The Association of Taste with Change in Adiposity-Related Health Measures

Mary E. Fischer, PhD; Karen J. Cruickshanks, PhD; Carla R. Schubert, MS; Alex Pinto, MS; Guan-Hua Huang, PhD; Barbara E. K. Klein, MD; Ronald Klein, MD; James S. Pankow, PhD

ARTICLE INFORMATION

Article history:
Accepted 10 April 2014
Available online 29 May 2014

Keywords:
Taste intensity
Adiposity
Cluster analysis
Longitudinal
Food hedonics

2212-2672/$36.00
http://dx.doi.org/10.1016/j.jand.2014.04.013

ABSTRACT

The relationship between taste-intensity patterns and 5-year change in adiposity-related health measures was determined. Participants were members of the Beaver Dam Offspring Study, a study of the adult children of participants in the population-based Epidemiology of Hearing Loss Study. There were 1,918 participants (mean baseline age=48.8 years; range=22 to 84 years) with baseline taste (2005 to 2008) and follow-up (2010 to 2013) data. Outcomes included 5-year change in body mass index, waist circumference, blood pressure, non–high-density lipoprotein cholesterol, and glycosylated hemoglobin A1c, and hedonic ratings of specific foods. Cluster analysis with Ward's minimum variance method identified the following 5 patterns of the suprathreshold taste intensities of salt, sweet, sour, and bitter: salt and sweet intensities slightly above population averages, average sour and bitter intensities; salt, sour, and bitter intensities above population average, average sweet intensity; salt, sour, and bitter intensities above population average, sweet intensity substantially above average; all intensities below population averages; and all intensities close to population average. The General Linear Model procedure was used for testing cluster differences in the outcomes. With covariate adjustment, the group with all intensities close to population averages had a significantly lower average increase in body mass index compared with the group with above-average intensities for salt, sour, and bitter (+0.4 vs +0.9), and in glycosylated hemoglobin A1c compared with the group with above-average intensities for all tastes (+0.20% vs +0.34%). Clusters differed in the hedonics of foods representing sweetness and saltiness. The study's findings provide evidence that perceived taste intensity might be related to changes in adiposity-related health.
J Acad Nutr Diet. 2014;114:1195-1202.

FOOD CHOICE PLAYS A ROLE IN TOTAL CALORIC intake and in the maintenance of health. The relationship between dietary choices and adiposity has been of particular interest because of the association of obesity and central adiposity with chronic diseases, such as diabetes, cardiovascular disease, and cancer.[1-3] Previous cross-sectional studies have reported associations between specific dietary patterns and body mass index (BMI) and body fat distribution.[4-6] Prospectively, a link between food-choice patterns and change in BMI and waist circumference was observed in the Baltimore Longitudinal Study of Aging[7] and in the Framingham Offspring Cohort, subjects with higher Mediterranean-style dietary pattern scores were found to have significantly smaller waist circumferences after approximately 7 years of follow-up.[8]

Many factors are involved in food choice and consumption, including taste, food preference, familiarity with food items, level of education, cultural habits, cooking habits, health attitudes, weight concerns and dietary restraint, genetics, cost, availability, and advertising.[9-13] The relative importance of each of these factors in influencing food choice can vary between individuals. However, taste has been found to be one of the strongest general influences,[9,14] and research has suggested that taste perception plays a role in the reinforcing value of food.[15]

In the studies of factors related to food choice or consumption, food preferences, and the broad concept of flavor, a combination of taste, olfaction, and somatosensation were evaluated,[16,17] and response to any of the specific basic tastes, namely salt, sweet, sour, and bitter, was generally not measured. Work has been done, primarily in small, select study populations, investigating the relationship of food preferences and consumption with perception of 6-*n*-propylthiouracil (PROP), a bitter thiourea compound,[18-27] and

To take the Continuing Professional Education quiz for this article, log in to www.eatright.org, click the "myAcademy" link under your name at the top of the homepage, select "Journal Quiz" from the menu on your myAcademy page, click "Journal Article Quiz" on the next page, and then click the "Additional Journal CPE Articles" button to view a list of available quizzes, from which you may select the quiz for this article.

with the *TAS2R38* taste receptor gene, which plays a role in PROP taster status.[27-33] Studies have also evaluated the relationship of adiposity with PROP phenotype or genotype with inconsistent results.[23,25,30,34-36]

Because taste has been implicated as an important influence on dietary choices,[9,14] and dietary patterns have been found to be related to BMI and body fat distribution,[4-8] it is possible that taste is associated with changes in adiposity over time. The purpose of the present study was to evaluate the association between perceived intensity of the basic tastes of salt, sweet, sour, and bitter presented at suprathreshold concentrations and longitudinal change in adiposity-related health measures. Patterns of taste intensities were identified and the relationship between these patterns and changes in the health measures was assessed. In addition, differences in hedonic ratings for various food items across the taste-intensity patterns were evaluated.

METHODS

Study Population

The study population was comprised of participants in the Beaver Dam Offspring Study, a longitudinal cohort study of the adult children of participants in the population-based Epidemiology of Hearing Loss Study (1993 to present).[37-39] The baseline examination took place from 2005 through 2008 and there were 3,285 participants (ages 21 to 84 years, predominately non-Hispanic white).[40] Of these, 2,374 participants completed the taste test.[41] Taste testing was performed in the baseline examination in response to a request from the National Institute on Deafness and Other Communication Disorders to develop and test methods for assessing taste function in observational investigations.

The 5-year follow-up examination was conducted in 2010 through 2013. There were 1,918 participants with baseline taste-intensity measures and follow-up health information. Approval for this research was obtained from the Health Sciences Institutional Review Board of the University of Wisconsin and informed consent was obtained from all participants before each examination. Standardized protocols were followed by trained and certified examiners at each study phase.

Measurements

Taste Intensity. Filter-paper disks, 3 cm in diameter, impregnated with suprathreshold concentrations of 1.0 mol/L sodium chloride (salt), 1.8 mol/L sucrose (sweet), 0.1 mol/L citric acid (sour), and 0.001 mol/L quinine (bitter), along with disks containing 1.2 to 1.6 mg PROP were used for the whole-mouth taste testing during the baseline examination. An outside laboratory provided the disks (L. M. Bartoshuk, University of Florida). To minimize context effects, the tastes were presented in the standard order of salt, sweet, sour, bitter, and PROP. Each participant was asked to place each disk in his or her mouth and to move the disk around to moisten it with saliva. After approximately 10 seconds, the participant removed the taste disk and identified the tastant and estimated the intensity of the taste. Water was sipped between each tastant.

A general labeled magnitude scale was used for rating the perceived taste intensity.[42] The general labeled magnitude scale was anchored at one end with 0 labeled as "No sensation" and at the other end with 100 labeled as "Strongest imaginable sensation of any kind." Training was conducted in the use of the scale and only those participants who successfully completed the training by rating a standard set of sensations in the proper order took part in the taste testing. Additional details of the taste testing have been published.[43]

Health Measures. A number of health-related measures were obtained at baseline and at follow-up. Height and weight were measured using a Detecto 758C digital scale and height bar with the participants wearing clothing with pockets emptied and no shoes. BMI was calculated as weight in kilograms/(height in meters)^2. Waist circumference, at the umbilicus with the participant standing, was obtained using a tape measure (Gullick II, Country Technology, Inc) with a tensioning device ensuring constant tension across participants. Three sets of seated systolic and diastolic blood pressures were obtained with an automated blood pressure machine (Dinamap, GE Healthcare) after the participant had been sitting for 5 minutes; the third measurement was used in analyses. Blood samples were drawn and measurements of glycosylated hemoglobin A1c (HbA1c) using affinity chromatography (Isolab) and serum total and high-density lipoprotein (HDL) cholesterol using reflectance spectrophotometry were performed at the Collaborative Studies Clinical Laboratory, Fairview-University Medical Center, Minneapolis, MN. Non-HDL cholesterol was calculated as the difference between the total and the HDL cholesterol levels. The health measures from the baseline examination were subtracted from the follow-up measures to calculate the 5-year change. For a sensitivity analysis, the subset of participants with a history of diabetes, defined as a report of having been diagnosed by a doctor or a measured HbA1c $\geq$6.5% were excluded.

Hedonic Ratings. A hedonic general labeled magnitude scale[44] was used for rating the intensity of liking or disliking 10 food/drink items. The scale had a range of -100 (strongest imaginable disliking of any kind) to $+100$ (strongest imaginable liking of any kind). The items rated included mayonnaise, whole milk, black coffee, dark chocolate, salted pretzels, grapefruit juice, sweets, strawberries, sausage, and milk chocolate.[43] The data were analyzed as continuous.

Covariates. Baseline factors found to be related to taste intensity[41] were considered as possible covariates in the modeling of the association between taste-intensity cluster and change in health. The demographic variables included age, sex, and education (college graduate [16+ years of education] yes or no). The lifestyle factors evaluated were current smoking, any alcohol consumption in the past year, and frequency of dieting (never, rarely, sometimes, often, or always). Olfactory impairment was determined using the San Diego Odor Identification Test[45-47] and was considered present if less than six of the eight odorants were correctly identified. Participants also completed questions asking for the number of servings of vegetables and fruit consumed in a normal week. Response choices ranged from <1 per week to 4+ per day.

For participants aged 45 years and older, DNA was extracted from whole blood and genotyping was performed