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Sweet taste perception is greater in non-Hispanic black than in non-Hispanic white adults

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ABSTRACT

Objective: Research suggests a difference in sweet taste perception between non-Hispanic black (NHB) and non-Hispanic white (NHW) adults; however, limited research has examined sweet taste perception in relation to the dietary intake of sweet products. The aim of this study was to examine sweet taste perception and the consumption of sweet foods, beverages, and sugar in NHB and NHW adults, and to evaluate whether sweet taste perception is associated with dietary intake.

Methods: This cross-sectional study examined the association between race, sweet taste perception and sweet food, beverages, and sugar consumption in healthy, NHB and NHW adults. Seven day food records were analyzed in Nutrition Data System for Research software. Intensity of sweet taste perception was tested and the general labeled magnitude scale method was used to facilitate group comparisons. Independent *t* tests, Mann–Whitney tests, and Pearson correlations were used to assess associations.

Results: Participants were NHB (n = 98) and NHW (n = 90) adults, 41 ± 1 y of age (mean ± SEM) with energy intake of 2271 ± 53 kcal. Body mass index was higher in NHBs than in NHWs (36 ± 1 versus 32 ± 1 kg/m^2, $P = 0.048$), but no differences were observed in age, energy consumption, or total sugar intake. Sweet taste perception rating (median [interquartile range] NHB: 73.5 [63.9–83], NHW: 52.1 [46.4–57.7]; $P = 0.001$) and added sugar intake (NHB: 39.4 g/1000 kcal [36.3–42.4], NHW: 30 g/1000 kcal [26.7–33.4]; $P < 0.001$) were greater in NHB. Perceived sweet taste intensity was positively associated with consumption of servings of sweet products among NHBs ($R^2 = 0.057$, $P = 0.018$) but not NHWs ($R^2 = -0.012$, $P = 0.314$).

Conclusions: NHBs have a higher intensity of sweet taste perception than NHWs. The positive association of sweet taste perception and sweet product consumption in NHBs suggests that a higher intensity of sweet taste perception may be associated with an increased proportion of energy consumption from added sugars.

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Introduction

In the United States, health disparities between racial and ethnic groups exist. Non-Hispanic blacks (NHBs) are disproportionately affected by obesity, type 2 diabetes, and cardiovascular disease compared with non-Hispanic Whites (NHWs). In adults, NHB prevalence of obesity (46.8%) and diabetes (12.7%) is higher than in the NHW population (37.9% and 7.4% respectively) [1,2]. The prevalence of hypertension, a major risk factor for heart disease, is also higher among NHB adults (42.1%) than NHW adults (28%) [3].

Potential contributing factors to these disparities have been examined and may include differences in food preferences and food intake between racial and ethnic groups. Although many factors may drive food preference and intake, it has been suggested that variations in taste perception between individuals or groups may be a contributing factor to differences in dietary preferences and intake of certain types of foods [4]. For example, higher taste response to bitter taste was associated with a decreased preference for cruciferous and green leafy vegetables, whereas a higher taste response to sucrose was associated with a higher preference for sweet desserts [5]. Williams et al. examined these variations in taste perception between NHBs and NHWs and found that NHBs

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were significantly more responsive to sweet taste stimuli than NHWs [6].

Various studies have shown an increased preference for and intake of sweets in black populations. Schiffman et al. reported that young black adults had a greater desire for more intense sweet tastes than young white adults [7]. Mennella et al. found that NHB children and their mothers had a greater preference for cereals with higher sugar content than NHWs [8]. In addition to data showing differences in preference for sweet foods, National Health and Nutrition Examination Survey (NHANES) data from 2005 to 2010 indicate that NHBs consumed a larger percentage of their total calories from added sugars than NHWs [9]. Given the existing body of research, it seems plausible that differences in sweet taste perception may be related to a preference for sweet food and beverage products, which in turn, may influence dietary consumption of these products.

Individuals with diets high in added sugar are at increased risk for obesity [10]. The prevalence of type 2 diabetes and cardiovascular disease is strongly associated with obesity [11], so diets high in added sugar that contribute to obesity also may increase the risk for several chronic diseases. A greater preference for sweet food and beverages, leading to greater intake of added sugar among NHB adults may be a contributing factor to health disparities. Although differences in taste perception between NHBs and NHWs have been studied, the effect of these differences on actual dietary intake and specific health outcomes requires further exploration. The present study aimed to examine sweet taste perception and the consumption of sweet foods, beverages, and sugar in NHB and NHW adults, and to evaluate whether sweet taste perception is associated with dietary intake.

Methods

Participants were enrolled in a natural history study conducted at the National Institutes of Health (NIH) Clinical Center in Bethesda, MD. Study recruitment began in January 2007 and is ongoing. The trial was approved by the NIH National Institute of Diabetes and Digestive and Kidney Diseases' Institutional Review Board (IRB). Informed consent was obtained from all participants during the screening visit and all procedures were carried out in accordance with IRB regulations.

Population

Male and female healthy volunteers (N = 188) >18 y of age were recruited through the NIH Patient Recruitment and Public Liaison Office. Age, sex, race, and smoking history were self-reported and participant demographic data was obtained from medical records. Only NHB and NHW individuals were included in this analysis. Individuals were excluded from study participation if they were pregnant or breastfeeding, had a body mass index (BMI) <18.5 kg/m^2, or a current unstable medical condition including cardiac ischemia, severe respiratory insufficiency requiring oxygen therapy, hepatic, or cardiac failure. Potential participants with significant physical limitations or psychiatric conditions that could prevent participation in study procedures were also excluded. Data from the baseline study visit were used for this cross-sectional analysis. Height was measured in cm using a wall stadiometer (Seca 242, Hanover, MD, USA) and weight was measured in kg using a calibrated digital scale (Scale-Tronix 5702, Carol Stream, IL, USA). BMI was calculated as kg/m^2. Dual x-ray absorptiometry (GE Healthcare, Chicago, IL, USA) was used to measure percent body fat.

Dietary assessment

Dietary intake was assessed using food records, which each participant was instructed to complete for 7 d before their visit. Food records were collected and reviewed by nutrition staff for accuracy. To reflect the marketplace throughout the study, dietary intake data were collected using Nutrition Data System for Research software versions 2007 through 2015, developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN. Food records were analyzed for average daily intake of energy, macronutrients, total sugar, added sugar, and total servings of sweet products. Total servings of sweet products included fruit and fruit juices, flavored milk and sweetened beverages, yogurt, cereals, meal replacement supplements, snack bars, miscellaneous desserts, and sugar-sweetened spreads, syrups, and sauces.

Taste perception swallow test

To evaluate taste perception, the generally labeled magnitude scale (gLMS) was used, which combines the LMS for oral sensations with a process of magnitude matching [4]. To complete this process, participants completed a perceived intensity questionnaire using previously experienced light stimuli, which is independent of taste, as described by Bartoshuk et al. [12]. Participants were asked to rate the brightness of the brightest light ever seen, a well-lit room, and a dimly lit room on the gLMS. The gLMS score for light (0–100) was used to normalize results of the swallow test (perceived intensity of taste), also rated on the gLMS, and facilitate across group comparisons of taste perception. The swallow test was completed by swishing a pharmaceutical-grade solution in the mouth for 30s, spitting out the solution, and swallowing the residual solution left in the mouth. This swallow test reflects real-world taste perception because it includes stimulation to taste receptors in both the mouth and throat, modeling normal dietary intake. After the swallow test, participants rated perceived intensity of sweet taste using the gLMS scale. Swallow ratings were normalized using the participant's rating of the brightest light they have ever seen by dividing the swallow rating by the brightest light rating and multiplying it by 100.

Plasma lipid and glucose

Fasting blood work was collected at the baseline visit for measurement of hemoglobin A1c (HbA1c) and lipids (total cholesterol [TC], low-density lipoprotein cholesterol [LDL-C], high-density lipoprotein cholesterol [HDL-C], and triacylglycerols [TGs]). To assess endogenous insulin secretion sensitivity, the frequently sampled intravenous glucose tolerance test was performed and the insulin sensitivity index (SI) was calculated [13]. Any blood samples that were hemolyzed could not be analyzed and therefore lipid and SI data were not available for all subjects.

Statistical analysis

Data were analyzed using the SPSS, version 22 (IBM, Armonk, NY, USA). Age, BMI, and dietary intake are described as means ± SEM. Independent sample *t* tests were used to evaluate differences of normally distributed variables between groups. Mann–Whitney tests were performed to examine differences with data that were not normally distributed (median interquartile range). Analysis of covariance analyses were done to examine associations between perceived sweet taste and sweet product consumption between races. Significance for all analyses was determined at $P < 0.05$.

Results

Participants included 98 NHB and 90 NHW adults 41 ± 1 y of age (Table 1). There were no significant differences in age, sex, body fat percentage, history of smoking, TC, LDL-C, or HDL-C between groups. BMI was higher in NHB adults than in the NHW group ($P = 0.048$). TGs were lower in NHBs than in NHWs ($P = 0.04$). SI was lower in NHBs than in NHWs and HbA1c was higher ($P < 0.001$).

Energy intake was similar across groups with a mean of 2270.7 ± 53.4 kcal (Table 2). In addition, no differences were observed between NHB and NHW in the percentages of energy from carbohydrates, fat, or protein, but NHWs had a higher percentage of energy from alcohol ($P = 0.017$). NHBs consumed more added sugar than NHWs ($P < 0.001$), but there was no difference in total sugar consumed.

Sweet taste perception rating (Fig. 1) was greater in NHBs than NHWs (NHB: 73.5 [63.9–83]; NHW: 52.1 [46.4–57.7]; $P = 0.001$). Added sugar intake, in g/1000 kcal (Fig. 2A), was also greater in NHBs (NHB: 39.4 [36.3–42.4]; NHW: 30 [26.7–33.4]; $P < 0.001$), although sweet product consumption, in servings/d (Fig. 2B), was not different between races (NHB: 6.9 [5.9-7.9]; NHW: 5.6 [4.9–6.3]; $P = 0.07$). Perceived sweet taste was positively associated with sweet product consumption among NHBs but not NHWs ($R^2 = 0.057$, $P = 0.018$ and $R^2 = 0.012$, $P = 0.314$, respectively; Fig. 3).

Discussion

The present study found that NHBs have a higher sweet taste perception than NHWs. We sought to determine whether these

Table 1
Population characteristics

	NHB (n = 98)	NHW (n = 90)	Total (N = 188)
Age (y)	41 ± 1	42 ± 2	41 ± 1
Sex			
Female	59	59	118
Male	39	31	70
BMI (kg/m^2)	36 ± 1*	32 ± 1	34 ± 1
Body fat (%)†	40.1 ± 1	37.4 ± 1.2	38.8 ± 0.8
History of smoking			
Smokers	9	6	15
Non-smokers	89	84	173
Total cholesterol (mg/dL)‡	176.8 ± 3.1	176.1 ± 4.1	176.4 ± 2.5
LDL cholesterol (mg/dL)§	108.7 ± 3	103.3 ± 3.5	106.1 ± 2.3
HDL cholesterol (mg/dL)§	49.9 ± 1.3	52.5 ± 1.9	51.1 ± 1.1
Triacylglycerols (mg/dL)‡	90.9 ± 4.3*	115.5 ± 7.4	102.6 ± 4.3
Hemoglobin A1c (%)‖	5.8 ± 0.6*	5.5 ± 0.5	5.7 ± 0.1
Insulin sensitivity index (SI)¶	2.9 ± 0.3*	5.2 ± 0.4	4.1 ± 0.3

BMI, body mass index; HDL, high-density lipoprotein; LDL, low-density lipoprotein; NHB, non-Hispanic black; NHW, non-Hispanic white.
Data presented as mean ± SEM with exception of sex and history of smoking data, which are presented as number of participants.
*Indicates a significant difference between NHBs and NHWs (P <0.05).
†Total N = 184, NHB n = 94, NHW n = 90.
‡Total N = 183, NHB n = 96, NHW n = 87.
§Total N = 184, NHB n = 96, NHW n = 88.
‖Total N = 161, NHB n = 88, NHW n = 73.
¶Total N = 159, NHB n = 80, NHW n = 79.

Table 2
Dietary characteristics

	NHB (n = 98)	NHW (n = 90)	Total (N = 188)
Energy (kcal)	2330.8 ± 78.1	2205.2 ± 71.9	2270.7 ± 53.4
% Energy from carbohydrate	46.7 ± 0.7	46.7 ± 1.0	46.7 ± 0.6
% Energy from fat	35.3 ± 0.6	33.7 ± 0.8	34.6 ± 0.5
% Energy from protein	16.9 ± 0.4	17.5 ± 0.4	17.2 ± 0.3
% Energy from alcohol	1.1 ± 0.2†	2 ± 0.3	1.5 ± 0.2
Added sugar (g/1000 kcal)*	39.4 (36.3–42.4)†	30 (26.7–33.4)	34.9 (32.6–37.2)
Total sugar (g/1000 kcal)	53.2 ± 1.5	49.4 ± 1.7	51.4 ± 1.2

IQR, interquartile range; NHB, non-Hispanic black; NHW, non-Hispanic white.
Data presented as mean ± SEM.
*Data presented as median ± IQR.
†Indicates a significant difference between NHBs and NHWs (P <0.05).

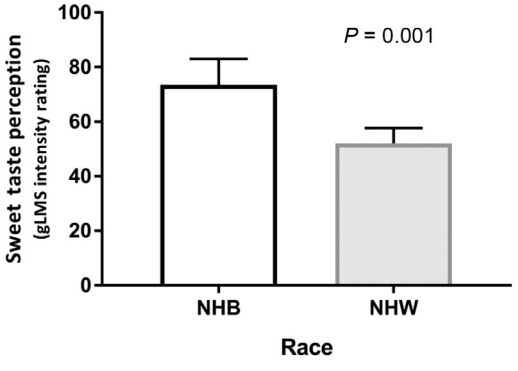

Fig. 1. Sweet taste perception is greater in NHB than NHW (calculated as swallow/bright light score × 100). Analyzed using Mann–Whitney test, median ± IQR with $P < 0.05$. gLMS, generally labeled magnitude scale; NHB, non-Hispanic black; NHW, non-Hispanic white.

differences in sweet taste perception were related to dietary sweet product intake. Although NHBs had a higher sweet taste perception, there were no differences in sweet product consumption, average daily energy, or total sugar consumption between the two groups. However, NHBs had a higher intake of added sugar than NHWs, suggesting that the proportion of energy from added sugar is higher in NHBs, which is consistent with NHANES data (2005–2010) [9].

Higher sweet taste perception in NHBs may be a contributing factor to the higher dietary added sugar intake that we observed. Research has suggested that the desirability of sweet taste is an inherent biological response and has demonstrated a strong relationship between sweet taste and the palatability and acceptance of food [14]. As an example, Low et al. [5] found that higher preferences for sucrose in water were positively correlated with higher preferences for sweet desserts. However, some studies have indicated that this relationship varies based on different thresholds for taste perception. Looy et al. [14] found that adults could be categorized into two distinct groups: sweet likers, those who indicated increased liking with increased concentrations of sweet, and sweet dislikers, those who showed increased dislike with increased concentrations of sweet. In the present study, we did not distinguish between likers and dislikers to determine preference for sweets, rather we examined the perceived intensity of sweet taste, although examining preference would add to our interpretation of results.

Although no differences were seen in sweet product consumption between groups, differences in types of specific sweet products consumed could possibly explain the higher intake of added sugar in NHB. In the present study, sweet products included all sweet-tasting foods, regardless of other characteristics such as whole versus processed food or naturally occurring versus added sugar contents in food. Both fresh fruit and sugar-sweetened beverages were considered sweet products, yet fresh fruit has health benefits associated with increased consumption of vitamins, minerals, fiber, and antioxidants, whereas consumption of sugar-sweetened beverages has been associated with negative health consequences [15].

It is notable that we found an association between sweet taste perception and sweet product consumption in NHBs but not in NHWs. It is possible that the relationship between perception and preference, and therefore consumption, differs by race. As previously discussed, although an innate preference for sweet taste is widely recognized, distinct categorization of “sweet likers” and “sweet dislikers” has been identified. It is possible that categorization of sweet-liking status may differ by race or that rejection thresholds may differ by race, although this has not been thoroughly examined in the literature. There is also evidence that the association between perception and preference for taste may be food specific [16] and therefore analysis of taste perception, race, and intake of subcategories of sweet products, such as sweet liquids or sweet solids, may reveal different relationships. Finally, studies have shown that taste preference is affected by exposure to cuisines, which could potentially account for racial differences in the relationship between taste perception, preference, and intake [17].

As indicated, many factors other than taste perception affect taste preferences, and similarly, factors other than simple preference affect food selection and intake; psychological and cultural factors as well as socioeconomic status likely play a role [18,19]. A lower intake of added sugar may represent a culturally determined response rather than a difference in taste perception. For example, cultural and societal pressures to achieve a lean body type may cause individuals to decrease added sugar consumption regardless

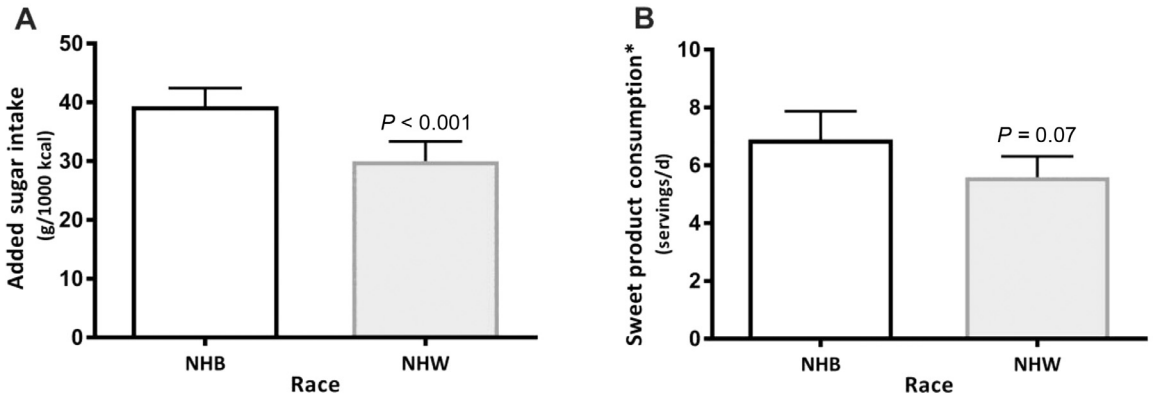

Fig. 2. (**A**) Added sugar intake is greater in NHB than NHW as analyzed using Mann–Whitney test, median ± interquartile range with $P < 0.05$. (**B**) The number of sweet food and beverage servings consumed per day is not significantly different between NHBs and NHWs. Analyzed with Mann–Whitney test, median ± IQR with $P < 0.05$. *Not including artificial sweeteners. NHB, non-Hispanic black; NHW, non-Hispanic white.

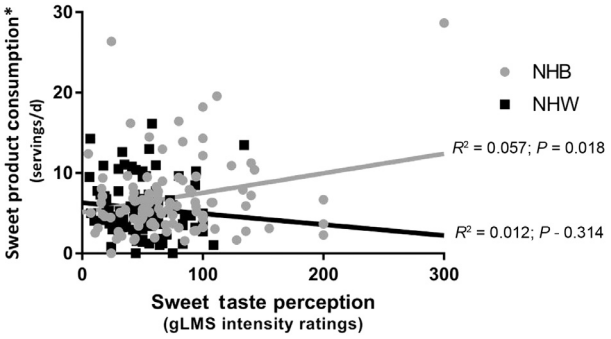

Fig. 3. Analysis of covariance analyses to compare the relationship between sweet taste perception and sweet product consumption between races. Interaction term for race $P = 0.043$. Taste perception calculated as swallow/bright light score × 100. *Not including artificial sweeteners. gLMS, generally labeled magnitude scale; NHB, non-Hispanic black; NHW, non-Hispanic white.

of taste perception. In addition, many individuals may consume artificially sweetened products in an effort to reduce caloric effects. Artificial sweeteners provide an intense sweet taste without the addition of calories, which may reflect a preference for sweet taste without an effect on caloric intake. Artificial sweeteners were not examined in this study, and this may be an important area for further research. Moreover, food and beverage cost and access greatly influence dietary intake. Individuals with limited access to healthy food may have a higher intake of processed sweet products regardless of sweet taste perception.

In addition to these factors, physical activity has been shown to play a role in dietary intake, but this was not evaluated in the present study [20]. This study was limited by lack of data on physical activity, socioeconomic status, and measures of factors motivating dietary intake. Because these variables have the potential to modify the relationship between taste perception and intake, and therefore disease risk, they would be useful to measure in future studies. The present study also did not seek to measure taste preference, which is likely a key component in attempting to understand the complicated relationship between perception and intake. In addition, this study only examined intake of sweet products that were not sweetened with artificial sweeteners because the relationship between taste perception and artificial sweetener intake may be distinct from that between taste perception and intake of foods sweetened with caloric sweeteners. However, this is an area for further exploration.

In the present study, NHBs had a higher BMI than NHWs, which could be a confounding factor. Multiple publications have explored associations between taste and BMI; however, findings have been inconsistent in terms of the relationship between taste threshold or sensitivity and BMI, with some studies finding no association and others findings differences by BMI with only certain taste sensations [21–23]. In addition, in the present study there was no difference between NHBs and NHWs in body fat percentage, which is a more precise indicator of true adiposity. To further minimize potential confounding by BMI, dietary variables were all adjusted for energy intake, which is highly correlated to BMI. It also should be noted that the study population had an average BMI that falls within the obese range and is higher than the average BMI in the United States [24]. Given the uncertainties regarding associations between BMI and taste, it is impossible to determine whether our results would persist in a population of more normal BMI. Future studies should aim to include more participants with normal BMI to explore whether differences we observed between races holds true.

The present study also had many strengths. We used the gLMS scaling methodology, which is considered the gold standard for assessing taste perception [12]. Our findings are consistent with previous research that used this methodology and demonstrated higher taste sensations for sweet in NHBs compared with NHWs [6]. Our study population consisted of a large number of NHB and NHW participants from the Washington DC metro area who had very similar characteristics. In addition, the study used nutrition data from rigorously collected 7-d food records that are a validated measure of usual dietary intake [25,26]. Most studies looking at taste perception are not collecting data on dietary intake and therefore are only able to report on associations between liking and wanting and taste perception. This study was able to further that information to examine foods that participants actually consumed.

Conclusion

We found that NHBs had a higher sweet taste perception than NHWs. Although total sweet consumption did not differ by race, NHBs had a higher added sugar intake, which may contribute to negative health outcomes.

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