals with physical activity value that were in the third quartile, had their **BMR** value multiplied by the activity factor of 1.725
- Individuals with physical activity value that were in the highest quintile, had their **BMR** value multiplied by the activity factor of 1.9.

A variable with the result from the previous step determined the recommended average daily caloric requirement in order to maintain the current body weight of each individual. If the value of the average total energy (∑**DR1TKCAL DR2TKCAL/2)** was:

- < 0.75 of the daily caloric requirement, the subject was categorized as 'reduced calorie intake'.
- >= 0.75 and <=1.25 of the daily caloric requirement, the subject was categorized as 'average calorie intake'.
- >1.25 of the daily caloric requirement, the subject was categorized as 'excess calorie intake'.

The following will explain how the potential confounders variables were categorized.

For Smoking, the following variables were used:

**SMQ020** - Smoked at least 100 cigarettes in life

**SMQ040** - Do you now smoke cigarettes

Subjects were categorized into:

- Current smoker: value of 1 for **SMQ020**, and value of 1 or 2 for **SMQ040**
- Former smoker: value of 1 for **SMQ020**, and value of 3 for **SMQ040**
- Non smoker: value of 2 for **SMQ020**.

For Diabetes, the following variable was used:

**DIQ010** - Doctor told you have diabetes

Subjects were categorized into:

- Diabetics: value of 1 for **DIQ010**
- Non diabetics: value of 2 for **DIQ010**

For age, the following variable was used:

**RIDAGEYR** - Age at Screening Adjudicated - Recode

Subjects were categorized according to the value of the variable into:

- < 35
- 35>= and < 50
- 50 >= and < 65
- 65>=

For gender, the following variable was used:

**RIAGENDR** - Gender

Subjects were categorized into:

- Male: value of 1 for RIAGENDR
- Female: value of 2 for RIAGENDR

For race, the following variable were used:

**RIDRETH1** - Race/Ethnicity - Recode

Subjects were categorized into:

- Mexican American: value of 1 for **RIDRETH1**
- Other Hispanic: value of 2 for **RIDRETH1**
- Non-Hispanic White: value of 3 for **RIDRETH1**
- Other Hispanic Black: value of 4 for **RIDRETH1**
- Other Race – Including Multi – Racial: value of 5 for **RIDRETH1**

For Education, the following variable was used:

**DMDEDUC2** - Education Level - Adults 20+

Subjects will be categorized into:

- Less than 12 years of schooling: value of 1, 2 or 3 for **DMDEDUC2**
- Equal or more than 12 years of schooling: value of 4 or 5 for **DMDEDUC2**

For Socioeconomic level, the following variable was used:

**INDFMPIR -** Ratio of family income to poverty

Subjects were categorized according to the value of the variable into:

- < 1
- >= 1 and < 2
- >= 2 and < 3
- >= 3 and < 4
- >= 4 and

**BMXWAIST-** Waist Circumference (cm)

Subjects will be categorized into:

- Men:
    - < = 102
    - > 102
- Women:
    - < = 88
    - > 88

For whether a subject has had periodontal treatment before, the following variable was used:

**OHQ850** - Ever had treatment for gum disease?

Subjects were categorized into:

- Yes: value of 1 for **OHQ850**
- No: value of 2 for **OHQ850**

The following weight, strata and cluster variables were used for data analysis.

**WTMEC2YR -** Full Sample 2 Year MEC Exam Weight

**SDMVSTRA** - Masked Variance Pseudo-Stratum

**DMVPSU** - Masked Variance Pseudo-PSU

## Results

The number of individuals included in the analysis was 2636 subjects. Table 1 shows the characteristics of the study population. Based on the weighted sample, 52.45% of the study population were females. Seventy three percent of the subjects were categorized as non-Hispanic White. Most individuals belonged to 35-49 age category, followed by the 50-64 age set. Sixty two percent of the participants, completed 12 years or more of schooling. Current smokers constituted 16.8% of the sample while 26.7% of the individuals were former smokers. Individuals who answered 'yes' to the diabetes question were 7.4% of the study subjects. A hundred and fifteen subjects in our sample had missing values for some variables. Diabetes information was missing for 53 individuals, education data was missing for 8 subjects and previous gum treatment data for 56 participants.

Table 2 shows the sample distribution among exposure variables. Only 3.6% of individuals were categorized in the high carbohydrate intake, while 33.1% were in the low carbohydrate category. According to fat intake, 41.5% were in the high group versus 3.5% in the low fat group. Thirteen percent of the sample fell in the excess caloric intake class, while 35% were in the reduced caloric intake group. The mean total caloric intake averaged between the two 24-hours interviews was 2139.3 kcal. The average estimated caloric requirement was 2448.6.8kcal. The mean of the average share of calories from carbohydrate was 48.8%, the range was from 14.2% to 85%. The mean of the average portion of calories from fat was 33.5%, the range was from 6.9% to 68.4%. After adjusting for the difference between intensity of physical activity (1 moderate intensity activity minutes= 1/2 vigorous activity minute) the weekly physical activity minutes ranged from 5 to 6930 (mean=517.3). Table 3

show the distribution of the weighted sample according the values of activity the factor. In addition, it shows the range of adjusted weekly minutes on each quartile.

As a whole, 39.1% of the population were categorized as periodontitis patients (Tables 4-5). Periodontitis was statistically significantly higher in smokers ($p<0.0001$), high WC ($p<0.05$), diabetics ($p<0.05$), individuals with history of gum treatment ($p<0.05$) and male subjects ($p<0.0001$). According to the race/ethnicity, a statistical significance was detected between different groups ($p<0.0001$). Non-Hispanic white had the lowest prevalence of periodontitis while Mexican Americans had the highest prevalence of periodontitis. Individuals who had completed 12 years or more of education, and subjects with higher ratio of family income to poverty, had statistically significantly lower prevalence of periodontitis ($p<0.0001$).

Periodontitis was detected in 40.4% of the low carbohydrate group. That percentage was 38.4 and 39.5 in the average and high carbohydrate groups respectively. No statistical significance was detected in the relationship between carbohydrate intake and periodontal disease. Of the individuals belonging to the average fat intake, 39.6% were periodontitis patients. The periodontitis prevalence was slightly lower (38.6%) in the high fat group, and 36.7% in the low fat group. Statistical significance was not detected. Regarding total caloric intake, prevalence of periodontitis was 40.4%, 37.1% and 44% for the reduced, average and excess categories respectively, with no statistical significance.

Table 6 shows the distribution of the exposure variables in relation to gender. The majority of male and female subjects was in the average categories for all exposure

variables. Statistical significance was detected in the carbohydrate distribution ($p$<0.0001).

Table 7 shows the distribution of the exposure variables in relation to race/ethnicity. A statistical significance was detected for carbohydrate and fat intakes ($p$<0.0001). Table 8 shows the effect of age categories on the exposure variables. Only the fat groups had a statistical significance between them ($p$<0.05).

Tables 9 through 13 show the results of the 5 logistic regression models. In all models, statistical significance for the effect smoking, gender, race/ethnicity, history of periodontal treatment, age and the ratio of family income to poverty was detected. No statistical significance was shown for any of the exposure variables neither separate nor combined in one model. Education had a statistical significance in models 1, 2, 3 and 5 while WC was statistically significant in model 4.

Model 2 showed that individuals in the low carbohydrate group were17% more likely to have periodontitis when compared to the high carbohydrate group (95% confidence interval(CI) 0.66 to 2.08), while the average carbohydrate group are 13% more likely to have periodontitis when compared to the high carbohydrate group (95% CI 0.68 to 1.88).

Model 3 displayed that individuals in the low fat group are 16% less likely to develop periodontitis when compared to the high fat group (95% CI 0.44 to 1.24), while the average fat group are 4% more likely to have periodontitis when compared to the high fat group (95% CI 0.84 to 1.29).

Model 4 showed that individuals in the reduced calorie group had 10% less the odds of having periodontal disease when compared to the excess calorie group (95% CI

0.68 to 1.19), while the average calorie group are 16% less likely to have periodontitis when compared to the excess calorie group (95% CI 0.61 to 1.15).

Model 5 presented that individuals in the low carbohydrate group had 7% more chance of having periodontal disease when compared to the high carbohydrate group (95% CI 0.56 to 2.01), while the average carbohydrate group are 1% more likely to have periodontitis when compared to the high carbohydrate group (95% CI 0.60 to 1.32). In addition, it showed that individuals in the low fat group had 24% less odds of having periodontal disease when compared to the high fat group (95% CI 0.44 to 1.32), while the average fat group are 7% more likely to have periodontitis when compared to the high fat group (95% CI 0.85 to 1.35). Finally, this model showed that individuals in the reduced calorie group have 10% less odds of having periodontal disease when compared to the excess calorie group (95% CI 0.68 to 1.19), while the average calorie group are 17% less likely to have periodontitis when compared to the high calorie group (95% CI 0.60 to 1.15).

Figures 1 to 3 show the distribution of the exposure variables by periodontitis

Figure 4 shows the sample distribution according to the percentage of calories acquired from carbohydrate (uncategorized). Figure 5 shows the distribution according to the percentage of calories acquired from carbohydrate (uncategorized). Figure 6 shows the distribution of the study population according to percentage of the actual caloric intake by the estimated caloric requirement.

## Discussion

In the present study, the effect of carbohydrate, fat and total caloric intake on periodontal disease was studied using data from the NHANES 2009-2010 cycle. NHANES is a complex multistage survey that includes both a physical examination and health and nutrition questionnaires. Data from the 2009-2010 cycle represent the first NHANES that included full-mouth periodontal examination i.e. 6 sites per tooth, excluding third molars. Eke *et al* [2] found an increased periodontal disease prevalence when NHANES 2009-2010 data were analyzed compared to previous NHANES.[2] Their finding came in agreement with publications that quibbled about the efficiency of partial mouth exam, used in the earlier NHANES in representing the true prevalence of periodontal disease status.[3-5]

The definition of periodontitis used in this study was the presence of at least one site with both PD ≥4mm and CAL 3≥mm. This delineation of periodontitis aims to include only what is considered a true periodontal lesion. In addition, this definition has been used in previous NHANES publications and it appeared to eliminate the confounding effect of age.[8,46] The prevalence of periodontitis in the weighted sample (N=2636) was 39.1%. When the association between periodontal disease and the selected potential confounders was tested, a statistical significance was detected in all the bivariate analyses conducted between periodontitis and each of the covariates, making our results in agreement with the published literature vis-à-vis risk factors of periodontal disease.[2,6-10,47]

Male gender is the most common risk factor for periodontal disease. [47] In the current study, 48.6% of men in the weighted sample had periodontal disease, in contrast to

29.8% of women ($p$<0.0001). This difference in gender has been found in multiple studies, and can be attributed to the social dissimilarities between the two genders as well as certain biological differences.[4,47,48]

Diabetes is a global public health problem. Approximately, 8.3% of the US population are diabetics.[50] This percentage goes up to 26.9% among individuals who were 65 years or older.[50] The deleterious effect of diabetes on the periodontal condition has been shown on cross sectional and longitudinal studies.[4,47] Periodontal disease on the other hand has been associated with poorer glycemic control in diabetic patients. [47] Two hundred forty eight individuals were categorized as diabetic in the current study sample, and 52.7% of them were periodontitis patients versus 38.1% among non-diabetic individuals ($p$<0.0001).

Most studies that examined the association between smoking and periodontal disease have found a positive association between them. Smokers are 2 to 7 times more likely to experience periodontal breakdown when compared to non-smokers.[4] This relationship between smoking and periodontal disease has been presented in both cross-sectional and longitudinal studies.[47] In addition, there is strong evidence in the literature that smoking cessation slows the pathological periodontal breakdown process .[49] According to the present study, current smokers had the highest prevalence of periodontitis 59.5% followed by former smokers 41.3%.

When looking at the age categories in the current study sample, it is noticeable that the prevalence of periodontitis increases with age ($p$<0.0001). Individuals who were 65 years and older had a prevalence of 47.8% periodontal disease, while the youngest

age category had a prevalence of 29.9%. This finding is in agreement with the previously published data, and as mentioned earlier, it is not obvious whether this positive association between age and periodontal disease is due to changes occurring in the host or the passage of time.[4]

A negative association has been found between socioeconomic status and the risk of periodontal disease. [4,51,52] In addition, low education attainment is associated with higher risk of periodontal disease.[52,53] Our findings agree with these notions, as both socioeconomic status and education level are negatively associated with prevalence or periodontal disease ($p$<0.0001).

Individuals of Black and Mexican heritages have been associated with a higher risk of periodontal disease. [4,54] In the weighted sample 64.6% of Mexican Americans had periodontal disease. Non-Hispanic Black had the second highest prevalence of periodontal disease, 54.1 %, while non-Hispanic white had the lowest prevalence ($p$<0.0001).

Although obesity was not among the main exposure variables in the current study, it was considered a potential confounder. Obesity was measured in our study using WC. Individuals were divided into either normal WC or high WC. Periodontitis was statistically significantly associated with high WC ($p$<0.05). Obesity has been associated with periodontal disease in both cross sectional (Al-Zahrani et al.) and longitudinal studies (Gorman et al. and Jimenez et al.). [10,13,14] WC was used in the previous studies as one of the obesity/adiposity measures.

Nutritional epidemiology is a relatively new field that focuses on studying the association between nutritional factors and disease. Studying human nutrition is complex.[17] The huge diversity of dietary intake, the involvement of many confounding factors, the difficulty in obtaining authentic data and the trouble faced with long term follow up, are some of the challenges associated with examining the human diet. [17, 18] Strong associations in nutritional studies are not commonly found, which are an inherit limitation in this type of research e.g.: a relative risk of 0.7 to 1.5 is considered of great significance. [17]

Periodontitis, on the other hand, is a common chronic infectious disease, with several local, systemic and environmental factors contributing to its etiopathology, making it one of the most demanding diseases to examine.

Many reports have been recently published discussing the correlation between periodontal disease and nutritional elements. Most of the published studies looked at vitamins, minerals and/or few food groups.[16] In the current study, the effect of total caloric intake and percentages of carbohydrate and fat in the human diet was examined. The 2010 Dietary guidelines for Americans[39] were used in order to categorize individuals' diet with respect to carbohydrate and fat intake. Total caloric intake classification was done relying on the Harris-Benedict equation and the reported physical activity level for each subject. No statistical significance was detected between any of the exposure variables (total caloric intake, percentage of calories from carbohydrate and percentage of calories from fat) and periodontal disease. Even after controlling the effect of covariates in the logistic regression

models, no statistical significance could be detected for the effect of the exposure variable on periodontal disease.

The authors are not familiar with any previous publication that looked at the association between periodontal disease and the above selected aspects of nutrition, therefore, comparison with other studies is not possible. The results of this study, however, must be interpreted with caution. Due to the inherent restrictions of the study design in that it being cross sectional in nature and a diet study, this association may have been weakened. The aspects of diet that we choose, required a 24-hour recall method of data collection. Although this method provides immense details about diet quality and quantity, conducting such surveys require a massive effort and funding. In order to more accurately report total energy intake and macronutrients 4 to 5 24-hour surveys would be preferred.[17] In the current study, only individuals who completed the two 24-hour dietary questionnaire were included and their dietary values were averaged among the two data sets. This should have at least alleviated concerns about diet record accuracy.

Our research question obligated the need for both accurate periodontal and dietary data. The fact that the 2009-2010 NHANES is the only one to date with released data with a full periodontal mouth examination, has limited our ability to combine additional NHANES cycles to increase the sample size. Although, the final sample size of 2636 was relatively large, both periodontal disease and diet are influenced by an endless number of confounding factors. However, there is a major leverage in using NAHNES data set. The accurate data collection, the ability to merge and

analyze future data release and the national representation of this data, are among the strengths of this study.

A limitation of this study was the fact that it looked at both carbohydrate ,and fat intake as a whole. More information should be obtained by investigating the different types of carbohydrate and different types of fat.

As the relationship between diet and disease is almost always not linear, [16,17] there is a possibility that periodontal status is not sensitive to the categorization of carbohydrate, fat and total caloric intake in our study. A larger sample size would allow for a more restrictive sample grouping.

Periodontitis and other chronic life threatening conditions such as diabetes and heart diseases share several risk factors.[55,56] Diet may play a more crucial role in periodontal disease than what our current understanding accepts. Therefore, more research is needed to add to the body of knowledge in the relationship between periodontal disease and dietary factors.

# Conclusion

This study looked at the association between periodontal disease and carbohydrate, fat and total caloric intake using data from 2009-2010 NHANES. No statistically significant finding were detected. However, the results of this study cannot be generalized. More research needs to be done to investigate the effect of diet on periodontal status.

**Table 1.**

Characteristics of study population

| | N | Weighted N | SD of Wgt N | Weighted % | SE of Wgt % |
|---|---|---|---|---|---|
| **Gender** | | | | | |
| Male | 1316 | 49869652 | 3291982 | 49.55 | 0.72 |
| Female | 1320 | 50769386 | 3806652 | 50.45 | 0.72 |
| ` | | | | | |
| **Race/Ethnicity** | | | | | |
| Mexican American | 486 | 7862889 | 1635654 | 7.8130 | 2.0250 |
| Other Hispanic | 277 | 4703016 | 1197961 | 4.6732 | 1.2562 |
| Non-Hispanic White | 1369 | 73543217 | 8021325 | 73.0762 | 3.2882 |
| Non-Hispanic Black | 387 | 8603621 | 819654 | 8.5490 | 0.7999 |
| Other incl Multiracial | 117 | 5926293 | 891284 | 5.8887 | 0.9615 |
| | | | | | |
| **Age** | | | | | |
| 30-34 | 290 | 11733526 | 961260 | 11.66 | 0.64 |
| 35-49 | 939 | 38656953 | 2448800 | 38.41 | 1.63 |
| 50-64 | 792 | 32455551 | 2851202 | 32.25 | 1.30 |
| 65+ | 615 | 17793006 | 1920384 | 17.68 | 0.96 |
| | | | | | |
| **Hx of gum Tx** | | | | | |
| No | 1980 | 78616080 | 6409447 | 79.31 | 2.03 |
| Yes | 600 | 20506531 | 2239424 | 20.69 | 2.03 |
| N of missing = 56 | | | | . | |
| | | | | | |
| **Ratio of family Income to poverty** | | | | | |
| <1 | 643 | 16044332 | 1022112 | 15.94 | 1.35 |
| >=1 and <2 | 601 | 15706330 | 1276413 | 15.61 | 0.71 |
| >=2 and <3 | 376 | 14370829 | 1502777 | 14.28 | 1.05 |
| >=3 and <4 | 275 | 12721733 | 1902079 | 12.64 | 1.32 |
| >=4 | 741 | 41795814 | 3395979 | 41.53 | 1.29 |
| | | | | | |
| **Smoking** | | | | | |
| None | 1437 | 56886459 | 3723478 | 56.53 | 1.79 |
| Current | 516 | 16932765 | 1295782 | 16.83 | 0.76 |
| Former | 683 | 26819814 | 3065323 | 26.65 | 1.78 |
| | | | | | |
| **Diabetes** | | | | | |
| No | 2335 | 91884905 | 6554192 | 93.0287 | 0.5327 |
| Yes | 248 | 6885545 | 521423 | 6.9713 | 0.5327 |
| N of missing = 53 | | | | | |
| | | | | | |
| **WC** | | | | | |
| Normal | 1217 | 49624401 | 3557721 | 49.31 | 1.48 |
| High | 1419 | 51014636 | 4012129 | 50.69 | 1.48 |
| | | | | | |
| **Education** | | | | | |
| <12 years | 1257 | 37935002 | 3051255 | 37.78 | 1.62 |
| >=12 years | 1371 | 62472950 | 4675494 | 62.22 | 1.62 |
| N of missing = 8 | | | | | |

**Table 2.**

Distribution of study population according to the exposure variables

| | N | Weighted % | SE of Wgt % |
|---|---|---|---|
| **Carbohydrate intake** | | | |
| Low | 775 | 33.12 | 1.57 |
| Average | 1739 | 63.30 | 1.43 |
| High | 122 | 3.58 | 0.42 |
| | | | |
| **Fat intake** | | | |
| Low | 117 | 3.51 | 0.41 |
| Average | 1529 | 55.04 | 1.73 |
| High | 990 | 41.45 | 1.78 |
| | | | |
| **Total caloric intake** | | | |
| Reduced | 967 | 34.98 | 1.16 |
| Average | 1325 | 51.89 | 0.88 |
| Excess | 344 | 13.13 | 1.11 |

*Based on the percentage of calories from carbohydrate: less than 45% is a low carbohydrate diet, between 45-65% is an average carbohydrate diet, and greater than 65% is a high carbohydrate diet.
** Based on the percentage of calories from fat: less than 20% is a low fat diet, between 20-35% is an average fat diet and greater than 35% is a high fat diet.
*** Based on the estimated caloric requirement versus actual total caloric intake.

**Table 3.**

Sample distribution among the activity factor values

| Activity Factor | N | Weighted % | SE of Wgt % | Range of adjusted weekly minutes* |
|---|---|---|---|---|
| **1.2** | 848 | 26.65 | 1.66 | N/A |
| **1.375** | 463 | 18.07 | 0.84 | 5 and 90 |
| **1.55** | 434 | 18.79 | 0.88 | >90 and 250 |
| **1.725** | 444 | 19.38 | 1.13 | >250 and 665 |
| **1.9** | 447 | 17.11 | 0.93 | >665 and 6930 |

* 1 moderate intensity physical activity = ½ vigorous intensity physical activity

**Table 4.**

Overall prevalence of periodontitis

| Periodontitis | N | Weighted N | SD of Wgt N | % | SE of % |
|---|---|---|---|---|---|
| **No** | 1384 | 61275080 | 4895638 | 60.89 | 1.65 |
| **Yes** | 1252 | 39363957 | 2847612 | 39.11 | 1.65 |
| **Total** | 2636 | 100639037 | 6965824 | 100.000 | |

**Table 5.**

Prevalence of periodontitis among study population categories

| | N | Weighted % | SE of weighted % | Prevalence of periodontal disease | SE of Prevalence of periodontal disease | *P* Value |
|---|---|---|---|---|---|---|
| **Carbohydrate** | | | | | | 0.6215 |
| Low | 775 | 33.12 | 1.57 | 40.42 | 1.56 | |
| Average | 1739 | 63.30 | 1.43 | 38.41 | 2.12 | |
| High | 122 | 3.58 | 0.42 | 39.47 | 5.10 | |
| | | | | | | |
| **Fat** | | | | | | 0.8066 |
| Low | 117 | 3.51 | 0.41 | 36.78 | 6.03 | |
| Average | 1529 | 55.04 | 1.73 | 39.62 | 1.79 | |
| High | 990 | 41.45 | 1.78 | 38.64 | 1.99 | |
| | | | | | | |
| **Caloric Intake** | | | | | | 0.2437 |
| Reduced | 967 | 34.98 | 1.16 | 40.35 | 2.83 | |
| Average | 1325 | 51.89 | 0.88 | 37.05 | 2.00 | |
| Excess | 344 | 13.13 | 1.11 | 43.98 | 3.96 | |
| | | | | | | |
| **Smoking** | | | | | | <0.0001 |
| None | 1437 | 56.5252 | 1.7857 | 32.0369 | 2.2778 | |
| Current | 516 | 16.8252 | 0.7607 | 59.4512 | 2.7766 | |
| Former | 683 | 26.6495 | 1.7803 | 41.2851 | 2.4542 | |
| | | | | | | |
| **Diabetes** | | | | | | 0.0040 |
| No | 2335 | 93.03 | 0.53 | 38.07 | 1.81 | |
| Yes | 248 | 6.97 | 0.53 | 52.67 | 4.38 | |
| | | | | | | |
| **WC** | | | | | | 0.0342 |
| Normal | 1217 | 49.31 | 1.48 | 36.65 | 2.06 | |
| High | 697 | 21.04 | 1.13 | 41.51 | 1.95 | |
| | | | | | | |
| **Education** | | | | | | <0.0001 |
| <12 years | **1** | 1257 | 37.7809 | 1.6179 | 50.80 | 2.4620 |
| >= 12 years | **1** | 525 | 19.8843 | 0.9646 | 31.96 | 1.5479 |
| | | | | | | |
| **Gender** | | | | | | <0.0001 |
| Male | 1316 | 49.55 | 0.72 | 48.62 | 1.70 | |
| Female | 1320 | 50.45 | 0.72 | 29.78 | 2.20 | |

**Cont. Table 5.**

Prevalence of periodontitis among study population categories

| | N | Weighted % | SE of weighted % | Prevalence of periodontal disease | SE of Prevalence of periodontal disease | *P* Value |
|---|---|---|---|---|---|---|
| **Race/Ethnicity** | | | | | | <0.0001 |
| Mexican American | 486 | 7.8130 | 2.0250 | 64.5559 | 1.7370 | |
| Other Hispanic | 277 | 4.6732 | 1.2562 | 45.9151 | 2.6809 | |
| Non-Hispanic White | 1369 | 73.0762 | 3.2882 | 34.6353 | 1.8752 | |
| Non-Hispanic Black | 387 | 8.5490 | 0.7999 | 54.1438 | 3.4210 | |
| Other incl Multiracial | 117 | 5.8887 | 0.9615 | 33.7206 | 4.1681 | |
| | | | | | | |
| **Age** | | | | | | <0.0001 |
| 30-34 | 290 | 11.66 | 0.64 | 29.94 | 3.38 | |
| 35-49 | 939 | 38.41 | 1.63 | 33.11 | 2.11 | |
| 50-64 | 792 | 32.25 | 1.30 | 44.82 | 3.07 | |
| 65+ | 615 | 17.68 | 0.96 | 47.80 | 3.28 | |
| | | | | | | |
| **Hx of gum Tx** | | | | | | 0.0097 |
| No | 1980 | 79.31 | 2.03 | 36.19 | 1.92 | |
| Yes | 600 | 20.69 | 2.03 | 50.05 | 4.70 | |
| | | | | | | |
| **Ratio of family income to poverty** | | | | | | <0.0001 |
| <1 | 643 | 15.94 | 1.35 | 52.9 | 1.72 | |
| >=1 and <2 | 601 | 15.61 | 0.71 | 51.98 | 3.25 | |
| >=2 and <3 | 376 | 14.28 | 1.05 | 42.66 | 2.76 | |
| >=3 and <4 | 275 | 12.64 | 1.32 | 36.37 | 3.20 | |
| >=4 | 741 | 41.53 | 1.29 | 28.59 | 2.41 | |

*Based on the percentage of calories from carbohydrate: less than 45% is a low carbohydrate diet, between 45-65% is an average carbohydrate diet, and greater than 65% is a high carbohydrate diet.
** Based on the percentage of calories from fat: less than 20% is a low fat diet, between 20-35% is an average fat diet and greater than 35% is a high fat diet.
*** Based on the estimated caloric requirement versus actual total caloric intake.

**Table 6.**

Distribution of study population according to exposure variables and gender

| Gender | Carbohydrate Intake* | N | Wgt % | SE | Fat Intake** | N | Wgt % | SE | Tot caloric Intake*** | N | Wgt % | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Male** | **Low** | 449 | 37.91 | 2.06 | **Low** | 60 | 3.12 | 0.37 | **Reduced** | 467 | 34.27 | 1.75 |
| | **Average** | 817 | 59.34 | 2.16 | **Average** | 748 | 54.15 | 2.67 | **Average** | 665 | 51.85 | 1.73 |
| | **High** | 50 | 2.75 | 0.49 | **High** | 508 | 42.74 | 2.61 | **Excess** | 184 | 13.88 | 1.43 |
| **Female** | **Low** | 326 | 28.41 | 1.55 | **Low** | 57 | 3.90 | 0.72 | **Reduced** | 500 | 35.68 | 1.26 |
| | **Average** | 922 | 67.19 | 1.36 | **Average** | 781 | 55.91 | 1.49 | **Average** | 660 | 51.93 | 1.14 |
| | **High** | 72 | 4.40 | 0.67 | **High** | 482 | 40.19 | 1.36 | **Excess** | 160 | 12.39 | 1.25 |
| | *P*<0.0001 | | | | *P*=0.9963 | | | | *P*=0.5596 | | | |

*Based on the percentage of calories from carbohydrate: less than 45% is a low carbohydrate diet, between 45-65% is an average carbohydrate diet, and greater than 65% is a high carbohydrate diet.

** Based on the percentage of calories from fat: less than 20% is a low fat diet, between 20-35% is an average fat diet, and greater than 35% is a high fat diet.

*** Based on the estimated caloric requirement versus actual total caloric intake.

**Table 7.**

Distribution of study population according to exposure variables and race/ethnicity

| Race/Ethnicity | Carbohydrate Intake* | N | Wgt % | SE | Fat Intake** | N | Wgt % | SE | Tot caloric Intake*** | N | Wgt % | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mexican American** | **Low** | 104 | 22.39 | 1.97 | **Low** | 28 | 5.07 | 0.93 | **Reduced** | 178 | 36.23 | 2.32 |
| | **Average** | 350 | 72.03 | 2.24 | **Average** | 327 | 68.90 | 1.76 | **Average** | 234 | 48.50 | 2.56 |
| | **High** | 32 | 5.58 | 1.13 | **High** | 131 | 26.03 | 1.55 | **Excess** | 74 | 15.27 | 1.57 |
| **Other Hispanic** | **Low** | 47 | 17.72 | 2.43 | **Low** | 18 | 7.16 | 2.06 | **Reduced** | 124 | 42.47 | 2.82 |
| | **Average** | 215 | 77.27 | 2.13 | **Average** | 188 | 66.17 | 3.14 | **Average** | 130 | 48.85 | 2.61 |
| | **High** | 15 | 5.00 | 1.27 | **High** | 71 | 26.67 | 2.57 | **Excess** | 23 | 8.68 | 2.47 |
| **Non Hispanic White** | **Low** | 476 | 36.08 | 2.02 | **Low** | 44 | 2.71 | 0.44 | **Reduced** | 480 | 34.52 | 1.36 |
| | **Average** | 850 | 61.18 | 1.87 | **Average** | 710 | 51.78 | 2.15 | **Average** | 708 | 52.32 | 1.18 |
| | **High** | 43 | 2.73 | 0.40 | **High** | 615 | 45.51 | 2.28 | **Excess** | 181 | 13.15 | 1.56 |
| **Non Hispanic Black** | **Low** | 121 | 30.72 | 2.64 | **Low** | 17 | 4.46 | 0.77 | **Reduced** | 150 | 39.85 | 2.37 |
| | **Average** | 245 | 63.67 | 3.12 | **Average** | 227 | 59.1 | 3.47 | **Average** | 184 | 46.51 | 2.07 |
| | **High** | 21 | 5.61 | 1.19 | **High** | 143 | 36.36 | 2.92 | **Excess** | 53 | 13.64 | 1.90 |
| **Other incl Multirac** | **Low** | 27 | 26.23 | 4.56 | **Low** | 10 | 7.12 | 3.14 | **Reduced** | 35 | 25.95 | 4.17 |
| | **Average** | 79 | 66.41 | 5.08 | **Average** | 77 | 62.22 | 6.61 | **Average** | 69 | 61.31 | 3.58 |
| | **High** | 11 | 7.36 | 1.92 | **High** | 30 | 30.66 | 5.49 | **Excess** | 13 | 12.74 | 4.59 |
| | *P*<0.0001 | | | | *P*<0.0001 | | | | *P*=0.0863 | | | |

*Based on the percentage of calories from carbohydrate: less than 45% is a low carbohydrate diet, between 45-65% is an average carbohydrate diet, and greater than 65% is a high carbohydrate diet.
** Based on the percentage of calories from fat: less than 20% is a low fat diet, between 20-35% is an average fat diet, and greater than 35% is a high fat diet.
*** Based on the estimated caloric requirement versus actual total caloric intake.

**Table 8.**

Distribution of study population according to exposure variables and age categories

| Age | Carbohydrate Intake | N | Wgt % | SE | Fat Intake | N | Wgt % | SE | Tot Caloric Intake | N | Wgt % | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **30-34** | **Low** | 84 | 30.21 | 2.71 | **Low** | 19 | 5.56 | 1.86 | **Reduced** | 95 | 31.39 | 1.89 |
| | **Average** | 190 | 64.32 | 2.55 | **Average** | 180 | 61.08 | 3.05 | **Average** | 162 | 56.52 | 2.37 |
| | **High** | 16 | 5.47 | 1.38 | **High** | 91 | 33.36 | 2.95 | **Excess** | 33 | 12.09 | 1.68 |
| **35-49** | **Low** | 269 | 32.18 | 1.53 | **Low** | 41 | 3.68 | 0.53 | **Reduced** | 360 | 37.78 | 2.02 |
| | **Average** | 627 | 64.06 | 1.45 | **Average** | 565 | 57.15 | 2.95 | **Average** | 447 | 49.08 | 1.36 |
| | **High** | 43 | 3.76 | 0.65 | **High** | 333 | 39.16 | 2.87 | **Excess** | 132 | 13.14 | 1.98 |
| **50-64** | **Low** | 251 | 35.82 | 3.18 | **Low** | 37 | 3.39 | 0.70 | **Reduced** | 302 | 34.49 | 1.66 |
| | **Average** | 497 | 60.84 | 2.95 | **Average** | 443 | 51.37 | 2.09 | **Average** | 391 | 52.21 | 1.65 |
| | **High** | 44 | 3.34 | 0.72 | **High** | 312 | 45.24 | 2.00 | **Excess** | 99 | 13.29 | 1.57 |
| **65+** | **Low** | 171 | 32.14 | 1.84 | **Low** | 20 | 2.00 | 0.63 | **Reduced** | 210 | 32.14 | 2.13 |
| | **Average** | 425 | 65.48 | 1.82 | **Average** | 341 | 53.15 | 1.53 | **Average** | 325 | 54.37 | 1.63 |
| | **High** | 19 | 2.38 | 0.79 | **High** | 254 | 44.85 | 1.71 | **Excess** | 80 | 13.50 | 1.81 |
| | *P*=0.2357 | | | | | *P*=0038 | | | *P*=0.2891 | | | |

**Table 9.** Logistic regression model 1.

| Effect | OR | 95% Wald Confidence Limits | | *P* Value |
|---|---|---|---|---|
| Smoking (none vs former) | 0.802 | 0.651 | 0.988 | <.0001 |
| Smoking (current vs former) | 2.307 | 1.714 | 3.106 | <.0001 |
| diabetes (no vs yes) | 0.888 | 0.617 | 1.278 | 0.5215 |
| Education (<12 Y vs >=12) | 1.436 | 1.224 | 1.685 | <.0001 |
| WC (normal vs high) | 0.796 | 0.628 | 1.009 | 0.0596 |
| Gender (male vs female) | 2.689 | 2.141 | 3.377 | <.0001 |
| Race/ethnicity* ( MA vs ORM) | 2.816 | 2.043 | 3.882 | <.0001 |
| Race/ethnicity* (OH vs ORM) | 1.434 | 1.012 | 2.033 | 0.8634 |
| Race/Ethnicity* (NHW vs ORM) | 0.901 | 0.618 | 1.315 | <.0001 |
| Race/Ethnicity* (NHB vs ORM) | 1.830 | 1.282 | 2.612 | 0.0597 |
| Had gum Tx before (No vs yes) | 0.630 | 0.419 | 0.946 | 0.0259 |
| Age (30-34 vs 65+) | 0.290 | 0.185 | 0.455 | <.0001 |
| Age (35-49 vs 65+) | 0.408 | 0.271 | 0.615 | 0.0004 |
| Age (50 vs 65+) | 0.854 | 0.550 | 1.325 | 0.0005 |
| Ratio of f income to poverty (<1 vs >=4) | 1.870 | 1.361 | 2.568 | 0.0306 |
| Ratio of f income to poverty (>=1 to<2 vs >=4) | 2.095 | 1.547 | 2.837 | 0.0040 |
| Ratio of f income to poverty (>=2 to<3 vs >=4) | 1.554 | 1.017 | 2.374 | 0.7302 |
| Ratio of f income to poverty (>=3 to<4 vs >=4) | 1.187 | 0.849 | 1.661 | 0.1057 |

| Effect | DF | Wald Chi-Square | *P* Value |
|---|---|---|---|
| Smoking | 2 | 32.3628 | <.0001 |
| Diabetes | 1 | 0.4108 | 0.5215 |
| Education | 1 | 19.6780 | <.0001 |
| WC | 1 | 3.5497 | 0.0596 |
| Gender | 1 | 72.4160 | <.0001 |
| Race/Ethnicity | 4 | 109.7046 | <.0001 |
| Hx of gum Tx | 1 | 4.9658 | 0.0259 |
| Age | 3 | 46.7408 | <.0001 |
| Ratio of f income to poverty | 4 | 33.2194 | <.0001 |

* MA=Mexican American, OH=Other Hispanic, NHW=Non-Hispanic White, NHB=Other Hispanic Black , ORM=Other Race – including Multiracial

**Table 10.** Logistic regression model 2.

| Effect | OR | 95% Wald Confidence Limits | | P Value |
|---|---|---|---|---|
| Carbohydrate* (low vs high) | 1.168 | 0.655 | 2.084 | 0.6080 |
| Carbohydrate* (average vs high) | 1.129 | 0.677 | 1.883 | 0.7594 |
| Smoking (none vs former) | 0.806 | 0.654 | 0.995 | <.0001 |
| Smoking (current vs former) | 2.314 | 1.719 | 3.117 | <.0001 |
| diabetes (no vs yes) | 0.892 | 0.624 | 1.276 | 0.5326 |
| Education (<12 Y vs >=12) | 1.436 | 1.223 | 1.686 | <.0001 |
| WC (normal vs high) | 0.797 | 0.628 | 1.012 | 0.0628 |
| Gender (male vs female) | 2.677 | 2.143 | 3.345 | <.0001 |
| Race/ethnicity** ( MA vs ORM) | 2.807 | 2.029 | 3.884 | <.0001 |
| Race/ethnicity** (OH vs ORM) | 1.432 | 1.003 | 2.043 | 0.8780 |
| Race/Ethnicity**(NHW vs ORM) | 0.894 | 0.604 | 1.323 | <.0001 |
| Race/Ethnicity** (NHB vs ORM) | 1.820 | 1.265 | 2.618 | 0.0634 |
| Had gum Tx before (No vs yes) | 0.629 | 0.417 | 0.947 | 0.0265 |
| Age (30-34 vs 65+) | 0.291 | 0.185 | 0.457 | <.0001 |
| Age (35-49 vs 65+) | 0.408 | 0.270 | 0.616 | 0.0004 |
| Age (50 vs 65+) | 0.853 | 0.548 | 1.329 | 0.0005 |
| Ratio of f income to poverty (<1 vs >=4) | 1.880 | 1.355 | 2.608 | 0.0321 |
| Ratio of f income to poverty (>=1 to<2 vs >=4) | 2.113 | 1.547 | 2.887 | 0.0036 |
| Ratio of f income to poverty (>=2 to<3 vs >=4) | 1.561 | 1.025 | 2.377 | 0.7195 |
| Ratio of f income to poverty (>=3 to<4 vs >=4) | 1.187 | 0.851 | 1.656 | 0.0952 |

| Effect | DF | Wald Chi-Square | *P* Value |
|---|---|---|---|
| Carbohydrate* | 2 | 0.2790 | 0.8698 |
| Smoking | 2 | 33.2221 | <.0001 |
| Diabetes | 1 | 0.3895 | 0.5326 |
| Education | 1 | 19.5380 | <.0001 |
| WC | 1 | 3.4618 | 0.0628 |
| Gender | 1 | 75.2219 | <.0001 |
| Race/Ethnicity | 4 | 110.4463 | <.0001 |
| Hx of gum Tx | 1 | 4.9248 | 0.0265 |
| Age | 3 | 46.4000 | <.0001 |
| Ratio of f income to poverty | 4 | 30.2341 | <.0001 |

*Based on the percentage of calories from carbohydrate: less than 45% is a low carbohydrate diet, between 45-65% is an average carbohydrate diet, and greater than 65% is a high carbohydrate diet.
** MA=Mexican American, OH=Other Hispanic, NHW=Non-Hispanic White,
NHB=Other Hispanic Black, ORM=Other Race – including Multiracial

**Table 11.** Logistic regression model 3

| Effect | OR | 95% Wald Confidence Limits | | P Value |
|---|---|---|---|---|
| Fa*t (low vs high) | 0.742 | 0.444 | 1.241 | 0.2588 |
| Fat* (average vs high) | 1.041 | 0.840 | 1.291 | 0.3239 |
| Smoking (none vs former) | 0.802 | 0.650 | 0.990 | <.0001 |
| Smoking (current vs former) | 2.318 | 1.728 | 3.109 | <.0001 |
| diabetes (no vs yes) | 0.889 | 0.619 | 1.276 | 0.5227 |
| Education (<12 Y vs >=12) | 1.441 | 1.224 | 1.696 | <.0001 |
| WC (normal vs high) | 0.794 | 0.623 | 1.011 | 0.0616 |
| Gender (male vs female) | 2.690 | 2.148 | 3.368 | <.0001 |
| Race/ethnicity** ( MA vs ORM) | 2.771 | 2.004 | 3.831 | <.0001 |
| Race/ethnicity** (OH vs ORM) | 1.421 | 0.989 | 2.042 | 0.8722 |
| Race/Ethnicity** (NHW vs ORM) | 0.889 | 0.603 | 1.310 | <.0001 |
| Race/Ethnicity** (NHB vs ORM) | 1.804 | 1.257 | 2.589 | 0.0638 |
| Had gum Tx before (No vs yes) | 0.629 | 0.418 | 0.948 | 0.0266 |
| Age (30-34 vs 65+) | 0.292 | 0.186 | 0.458 | <.0001 |
| Age (35-49 vs 65+) | 0.409 | 0.271 | 0.616 | 0.0003 |
| Age (50 vs 65+) | 0.856 | 0.550 | 1.331 | 0.0004 |
| Ratio of f income to poverty (<1 vs >=4) | 1.876 | 1.373 | 2.564 | 0.0282 |
| Ratio of f income to poverty (>=1 to<2 vs >=4) | 2.106 | 1.555 | 2.851 | 0.0036 |
| Ratio of f income to poverty (>=2 to<3 vs >=4) | 1.550 | 1.025 | 2.345 | 0.7467 |
| Ratio of f income to poverty (>=3 to<4 vs >=4) | 1.189 | 0.850 | 1.664 | 0.1059 |

| Effect | DF | Wald Chi-Square | *P* Value |
|---|---|---|---|
| Fat | 2 | 1.2955 | 0.5232 |
| Smoking | 2 | 33.1325 | <.0001 |
| Diabetes | 1 | 0.4086 | 0.5227 |
| Education | 1 | 19.2289 | <.0001 |
| WC | 1 | 3.4945 | 0.0616 |
| Gender | 1 | 74.2906 | <.0001 |
| Race/Ethnicity | 4 | 112.2973 | <.0001 |
| Hx of gum Tx | 1 | 4.9169 | 0.0266 |
| Age | 3 | 47.4554 | <.0001 |
| Ratio of f income to poverty | 4 | 33.3053 | <.0001 |

* Based on the percentage of calories from fat: less than 20% is a low fat diet, between 20-35% is an average fat diet and greater than 35% is a high fat diet.
.** MA=Mexican American, OH=Other Hispanic, NHW=Non-Hispanic White, NHB=Other Hispanic Black, ORM=Other Race – including Multiracial

**Table 12.** Logistic regression model 4

| Effect | OR | 95% Wald Confidence Limits | | P Value |
|---|---|---|---|---|
| Total Caloric intake* (reduced vs excess) | 0.901 | 0.681 | 1.192 | 0.9084 |
| Total Caloric intake* (average vs excess) | 0.837 | 0.611 | 1.147 | 0.4083 |
| Smoking (none vs former) | 0.807 | 0.652 | 0.998 | <.0001 |
| Smoking (current vs former) | 2.281 | 1.673 | 3.112 | <.0001 |
| diabetes (no vs yes) | 0.879 | 0.616 | 1.255 | 0.4778 |
| Education (<12 Y vs >=12) | 0.794 | 0.624 | 1.011 | 0.0609 |
| WC (normal vs high) | 1.441 | 1.223 | 1.699 | <.0001 |
| Gender (male vs female) | 2.691 | 2.142 | 3.381 | <.0001 |
| Race/ethnicity** ( MA vs ORM) | 2.773 | 2.004 | 3.838 | <.0001 |
| Race/ethnicity** (OH vs ORM) | 1.421 | 1.008 | 2.003 | 0.8668 |
| Race/Ethnicity**(NHW vs ORM) | 0.892 | 0.617 | 1.291 | <.0001 |
| Race/Ethnicity** (NHB vs ORM) | 1.808 | 1.281 | 2.553 | 0.0618 |
| Had gum Tx before (No vs yes) | 0.629 | 0.420 | 0.944 | 0.0251 |
| Age (30-34 vs 65+) | 0.292 | 0.186 | 0.458 | <.0001 |
| Age (35-49 vs 65+) | 0.408 | 0.272 | 0.612 | 0.0003 |
| Age (50 vs 65+) | 0.854 | 0.551 | 1.323 | 0.0005 |
| Ratio of f income to poverty (<1 vs >=4) | 1.864 | 1.357 | 2.561 | 0.0300 |
| Ratio of f income to poverty (>=1 to<2 vs >=4) | 2.082 | 1.547 | 2.803 | 0.0038 |
| Ratio of f income to poverty (>=2 to<3 vs >=4) | 1.547 | 1.018 | 2.351 | 0.7360 |
| Ratio of f income to poverty (>=3 to<4 vs >=4) | 1.184 | 0.839 | 1.670 | 0.1122 |

| Effect | DF | Wald Chi-Square | *P* Value |
|---|---|---|---|
| Total caloric intake* | 2 | 1.3589 | 0.5069 |
| Smoking | 2 | 28.8983 | <.0001 |
| Diabetes | 1 | 0.5040 | 0.4778 |
| Education | 1 | 3.5124 | 0.0609 |
| WC | 1 | 18.9798 | <.0001 |
| Gender | 1 | 72.2758 | <.0001 |
| Race/Ethnicity | 4 | 99.6907 | <.0001 |
| Hx of gum Tx | 1 | 5.0172 | 0.0251 |
| Age | 3 | 47.7945 | <.0001 |
| Ratio of f income to poverty | 4 | 32.4814 | <.0001 |

* Based on the estimated caloric requirement versus actual total caloric intake.
** MA=Mexican American, OH=Other Hispanic, NHW=Non-Hispanic White, NHB=Other Hispanic Black , ORM=Other Race – including Multiracial

**Table 13**. Logistic regression model 5

| Effect | OR | 95% Wald Confidence Limits | | P Value |
|---|---|---|---|---|
| Carbohydrate *(low vs high) | 1.077 | 0.577 | 2.010 | 0.7376 |
| Carbohydrate *(average vs high) | 1.011 | 0.601 | 1.700 | 0.8497 |
| Fat** (low vs high) | 0.758 | 0.436 | 1.318 | 0.2988 |
| Fat** (average vs high) | 1.073 | 0.852 | 1.351 | 0.3019 |
| Total Caloric intake ***(reduced vs excess) | 0.902 | 0.682 | 1.194 | 0.9397 |
| Total Caloric intake ***(average vs excess) | 0.831 | 0.602 | 1.148 | 0.3812 |
| Smoking (none vs former) | 0.812 | 0.657 | 1.003 | <.0001 |
| Smoking (current vs former) | 2.290 | 1.684 | 3.113 | <.0001 |
| diabetes (no vs yes) | 0.882 | 0.620 | 1.255 | 0.4865 |
| Education (<12 Y vs >=12) | 1.445 | 1.222 | 1.709 | <.0001 |
| WC (normal vs high) | 0.794 | 0.622 | 1.013 | 0.0633 |
| Gender (male vs female) | 2.679 | 2.151 | 3.338 | <.0001 |
| Race/ethnicity‡ ( MA vs ORM) | 2.725 | 1.952 | 3.804 | <.0001 |
| Race/ethnicity‡ (OH vs ORM) | 1.410 | 0.976 | 2.035 | 0.8914 |
| Race/Ethnicity‡ (NHW vs ORM) | 0.879 | 0.598 | 1.293 | <.0001 |
| Race/Ethnicity‡ (NHB vs ORM) | 1.777 | 1.244 | 2.538 | 0.0689 |
| Had gum Tx before (No vs yes) | 0.628 | 0.417 | 0.945 | 0.0259 |
| Age (30-34 vs 65+) | 0.293 | 0.186 | 0.462 | <.0001 |
| Age (35-49 vs 65+) | 0.407 | 0.271 | 0.611 | 0.0003 |
| Age (50 vs 65+) | 0.855 | 0.548 | 1.332 | 0.0005 |
| Ratio of f income to poverty (<1 vs >=4) | 1.881 | 1.359 | 2.604 | 0.0288 |
| Ratio of f income to poverty (>=1 to<2 vs >=4) | 2.105 | 1.550 | 2.859 | 0.0032 |
| Ratio of f income to poverty (>=2 to<3 vs >=4) | 1.553 | 1.029 | 2.344 | 0.7297 |
| Ratio of f income to poverty (>=3 to<4 vs >=4) | 1.182 | 0.841 | 1.660 | 0.1001 |

| Effect | DF | Wald Chi-Square | *P* Value |
|---|---|---|---|
| Carbohydrate | 2 | 0.2199 | 0.8959 |
| Fat | 2 | 1.1198 | 0.5713 |
| Total caloric intake | 2 | 1.3647 | 0.5054 |
| Smoking | 2 | 30.0897 | <.0001 |
| Diabetes | 1 | 0.4842 | 0.4865 |
| Education | 1 | 18.4760 | <.0001 |
| WC | 1 | 3.4486 | 0.0633 |
| Gender | 1 | 77.2660 | <.0001 |
| Race/Ethnicity | 4 | 100.1813 | <.0001 |
| Hx of gum Tx | 1 | 4.9655 | 0.0259 |
| Age | 3 | 48.5212 | <.0001 |
| Ratio of f income to poverty | 4 | 30.4422 | <.0001 |

*Based on the percentage of calories from carbohydrate: less than 45% is a low carbohydrate diet, between 45-65% is an average carbohydrate diet, and greater than 65% is a high carbohydrate diet.
** Based on the percentage of calories from fat: less than 20% is a low fat diet, between 20-35% is an average fat diet and greater than 35% is a high fat diet.
*** Based on the estimated caloric requirement versus actual total caloric intake.
‡ MA=Mexican American, OH=Other Hispanic, NHW=Non-Hispanic White, NHB=Other Hispanic Black, ORM=Other Race – including Multiracial

**Figure 1.**

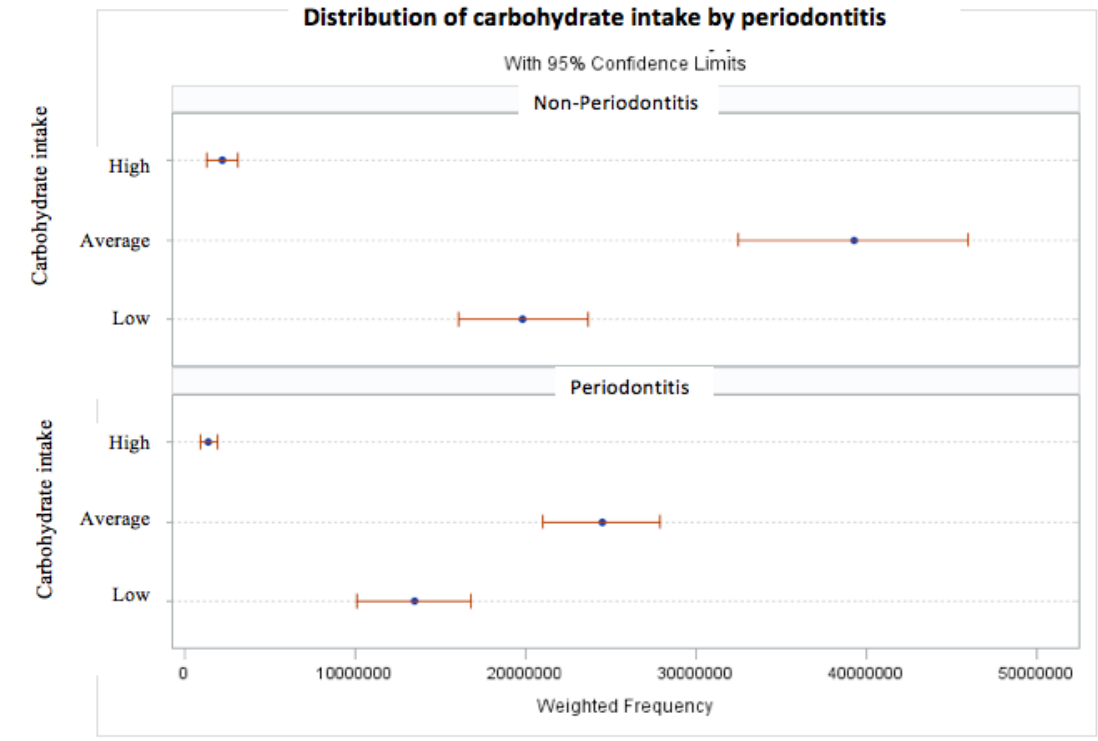



**Figure 2.**

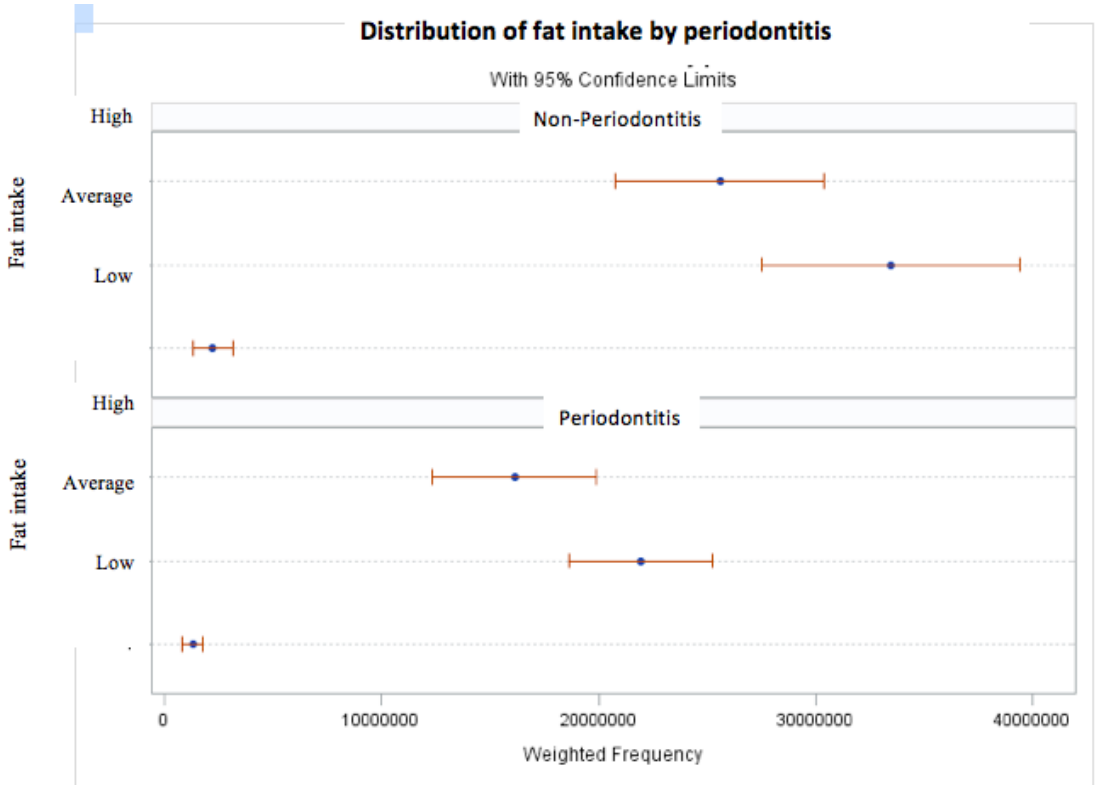


**Figure 3.**

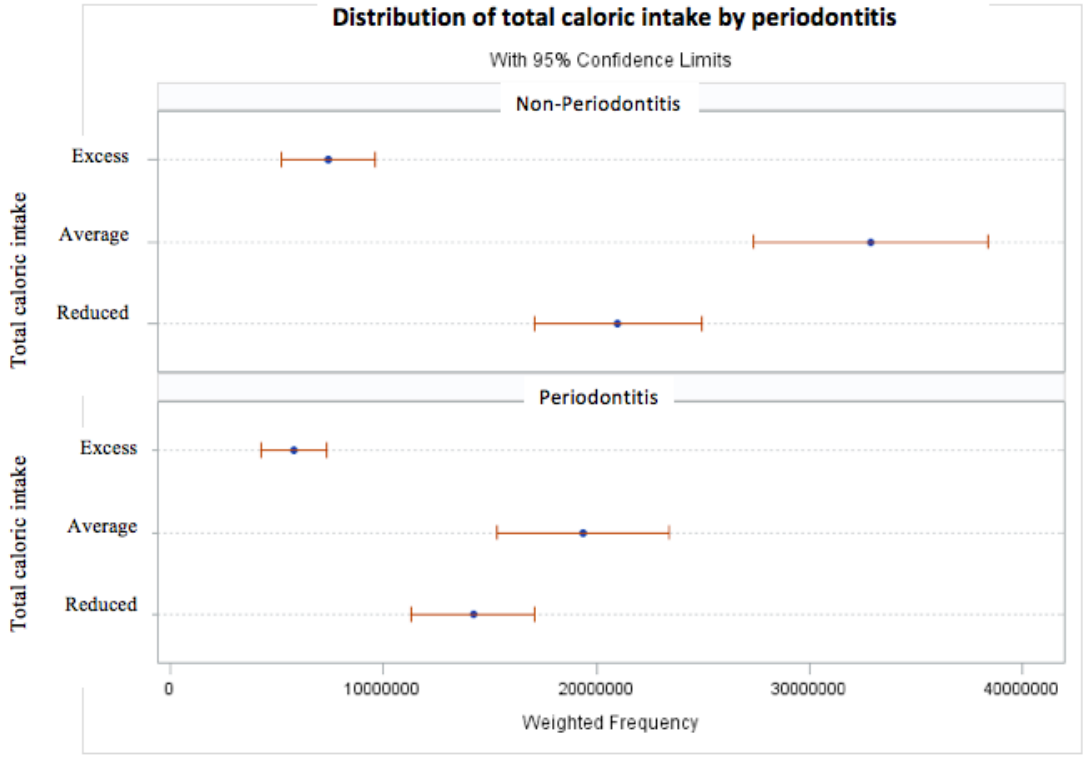

Distribution of total caloric intake by periodontitis
With 95% Confidence Limits
Non-Periodontitis
Excess
Average
Reduced
Total caloric intake
Periodontitis
Excess
Average
Reduced
Total caloric intake
0
10000000
20000000
30000000
40000000
Weighted Frequency

**Figure 4.**

Distribution according to % of calories acquired from carbohydrate (uncategorized)

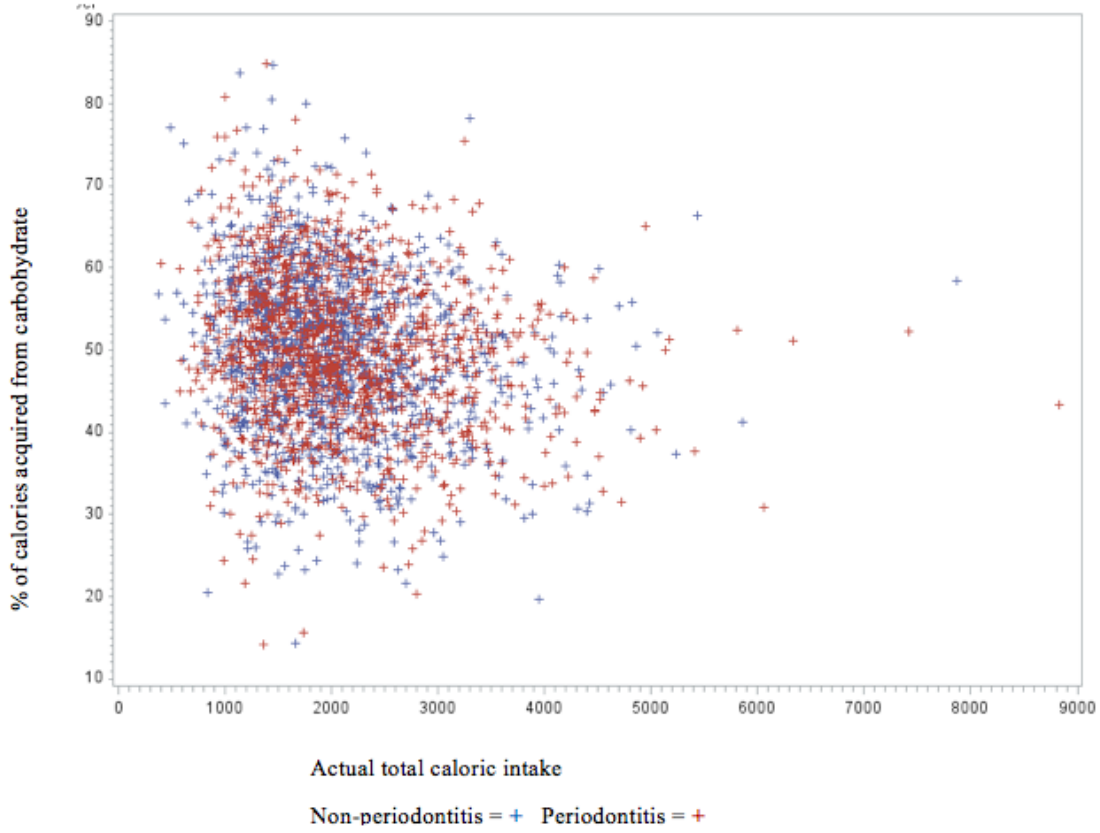


**Figure 5.**

Distribution according to % of calories acquired from fat (uncategorized)

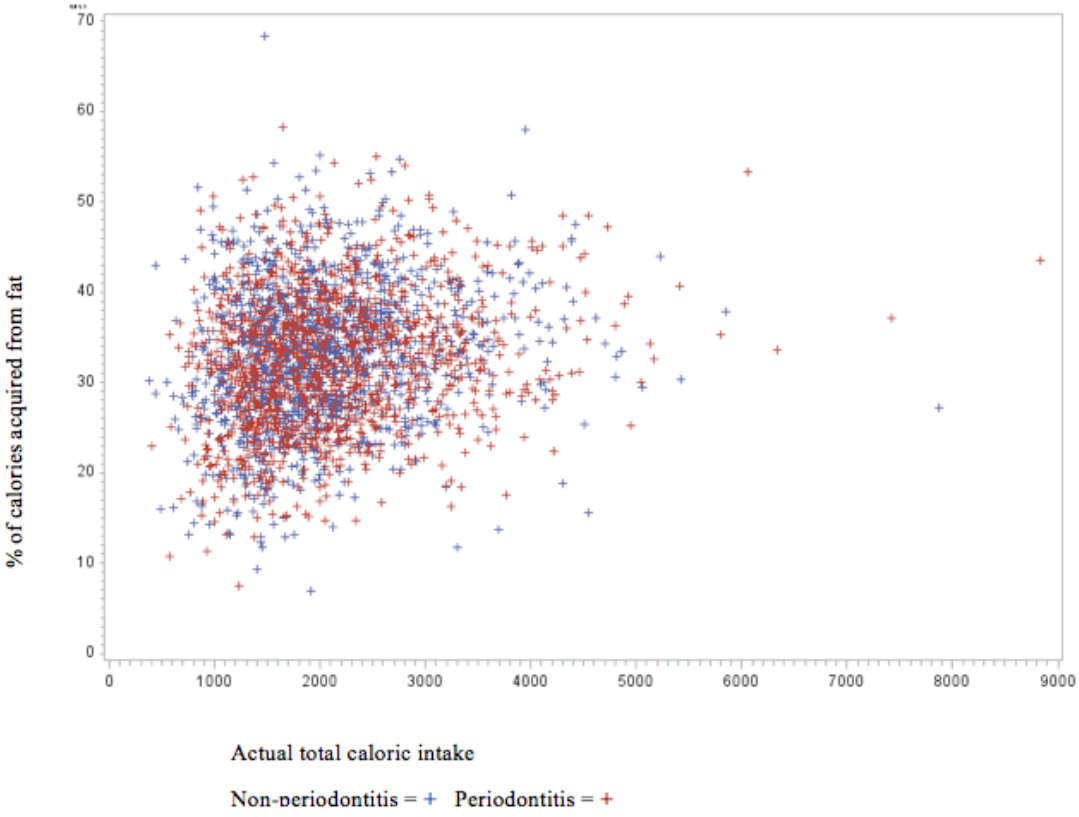
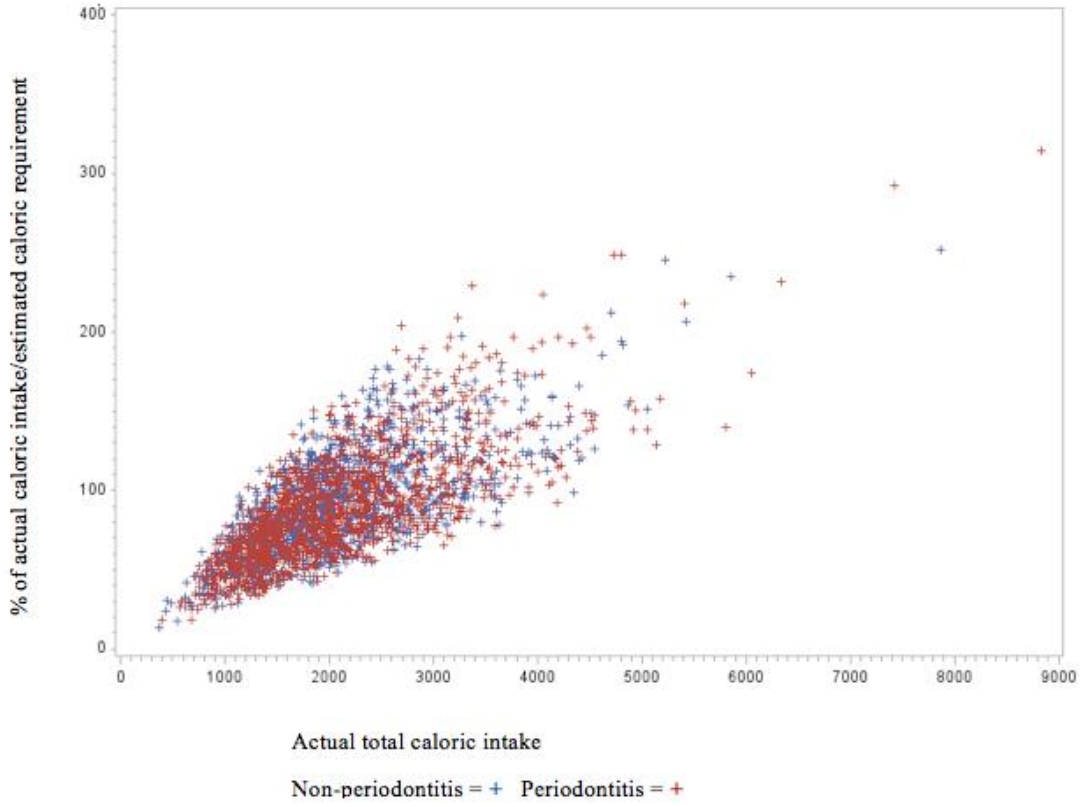


**Figure 6.**

Distribution according to % of actual caloric intake/estimated caloric requirement



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**Appendix 1**

Variables for probing depth.

**OHX02PCD, OHX02PCM, OHX02PCS, OHX02PCP, OHX02PCL, OHX02PCA, OHX03PCD, OHX03PCM, OHX03PCS, OHX03PCP, OHX03PCL, OHX03PCA, OHX04PCD, OHX04PCM, OHX04PCS, OHX04PCP, OHX04PCL, OHX04PCA, OHX05PCD, OHX05PCM, OHX05PCS, OHX05PCP, OHX05PCL, OHX05PCA, OHX06PCD, OHX06PCM, OHX06PCS, OHX06PCP, OHX06PCL, OHX06PCA, OHX07PCD, OHX07PCM, OHX07PCS, OHX07PCP, OHX07PCL, OHX07PCA, OHX08PCD, OHX08PCM, OHX08PCS, OHX08PCP, OHX08PCL, OHX08PCA, OHX09PCD, OHX09PCM, OHX09PCS, OHX09PCP, OHX09PCL, OHX09PCA, OHX10PCD, OHX10PCM, OHX10PCS, OHX10PCP, OHX10PCL, OHX10PCA, OHX11PCD, OHX11PCM, OHX11PCS, OHX11PCP, OHX11PCL, OHX11PCA, OHX12PCD, OHX12PCM, OHX12PCS, OHX12PCP, OHX12PCL, OHX12PCA, OHX13PCD, OHX13PCM, OHX13PCS, OHX13PCP, OHX13PCL, OHX13PCA, OHX14PCD, OHX14PCM, OHX14PCS, OHX14PCP, OHX14PCL, OHX14PCA, OHX15PCD, OHX15PCM, OHX15PCS, OHX15PCP, OHX15PCL, OHX15PCA, OHX18PCD, OHX18PCM, OHX18PCS, OHX18PCP, OHX18PCL, OHX18PCA, OHX19PCD, OHX19PCM, OHX19PCS, OHX19PCP, OHX19PCL, OHX19PCA, OHX20PCD, OHX20PCM, OHX20PCS, OHX20PCP, OHX20PCL, OHX20PCA, OHX21PCD, OHX21PCM, OHX21PCS,**

**OHX21PCP, OHX21PCL, OHX21PCA, OHX22PCD, OHX22PCM, OHX22PCS, OHX22PCP, OHX22PCL, OHX22PCA, OHX23PCD, OHX23PCM, OHX23PCS, OHX23PCP, OHX23PCL, OHX23PCA, OHX24PCD, OHX24PCM, OHX24PCS, OHX24PCP, OHX24PCL, OHX24PCA, OHX25PCD, OHX25PCM, OHX25PCS, OHX25PCP, OHX25PCL, OHX25PCA, OHX26PCD, OHX26PCM, OHX26PCS, OHX26PCP, OHX26PCL, OHX26PCA, OHX27PCD, OHX27PCM, OHX27PCS, OHX27PCP, OHX27PCL, OHX27PCA, OHX28PCD, OHX28PCM, OHX28PCS, OHX28PCP, OHX28PCL, OHX28PCA, OHX29PCD, OHX29PCM, OHX29PCS, OHX29PCP, OHX29PCL, OHX29PCA, OHX30PCD, OHX30PCM, OHX30PCS, OHX30PCP, OHX30PCL, OHX30PCA, OHX31PCD, OHX31PCM, OHX31PCS, OHX31PCP, OHX31PCL, OHX31PCA**

## Appendix 2

**OHX02LAD, OHX02LAM, OHX02LAP, OHX02LAS, OHX02LAL, OHX02LAA, OHX03LAD, OHX03LAM, OHX03LAS, OHX03LAP, OHX03LAL, OHX03LAA, OHX04LAD, OHX04LAM, OHX04LAS, OHX04LAP, OHX04LAL, OHX04LAA, OHX05LAD, OHX05LAM, OHX05LAS, OHX05LAP, OHX05LAL, OHX05LAA, OHX06LAD, OHX06LAM, OHX06LAS, OHX06LAP, OHX06LAL, OHX06LAA, OHX07LAD, OHX07LAM, OHX07LAS, OHX07LAP, OHX07LAL, OHX07LAA, OHX08LAD, OHX08LAM, OHX08LAS, OHX08LAP, OHX08LAL, OHX08LAA, OHX09LAD, OHX09LAM, OHX09LAS, OHX09LAP, OHX09LAL, OHX09LAA, OHX10LAD, OHX10LAM, OHX10LAS, OHX10LAP, OHX10LAL, OHX10LAA, OHX11LAD,**

**OHX11LAM, OHX11LAS, OHX11LAP, OHX11LAL, OHX11LAA, OHX12LAD, OHX12LAM, OHX12LAS, OHX12LAP, OHX12LAL, OHX12LAA, OHX13LAD, OHX13LAM, OHX13LAS, OHX13LAP, OHX13LAL, OHX13LAA, OHX14LAD, OHX14LAM, OHX14LAS, OHX14LAP, OHX14LAL, OHX14LAA, OHX15LAD, OHX15LAM, OHX15LAS, OHX15LAP, OHX15LAL, OHX15LAA, OHX18LAD, OHX18LAM, OHX18LAS, OHX18LAP, OHX18LAL, OHX18LAA, OHX19LAD, OHX19LAM, OHX19LAS, OHX19LAP, OHX19LAL, OHX19LAA, OHX20LAD, OHX20LAM, OHX20LAS, OHX20LAP, OHX20LAL, OHX20LAA, OHX21LAD, OHX21LAM, OHX21LAS, OHX21LAP, OHX21LAL, OHX21LAA, OHX22LAD, OHX22LAM, OHX22LAS, OHX22LAP, OHX22LAL, OHX22LAA, OHX23LAD, OHX23LAM, OHX23LAS, OHX23LAP, OHX23LAL, OHX23LAA, OHX24LAD, OHX24LAM, OHX24LAS, OHX24LAP, OHX24LAL, OHX24LAA, OHX25LAD, OHX25LAM, OHX25LAS, OHX25LAP, OHX25LAL, OHX25LAA, OHX26LAD, OHX26LAM, OHX26LAS, OHX26LAP, OHX26LAL, OHX26LAA, OHX27LAD, OHX27LAM, OHX27LAS, OHX27LAP, OHX27LAL, OHX27LAA, OHX28LAD, OHX28LAM, OHX28LAS, OHX28LAP, OHX28LAL, OHX28LAA, OHX29LAD, OHX29LAM, OHX29LAS, OHX29LAP, OHX29LAL, OHX29LAA, OHX30LAD, OHX30LAM, OHX30LAS, OHX30LAP, OHX30LAL, OHX30LAA, OHX31LAD, OHX31LAM, OHX31LAS, OHX31LAP, OHX31LAL, OHX31LAA**