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Sweet taste preference on snack choice, added sugars intake, and diet quality– a pilot study

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Abstract

Humans seek to eat what is palatable, especially when snacking. Theoretically, a person who enjoys sweet taste more may choose snacks with higher sugar and calories, leading to lower overall diet quality, yet individual eating behavior traits may interfere with this relationship. We investigated the influences of sweet taste preference (assessed using a forced-choice paired-comparison method) and eating behaviors (i.e., uncontrolled eating, emotional eating, and cognitive restraint using the Three-Factor Eating Questionnaire–R18) on diet quality and added sugars intake (validated short Healthy Eating Index survey) in 65 adults (23.0 ± 5.5 years). Participants were divided into sweet dislike, moderate sweet liker, and extreme sweet liker groups by preferred sucrose concentration tertiles. Most participants selected a low-calorie, high-sweetness snack, and neither sweet preference nor eating behavior traits were associated with snack choice. Compared to extreme sweet likers, sweet dislikers and moderate sweet likers had a lower added sugars intake, $F(2, 62) = 7.32$, $p = 0.001$, and better diet quality, $F(2, 62) = 4.06$, $p = 0.02$. Preferred sucrose concentration correlated only with higher added sugars intake ($r = 0.49$, $p < 0.001$) and lower diet quality ($r = -0.27$, $p = 0.03$) but not with the intake of other food groups. Higher sweet preference increased the odds of consuming medium (OR = 2.18, 95% CI = 0.32, 6.08) and high (OR = 3.17, 95% CI = 1.85, 7.86) amounts of added sugars. Adding other covariates did not improve the statistical model. Interestingly, only sweet preference, but not added sugars intake and eating behaviors, was associated with diet quality. Thus, our data suggest that sweet preference may have a stronger influence on added sugars intake and diet quality compared to eating behaviors, although these findings should be replicated in other populations and with a larger sample size. Future studies may also assess liking for other sensory qualities (e.g., fat liking) to understand the contributions of taste preference to nutrient intake and diet quality.

Keywords Sweet, Sugar, Taste preference, Diet quality, Health eating index, Snacks

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Introduction

Taste preference plays an important role in diet and food choices [1]. The pleasure humans experience when tasting sweet substances is innate and could be a powerful driver for consuming added sugars [2, 3]. While the preference for sweet taste is universal, the preferred level of sweetness can vary greatly across individuals [2, 4–9]. Information on individual differences in sweet taste preferences can be captured using psychophysical assessments (i.e., administrating sweet taste tests) [4, 10–13]. By asking people to taste and make judgments on a set of sweet taste stimuli instead of relying on self-reported survey information, we can more objectively characterize people's sweet taste preferences [4, 10–13]. Using taste test methods, it is hypothesized that a person who prefers a higher level of sweetness may be more likely to choose foods that are higher in added sugars [14–16]. Although an attractive theory, studies investigating the relationship between sweet preference and diet have yielded inconsistent results [6, 14, 15, 17–20]. While some studies have detected an association between sweet taste preference with sugar/sugary foods [14, 15, 21], carbohydrate [14, 18, 22], and energy intake [6, 14, 18, 22, 23], others have not been able to find any association between sweet taste preference and dietary outcomes [4, 19, 20, 24–27]. These inconsistencies underscore the need to consider other factors that may influence food choice when investigating the relationship between taste and nutritional health.

Eating behavior traits are psychological constructs that describe a person's attitude toward foods and their tendency to over- or undereat. Humans begin to develop eating behaviors as children and carry these traits into adulthood [28, 29], when they remain relatively stable—substantial efforts are often required to modify disordered eating behaviors in adults [30]. Among the various questionnaires used to assess these traits [31], including the Eating Behavior Questionnaire [32], Power of Food Scale [33], Binge Eating Scale [34], Intuitive Eating Scale–2 [35], and Three-Factor Eating Questionnaire (TFEQ) [36], we choose an abbreviated, 18-item version of the popular TFEQ (TFEQ-R18) [37]. This questionnaire has been validated in both the general population [38] and people living with obesity [37] and in young and middle-aged adults [38]. The TFEQ-R18 assesses three eating behavior domains, cognitive restraint (conscious restriction of food intake to control body weight), emotional eating (tendency to eat under emotional stress), and uncontrolled eating (tendency to lose control over food intake and overeat) [37, 38]. These eating behavior traits have previously been associated with food consumption and dietary patterns.

Thus, when considering the determinants of food choice and dietary pattern, it is important to consider both taste preferences and eating behaviors. Indeed, emotional eating has been associated with increased consumption of high-energy-density foods [39], while cognitive restraint has been associated with a better overall dietary pattern [40]. Interestingly, eating behavior traits may also interact with taste preference. Higher degrees of uncontrolled eating and emotional eating has been associated with a higher likelihood of liking sweet foods; conversely, higher cognitive restraint is associated with a lower risk [41]. Further, discordance between taste preference and dietary intake has been previously reported [42]. It is theorized that the negative association between the preference for and the intake of high sweet foods is attributed to the high degree of cognitive restraint [42]. Accordingly, we need to consider how eating behavior traits may interfere with the relationship between taste preference and diet.

Snack consumption presents a highly salient relationship between taste preference and diet [43–45]. *Snacking* is defined as foods consumed outside of traditional set meals such as breakfast, lunch, and dinner, typically in lesser quantities [46]. Most U.S. adults consume one or more snacks every day, contributing to approximately 22% of total energy intake [46, 47] and 20% of daily consumption of refined carbohydrates [48]. Thus, choosing healthy or nutrient-poor snacks supports or detracts from a healthy diet [48, 49]. Many people have preconceptions of what types of food a meal should contain (filling and somewhat healthy, e.g., cereal/eggs for breakfast and grains/proteins for lunch/dinner) but fewer restrictions on the quality of foods they consider snacks. Furthermore, personal preference has a major influence on snacking habits [45, 48]. Therefore, it is reasonable to hypothesize that people who have a higher preference for sweet taste may be more likely to choose snacks that are higher in added sugars and calories.

Although sweet taste preference has been associated with added sugars intake [14, 16], it is unclear how it contributes to overall diet quality. One prevailing theory is that a higher preference for sweet taste may increase added sugars intake, thus lowering diet quality. Indeed, one study has found an association between sensory exposure to sweet taste and diet quality, with sweet taste exposure calculated as a function of the frequency of sweet foods/beverages consumption (self-reported) and the sweetness intensity of the food/beverage item [50]. However, the frequency of sweet foods/beverages may not always indicate preference, as the relationship between preference and intake may be influenced by other factors (e.g., eating behaviors, as mentioned above). In the United States, diet quality is commonly assessed using the Healthy Eating Index (HEI), with a score ranging from 0 to 100 that reflects individual adherence to key recommendations in the *Dietary Guidelines for Americans* developed by the U.S. Department of Agriculture

[51]. Higher sweet preference may increase added sugars intake, translating to a lower score in the added sugars component of the HEI, thus leading to a lower overall HEI score. However, it is possible that individuals who do not prefer sweet tastes may seek other sensory qualities, such as salt and fat, leading to increased intake of saturated fats and sodium, which can also result in a lower HEI score. To examine these possibilities, we used the HEI to explore the effect of sweet preference on overall dietary pattern.

This study aimed to determine the influence of sweet taste preference and eating behaviors on snack choice, added sugars intake, and dietary pattern. Using a taste test method described in the NIH Toolbox for Assessment of Neurological and Behavioral Function [13] to asses sweet preference, we hypothesized that individuals with a high degree of sweet preference, emotional eating, and uncontrolled eating behaviors will be more likely to choose a sweet, high-calorie snack. We further hypothesize that individuals with cognitive restraint tendencies will be more likely to choose a low-calorie snack. Real snacks were presented to participants to provide ecological validity in our study paradigm. In addition, we hypothesized that sweet preference, emotional eating, and uncontrolled eating will be positively associated with added sugars intake, while cognitive restraint will be negatively associated. Finally, we hypothesized that sweet preference, emotional eating, and uncontrolled eating will be negatively associated with diet quality, while a high degree of cognitive restraint will be positively associated.

Materials and methods

Participants

We recruited individuals between the ages of 18 and 55 years in the Brooklyn, New York, area from October 2023 to May 2024. Participants were recruited using flyers, online advertisements (e.g., flyers posted on social media platforms), and word of mouth. Interested individuals were screened using a brief screener to ensure eligibility before enrollment. We excluded individuals above the age of 55 years because of the higher risk of having chronic disease diagnoses that may alter eating behavior. We also excluded individuals with conditions that affected their senses of taste and smell or with allergies to foods used in this study and those who were pregnant or planning to become pregnant. We also excluded individuals who had lived in the United States for less than 5 years, as recent changes in their food environment may influence taste preference and food choice [52]. We obtained informed consent from participants in person prior to all data collection.

Study design

Participants each attended one in-person session, where we took anthropometric measurements (i.e., height and weight) using a laboratory stadiometer (Health O Meter, McCook, IL) to the nearest 0.25 inches and 0.25 lb., respectively. Participants were asked to complete the Monell Forced-Choice Paired-Comparison Preference Test to assess their sweet taste preference (see the *Taste test* section, below). In addition, participants were asked to taste a single solution of 1.05 M sucrose and rate its sweetness (i.e., intensity rating) on a 100-point visual analog scale. Afterward, participants were asked to complete a series of surveys to assess their food intake and eating behaviors (see the *Surveys* section, below). Finally, participants were asked to choose one snack to take with them (see the *Snack choice* section, below).

Taste tests

The Monell Forced-Choice Paired-Comparison Preference Test recommended in the NIH Toolbox for Assessment of Neurological and Behavioral Function [13] as the gold standard to assess sweet taste preference was used to determine the preferred sucrose concentration for each participant. In this method, participants were asked to taste and make judgments on stimuli of pure sweetness in solutions of known concentrations. The procedure for this test is described elsewhere [11]. Briefly, participants were instructed to refrain from eating any foods and consuming any beverages with flavor within one hour of their study session. Participants began each session by rinsing their mouth twice with distilled water. They were asked to taste a series of sucrose solution pairs and choose which one they preferred. The pairs comprised two of five concentrations of sucrose solutions (0.09 M, 0.18 M, 0.35 M, 0.70 M, and 1.05 M), with intensity ranging from barely detectable (0.09 M) to extremely sweet (1.05 M).

For each taste test trial, participants were asked to taste (but not swallow) a pair of 10-mL samples and to choose which solution they preferred. They then rinsed their mouth twice, in a 1-minute time gap, before tasting the next pair of samples. The first sample pair was from the middle of the range (0.18 M and 0.70 M), and the next pair comprised the chosen sample with the next lower or higher concentration, based on the first choice. This pattern continued until the participant chose the same concentration of sucrose two consecutive times. The entire task was repeated after a 3-minute break, with the stimulus pairs presented in reverse intensity order. As described in Mennella et al. [53], the geometric mean of the two trials was calculated and used as the most preferred concentration of sweetness.

In addition, participants were also asked to taste one single 1.05 M sucrose solution and rate the sweetness intensity of the solution. The concentration of this solution is the same as the sweetness solution in the Monell Forced-Choice Paired-Comparison Preference Test. A solution of similar sucrose concentration was used in previous studies to characterize how much people like sweet tastes [12, 21].

The sucrose solutions were prepared using food-grade sucrose (Fisher Chemical, crystalline/NF, catalog # S3-500) dissolved in distilled water. Samples were presented as 10-mL aliquots in 30-mL plastic medicine cups and served at room temperature (~ 23 °C). Samples were kept refrigerated at 4 °C until the scheduled sessions and were used within 5 days.

Surveys

We collected food intake and diet quality data using the short Healthy Eating Index (sHEI) Questionnaire, a validated method to estimate food intake [54]. The 22-item sHEI is a reliable proxy for food intake frequencies, designed to mirror the 13 components of the Healthy Eating Index–2015 [51]. Nine of these components assess intake adequacy (i.e., total fruits, whole fruits, vegetables, greens and beans, whole grains, dairy, protein foods, seafood and plant proteins, and fatty acids), and four assess moderation (i.e., refined grains, sodium, added sugars, and saturated fats). A score is calculated for each of the 13 food groups and summed to an overall sHEI score ranging from 0 to 100. The scoring algorithm accounts for a person's gender and the frequency at which they consume various food groups. The sHEI score is an indicator of how well a diet compares to the *Dietary Guidelines for Americans* and an assessment of overall diet quality, with a higher score indicating higher dietary quality. In addition, we estimated added sugars intake by combining frequencies of consumption of sugary foods and sugar-sweetened beverages from the sHEI questionnaire.

Eating behavior traits were assessed using the TFEQ-R18 [37], a validated questionnaire with good reliability widely used to assess eating behavior traits: uncontrolled eating, emotional eating, and cognitive restraint. Higher scores indicate higher tendencies to exhibit each trait.

Table 1 The list of snacks available for participants

Sweet level	Energy density	
	Low calories	High calories
Low sweet	Carrots	Almonds
	Cucumbers	Beef/cheese sticks
	Green bell peppers	Potato chips
High sweet	Apple	Brownies
	Fruit cups	Gummies
	Strawberries	Oreos

Participants choose one of the 12 snacks above to take with them at the end of the study. These snacks were presented to participants on a table, side by side, at room temperature

Snack choice

Participants were asked to choose 1 of 12 snacks to take with them at the end of the study session. The snacks were previously tested in a pilot study to determine the influence of sensory exposure on snack consumption [55] (Table 1). These snacks were chosen because they broadly represent two sweet levels, sweet and nonsweet, and two energy density levels, high and low. It was shown that exposure to certain sensory stimuli may affect the participants' consumption of the snacks. In our study, we used the same list of 12 snacks to test whether sweetness preference may affect which of these snacks the participants would choose. The 12 snacks were laid out on a desk so participants could visually see all the options. After completing the taste tests and on their way out, participants were told to "pick one snack from the desk to take with you" as they were receiving their study compensation. This was to imply the go-to snack was a part of the study compensation to blind the participants from the true purpose, which was to test whether sweet taste preference corresponds to snack choice. Research assistants observed and recorded each participant's snack choice.

Power analysis

We conducted a power analysis using G*Power [56, 57] based on the correlation between sweet taste liking and sugar intake found in a group of 44 adults ages 20 to 40 years reported by Jayasinghe et al., $r = 0.41$ [14]. With the type I error rate set to $\alpha = 0.05$ and type II error rate of $\beta = 0.05$ (95% power), it is estimated that a total of 67 participants is needed to detect a significant relationship between sweet taste liking and diet.

Data analyses

Preferred sucrose concentration, identified using the Monell Forced-Choice Paired Comparison Procedure (see the *Taste test* section, above), was used to assess sweet preference. Participants were categorized as "sweet disliker", "moderate sweet liker", and "extreme sweet likers" by the group sucrose preference tertiles. Participants with a preferred sucrose concentration ≤ 33.3 percentile were categorized as sweet dislikers, participants with a preferred sucrose concentration between 33.4 and 66.6 percentile were categorized as moderate sweet likers, and participants with a preferred sucrose concentration ≥ 66.7 percentile were categorized as extreme sweet likers. Diet quality was assessed by dividing each participant's sHEI score (see the *Surveys* section, above) into groups based on tertiles: low (< 41), medium (41–50), and high (≥ 50). Added sugars intake was estimated for each participant based on the intake frequencies of foods high in added sugars and sugar-sweetened beverages, from the sHEI questionnaire, with participants categorized into groups based on tertiles: low (< 260 g/day), medium (260–572 g/day), or high (≥ 572 g/day).

Chi-square tests were used to determine differences between categorical variables (e.g., sex, snack choice count). Relationships between variables were assessed using Pearson's correlation coefficients, and analysis of variance (ANOVA) were used to compare the differences in eating behavior scores, added sugars intake, and sHEI score across the sweet disliker, moderate sweet liker, and extreme sweet liker groups. We employed two sets of logistic regression models using demographics, sweet preference, and eating behavior traits to predict participants' added sugars intake and diet quality, and for the final models retained only variables associated with the variable of interest (either added sugars intake or sHEI score). Other potential factors that may influence added sugars intake and diet quality, such as participants' age and household income, were considered as covariates.

Table 2 Participant characteristics

Characteristic	Participants [*n* (%) or mean ± SD]
Sex, n	28 men (43.1%)
	37 women (56.9%)
Race/ethnicity, n	23 African Americans/Blacks (35.4%)
	12 Asians (18.5%)
	12 Europeans/Whites (18.5%)
	9 Hispanics (13.8%)
	3 North Africans (4.6%)
	6 of mixed races/other races (9.2%)
Age, years	23.0 ± 5.5
Body mass index, kg/m^2	27.9 ± 8.3
Regular smoker/tobacco use, n	7 (10.8%)
Household income, US dollars	8 ≤ $9,999 (12.3%)
	6 $10,000 to $24,999 (9.2%)
	14 $25,000 to $49,999 (21.5%)
	12 $50,000 to $74,999 (18.5%)
	13 $75,000 to $99,999 (20.0%)
	9 $100,000 to $149,999 (13.8%)
	3 ≥ $150,000 (4.6%)
Preferred sucrose concentration, M	0.43 ± 0.27
Sweet-liking status	32 sweet dislikers (49.2%)
	33 sweet likers (50.8%)
Snack choice	5 low-sweet, low-calorie snack (7.7%)
	14 low-sweet, high-calorie sweet snack (21.5%)
	32 high-sweet, low-calorie snack (49.2%)
	14 high-sweet, high-calorie snack (21.5%)
Added sugars intake, grams	123.4 ± 69.1
Healthy Eating Index score	44.6 ± 8.7

* Sweet dislikers preferred ≤ 0.35 M sucrose solutions; sweet likers preferred > 0.35 M sucrose solutions

Means ± standard deviations (SDs) or percentages were used for the descriptive statistics. Significance was set a priori at $p < 0.05$. All statistical calculations were performed using R (version 4.2.2) and R Studio (version 2024.04.1).

Ethical consideration

Study procedures were reviewed and approved by the Human Research Protection Program at the City University of New York (protocol #2023-0648-Brooklyn). The study was conducted in accordance with the guidelines of the Declaration of Helsinki, and participants provided written, informed consent prior to engaging in study procedures.

Results

Participant characteristics

We recruited 66 participants between 18 and 42 years old from the Brooklyn, New York, area between November 2023 and April 2024. One participant did not complete the study and was excluded from the analyses (final $n = 65$). A description of the participants' characteristics can be found in Table 2. Participants were from diverse ancestry backgrounds. 7 out of 65 of our participants regularly smoked or used tobacco products. Because of the potential effects of regular smoking on sweet preference and perception, we tested for the differences between these groups and found no significant differences between the two groups ($t(7.17) = 0.89$, $p = 0.40$ for sweet preference; $t(7.47) = 0.76$, $p = 0.47$ for intensity perception), so we incorporated both groups in our subsequent analyses. Chi-square tests revealed no statistically significant differences between the numbers of sweet dislikers ($n = 22$), moderate sweet likers ($n = 21$), and extreme sweet likers ($n = 22$) based on sex distribution and body mass index (BMI). Categorized by BMI, 3.1% of participants were living with underweight, 40% were of healthy weight, 23.1% were overweight, and 33.8% were living with obesity. The average added sugars intake of the participants was 123.4 ± 69.1 g/day (range, 32.5–325 g/day); 93.8% of the participants exceeded the recommended daily intake of added sugars. The average sHEI score for our participants was 44.6 ± 8.7 (out of 100), indicating overall moderate diet quality.

Relationships among demographics, sweet preference, and eating behaviors

Participant age was positively associated with BMI ($r = 0.34$, $p = 0.006$), and BMI positively correlated with uncontrolled eating behavior ($r = 0.34$, $p = 0.005$) and emotional eating behavior ($r = 0.36$, $p = 0.004$) [Figure 1], as measured by the TFEQ-R18. However, age did not correlate with eating behavior traits, or to sweet preference measured using the Force-Choice Paired-Comparison

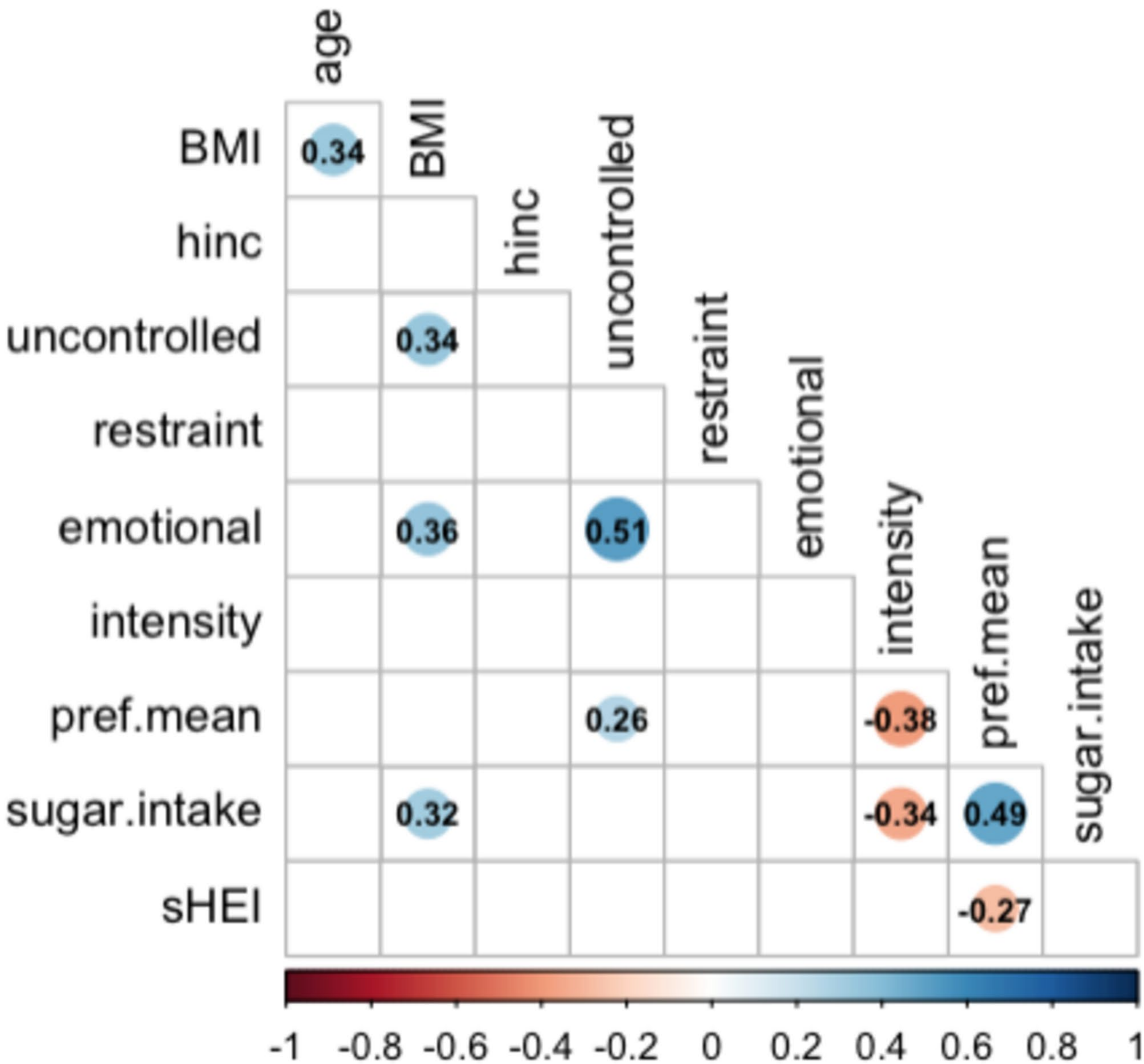

Fig. 1 Correlations among participants' characteristics, eating behavior traits, and dietary outcomes. BMI = body mass index, hinc = household income, intensity = intensity rating of 1.05 M sucrose solution, pref.mean = preferred sucrose concentration, sHEI = Healthy Eating Index

preference test. Among eating behavior traits, uncontrolled eating behavior was positively associated with emotional eating behavior ($r = 0.51$, $p < 0.001$). Dietary restraint behavior was not associated with any eating behavior trait. Participants' sweet preference positively correlated with uncontrolled eating behavior ($r = 0.26$, $p = 0.04$) but not with other eating behavior traits. Uncontrolled eating scores also differed across ancestry groups, $F(2,62) = 5.30$, $p = 0.007$. A Tukey posthoc test revealed that extreme sweet liker had higher uncontrolled eating scores compared to sweet dislikers (17.8 ± 4.5 and 22.8 ± 6.1, respectively, $p = 0.006$).

Influence of sweet preference and eating behaviors on snack choice

When offered a choice of 1 of 12 snacks to take with them after the study session, more participants chose high-sweet, low-calorie snacks ($\chi^2(1, 65) = 6.6973$, $p = 0.01$) [Figure 2] than other snacks. The most popular snack was fruit cups (41.5%), followed by brownies (13.8%). The least popular snacks were green bell peppers and carrots: 0 participants chose either snack. Snack choice was not associated with sweet preference or eating behavior traits.

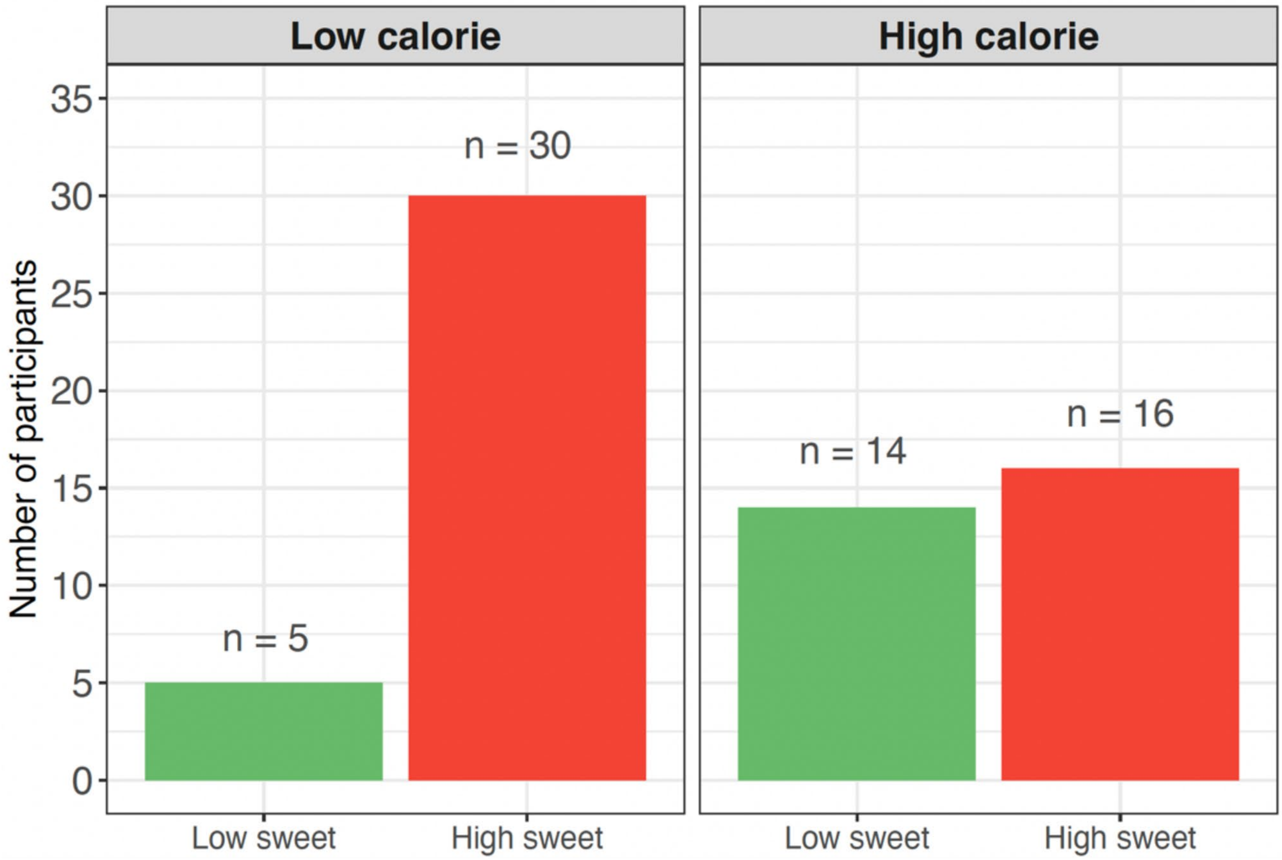

Fig. 2 Added sugars intake across More participants chose high-sweet, low-calorie snacks than other snack types

Influence of sweet preference and eating behaviors on added sugars intake

Added sugars intake, estimated from consumption frequencies of sugary foods and beverages from the sHEI, positively correlated with sweet preference ($r = 0.49$, $p < 0.001$) and BMI ($r = 0.32$, $p = 0.01$) and negatively correlated with sweetness intensity rating (r = -0.34, $p = 0.005$) [Figure 1]. Participants' rating of the intensity of a 1.05 M sucrose solution negatively correlated with sweet preference (r = -0.38, $p = 0.002$): those who preferred a higher sucrose concentration also rated the 1.05 M sucrose solution as less sweet. Eating behaviors were not associated with added sugars intake.

Participants' added sugars intake significantly differed across sweet liking groups, F(2, 62) = 7.32, $p = 0.001$. A Tukey posthoc analysis revealed that extreme sweet likers (218.7 ± 312.2) consumed more added sugars compared to sweet dislikers (91.3 ± 50.3), $p = 0.001$. Extreme sweet likers also consumed more added sugars compared to moderate sweet likers (116.7 ± 58.7), $p = 0.04$, but there was no difference between sweet dislikers and moderate sweet likers in added sugars intake [Table 3].

We performed multinomial logistic regression analyses to determine whether the participants were likely to consume low (59.1 ± 12.8 g/day), medium (108.7 ± 18.9 g/day), or high (206.1 ± 52.5 g/day) amounts of added sugars. Only variables that significantly correlated with added sugars intake (i.e., sweet preference, sweet intensity perception, and BMI) were used in the regression models. Multiple models were built, using combinations of these three variables, to predict added sugars consumption (Table 4). The model with sweet preference (Model 1) and the model with sweet preference + sweet intensity (Model 2) had the best fit, both with Akaike Information Criterion, or AIC, = 137.5. However, sweet intensity was not a significant predictor in Model 2. Further, adding BMI in subsequent models did not improve the model fit. Overall, using information based on the simplest model with the best fit (i.e., Model 1), we found that higher sweet preference increased the odds of consuming medium (OR = 2.18, 95% CI = 0.32, 6.08) and high (OR = 3.17, 95% CI = 1.85, 7.86) amounts of added sugars.

Influence of sweet preference and eating behaviors on diet quality

Diet quality, as assessed using the sHEI score, negatively correlated with preferred sucrose concentration (r = -0.27, $p = 0.03$) but not with other variables. Participants' diet quality significantly differed across sweet liking

Table 3 Characteristics of sweet dislikers vs. sweet likers

Characteristic	Disliker (*n* = 22)	Moderate liker (*n* = 21)	Extreme liker (*n* = 22)	*p*-Value
Age, years	22.4 ± 4.0	23.2 ± 5.5	23.5 ± 6.8	0.80
Body mass index, kg/m^2	26.5 ± 5.9	27.9 ± 8.4	29.4 ± 10.2	0.53
Intensity rating of 1.05 M sucrose solution	82.8 ± 9.6	71.0 ± 22.0	66.5 ± 17.5	< 0.001**
Preferred sucrose concentration, M	0.15 ± 0.05	0.38 ± 0.09	0.76 ± 0.14	< 0.001***
Restrictive eating score	13.8 ± 4.2	13.9 ± 3.2	13.4 ± 4.4	0.91
Uncontrolled eating score	17.8 ± 4.5	19.7 ± 4.2	22.8 ± 6.1	< 0.01**
Emotional eating score	12.4 ± 4.1	11.7 ± 5.9	13.1 ± 6.2	0.72
Snack choice, *n*	2 low-sweet, low-calorie snack	2 low-sweet, low-calorie snack	1 low-sweet, low-calorie snack	
	6 low-sweet, high-calorie sweet snack	4 low-sweet, high-calorie sweet snack	4 low-sweet, high-calorie sweet snack	0.34[a]
	9 high-sweet, low-calorie snack	13 high-sweet, low-calorie snack	8 high-sweet, low-calorie snack	
	5 high-sweet, high-calorie snack	3 high-sweet, high-calorie snack	8 high-sweet, high-calorie snack	
Added sugars intake, g/day	91.3 ± 50.3	116.7 ± 58.7	218.7 ± 312.2	< 0.001**
Healthy Eating Index score	46.2 ± 7.8	47.1 ± 6.9	40.4 ± 10.1	0.02*

Data are mean ± SD except as noted. [a] Chi-square test. All other comparisons used analysis of variance. ** $p < 0.01$, *** $p < 0.001$

groups, F(2, 62) = 4.06, $p = 0.02$. A Tukey posthoc analysis revealed that extreme sweet likers (40.4 ± 10.1) had a lower diet quality compared to sweet dislikers (46.2 ± 7.8), $p = 0.06$. Extreme sweet likers also had a lower diet quality compared to moderate sweet likers (47.1 ± 6.9), $p = 0.03$, but there was no difference between sweet dislikers and moderate sweet likers in diet quality [Table 3].

Additional analyses to test for differences in each sHEI scoring component across sweet dislikers, moderate sweet likers, and extreme sweet likers found that only added sugars intake differed between the groups, F(2, 62) = 7.58, $p = 0.001$. Sweet dislikers had a higher sugar HEI score (indicating a lower added sugars intake) compared to extreme sweet likers ($p < 0.001$). Moderate sweet likers also had a higher sugar HEI score compared to extreme sweet likers ($p = 0.03$), but there was no difference between dislikers and moderate likers [Figure 3]. Logistic regression analysis revealed that higher sweet preference decreased the odds of having a medium diet quality (OR = -2.54, 95% CI = 0.00, 0.46) but had no effect on people with high diet quality. Eating behaviors were not significantly associated with sHEI score or diet quality.

Discussion

Although the *Dietary Guidelines for Americans 2020–2025* recommends incorporating personal preferences to achieve a healthy dietary pattern [58], the question of how taste preference may influence diet and food choice warrants further investigation. Here, we assessed the influence of sweet preference and eating behavior on snack choice, added sugars intake, and diet quality in a group of young adults and found that, neither sweet preference nor eating behavior traits were associated with snack choice. Participants who preferred sweeter tastes were more likely to consume higher amounts of added sugars and had lower diet quality. However, the association between a higher preference for sweet taste and low diet quality could not be attributed to the intake of added sugars. While we found an association between sweet preference and uncontrolled eating, none of the other eating behavior traits were associated with any dietary outcomes. We further classified our participants into sweet disliker, moderate sweet liker, and extreme sweet liker groups to compare dietary patterns (i.e., sHEI components), and found a difference only in added sugars intake, and not in any other component. Overall, the results suggest that sweet preference may have a stronger influence on added sugars intake and diet quality than do eating behaviors. In addition to assessing dietary habits and health status, clinicians could explore employing taste tests to better understand the preferences of their patients with the goal of offering more tailored nutritional advice.

The way we experience pleasure from sweet taste affects whether we consume or reject foods high in added sugars [14, 59]. Though it seems intuitive that people who enjoy sweet taste more may consume more added sugars, previous studies have yielded inconsistent results [6, 14, 15, 17–20], possibly due to variations in how sweet preference and dietary outcomes were assessed [12, 60]. While 24-hour diet recalls and food diaries are popular assessment methods and may potentially provide higher-resolution data, they have a high participant burden and tend to assess only short-term intakes, not overall dietary patterns [60]. In our study, we estimated added sugars

Table 4 Outcomes from multinomial logistic regression analyses of the effects of sweet preference, sweet intensity perception, and body mass index

	95% confidence interval of odds ratio (OR)			
Model 1, AIC = 137.5	**OR**	**Lower bound**	**Upper bound**	***p*-Value**
Low sugar intake	--	--	--	--
Medium sugar intake				
Sweet preference	2.18	0.32	6.08	0.03*
High sugar intake				
Sweet preference	3.17	1.85	7.86	< 0.01**
Model 2, AIC = 137.5				
Low sugar intake	--	--	--	--
Medium sugar intake				
Sweet preference	2.13	0.26	6.33	0.03*
Sweet intensity	0.42	-0.04	0.06	0.68
High sugar intake				
Sweet preference	2.64	1.10	7.47	< 0.01**
Sweet intensity	-1.24	-0.09	0.02	0.21
Model 3, AIC = 140.1				
Low sugar intake	--	--	--	--
Medium sugar intake				
Sweet preference	2.10	0.21	6.28	0.04*
Sweet intensity	0.42	-0.04	0.06	0.67
Body mass index	0.11	-0.08	0.09	0.91
High sugar intake				
Sweet preference	2.59	1.03	7.40	< 0.01**
Sweet intensity	-1.29	-0.09	0.02	0.20
Body mass index	1.01	-0.04	0.13	0.31
Model 4, AIC = 140.1				
Low sugar intake	--	--	--	--
Medium sugar intake				
Sweet preference	-0.76	-21.05	9.13	0.45
Sweet intensity	-0.75	-0.13	0.06	0.45
Sweet preference x sweet intensity	1.12	-0.08	0.32	0.23
High sugar intake				
Sweet preference	-0.24	-15.18	11.82	0.81
Sweet intensity	-1.20	-0.17	0.04	0.23
Sweet preference x sweet intensity	0.87	-0.10	0.27	0.39
Model 5, AIC = 142.6				
Low sugar intake	--	--	--	--
Medium sugar intake				
Sweet preference	-0.78	-21.67	9.32	0.43
Sweet intensity	-0.76	-0.13	0.06	0.44
Sweet preference x sweet intensity	1.21	-0.08	0.33	0.23
Body mass index	-0.06	-0.09	0.08	0.95
High sugar intake				
Sweet preference	-0.23	-15.38	12.10	0.82
Sweet intensity	-1.18	-0.17	0.04	0.24
Sweet preference x sweet intensity	0.83	-0.11	0.27	0.40
Body mass index	0.91	-0.05	0.13	0.36

AIC = Akaike Information Criterion. * $p < 0.05$, ** $p < 0.01$

intake and diet quality using the short Healthy Eating Index (sHEI) food-frequency questionnaire, which captures overall dietary patterns over a longer time period (e.g., from a few months up to 1 year) [60, 61]. We found a significant correlation between sweet preference and intake of sweet foods and beverages, in agreement with other studies that investigated the relationship between sweet taste preference and diet using food-frequency

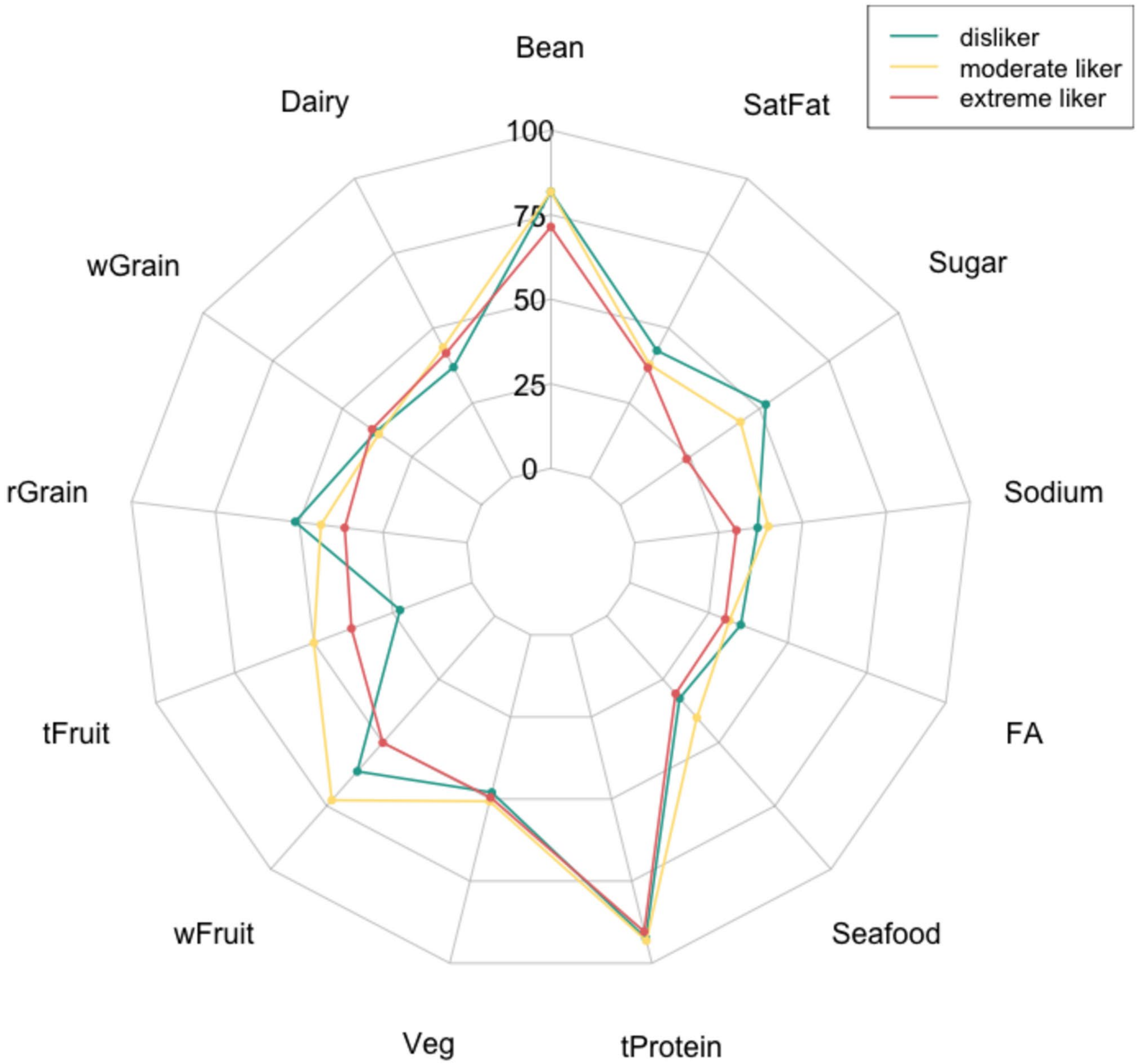

Fig. 3 Differences in Healthy Eating Index component scores across sweet dislikers, moderate likers, and extreme likers. Data are expressed as a percentage of the maximum score for each food category. Bean = greens and beans, SatFat = saturated fat, FA = fatty acids, Veg = vegetables; t = total, r = refined, and w = whole

questionnaires [6, 15]. Categorizing our participants by sweet preference might limit some data variability. It has been previously reported that sweet likers and sweet dislikers have different correlation patterns between added sugars intake and other dietary intake outcomes [16], so classifying participants by their sweet-liking status may help detect relationships between preference for sweet taste and dietary outcomes.

In our study, sweet preference positively correlated with added sugars intake and negatively correlated with diet quality in a relatively young adult population. Our finding is consistent with previous studies that observed a positive relationship between sweet taste preference with sugar/sugary foods intake [14, 15, 21] and provides new insight into the association between sweet preference and overall diet quality. Although it would be logical to assume that the association between sweet preference and diet quality is mediated through added sugars intake, interestingly, we did not observe a relationship between added sugars intake and diet quality. Indeed, current evidence on the association between added sugars intake and overall diet quality is mixed [62]. According to a study using data from the *Global Dietary Database*, although sugar intake has decreased over the years globally, the overall diet quality remained low [63]. This suggests that preference for sweet taste may also affect the intake of other foods to lower diet quality. In an attempt to understand what drives the association between sweet preference and diet quality, we compared the difference in each sHEI component score between sweet dislikers, moderate sweet likers, and extreme sweet likers. Aside from added sugars intake, we found no significant differences in the sHEI component scores between the two groups. However, according to a study conducted using data from 161,625 participants from the UK Biobank, liking highly palatable foods in general is associated with higher body mass index, waist circumference, body fat percentage, and high circulating triglyceride levels [64]. In this study, highly palatable foods were collectively defined as foods that are high in sweetness, fattiness, and savoriness [64]. Therefore, it may be worth investigating the combined effects of multiple highly palatable sensory qualities on diet and health outcomes. In particular, a strong preference for sweet and fat tastes combined has been shown to be associated with the prevalence of overweight/obesity and negative health outcomes [41, 42, 65, 66]. Yet, a limited number studies directly assessed whether the associates between taste preference and health outcomes could be explained by diet quality. Future studies may explore other variables (e.g., fatty sensation preference) to provide more insights into the connection between taste preference and diet quality.

Contrary to previous reports, our study did not find significant associations between eating behaviors and dietary outcomes [38–40, 67–72]. Higher cognitive restraint (i.e., the tendency to be on a diet) has been reported to be associated with lower sugar intake [38, 40], while emotional and uncontrolled eating behaviors have been associated with higher intake of sweet foods and added sugars [39, 67–72]. However, these findings may be sex specific; for example, cognitive restraint may affect dietary patterns differently in women than in men. A previous study of mostly university students found that women who exhibited high cognitive restraint had a higher intake of legumes and fruits and a lower intake of carbohydrates such as sugars, pastries, and high-starch foods compared to those with lower cognitive restraint [40]. On the other hand, men with high cognitive restraint tendencies consumed more fruits, vegetables, soup, and foods rich in protein like milk and eggs, without avoiding energy-dense foods [40]. Despite these differences, both men and women with high cognitive restraint had overall better diet quality than did people with low cognitive restraint [40]. Differences in the effect of eating behaviors on diet have also been observed in adolescents and in other eating behavior domains. For example, boys but not girls with higher emotional eating tendencies consume more fruits and vegetables [39]. Due to our study's modest sample size, we did not separate our analyses by sex. Future studies may consider sex differences when studying the influence of eating behavior on dietary outcomes.

We found a positive correlation between sweet preference and uncontrolled eating behavior, confirming previous reports that people with a high degree of uncontrolled eating (defined as the tendency to overeat and lose control of eating, accompanied by a subjective feeling of hunger) [38], tend to like sweet tastes more than people with lower uncontrolled eating [41, 73, 74]. It is possible that people with a higher degree of uncontrolled eating have more turbulent hunger-satiety signaling. Further, it is also possible that the shift of hedonic valence during the hunger state may make palatable stimuli more pleasant than when tasting them in a satiated state [74, 75]. However, there are conflicting reports on whether hunger may affect sweet preference/sensitivity and if so, on whom [75–79]. It seems that factors such as sex [75] and baseline sweet preference [79] may interact with the effect of hunger on this shift of hedonic valence. It could interesting to test the effects of hunger/satiated states, under controlled conditions, on people who (1) have a higher sweet preference, (2) demonstrate a higher level of uncontrolled eating behaviors (as we have found an association between uncontrolled eating behavior with sweet preference), and (3) of the same biological sex. It is also possible that a preference for higher sweetness may be a predisposition factor for uncontrolled eating episodes [80]. Further investigation is warranted to determine the mechanism behind the relationship between uncontrolled eating and sweet preference.

Most participants chose a high-sweet, low-calorie snack (i.e., fruits). We originally hypothesized that people with a higher sweet preference would be more likely to choose a sweet, high-calorie snack (i.e., brownies, gummies, oreos) and that people with a higher cognitive restraint would choose a low-calorie snack, but we were unable to identify any predictors of snack choice in our study. It is possible that snack choice is influenced by factors other than taste preference and eating behaviors, such as health beliefs and health concerns [45]. For example, vegans may avoid snacks that contain animal-based ingredients (e.g., beef jerky, brownies, gummy bears, potato chips). Also, we did not offer halal or kosher options, which may have led those who observe these restrictions to choose fruits instead of packaged products. Perhaps future studies can explore using other methods to capture snack consumption (i.e., 24-hour dietary recall) to see if the sugar content of the reported snack choice is associated with sweet-liking status.

Strengths and limitations

To the best of our knowledge, it is the first study to investigate the effects of sweet preference and eating behavior on diet using the sHEI to assess diet quality. The sHEI may provide a more comprehensive assessment of overall diet quality than evaluating the intake of specific nutrients alone. We attempted to improve the ecological validity of the sweet preference assessment by offering a real-life snack choice, instead of collecting snack choice preferences through a survey, but were unable to uncover predictors of snack choice. Although the snacks we provided broadly represent the qualities of interest (e.g., sweet vs. nonsweet, high vs. low caloric density), we acknowledge that more snack choices can be offered to in future studies to provide more options. Because we hypothesized that sweet preference would have a stronger influence on dietary outcomes compared to other perceptual measures, we did not collect data on the participants' sweet sensitivity (e.g., detection, recognition, and difference thresholds). We acknowledge that sensitivity data would provide a more comprehensive picture of the determinants of added sugars intake. While we were able to detect a significant relationship between sweet taste preference and added sugars intake in our younger adult cohort, these findings may not be generalizable to a wider population. We explored the effects of both sweet preference and eating behaviors on diet, but because of the modest sample size, we were unable to conduct moderator analyses to test if eating behaviors may affect the strength of the relationship between taste preference and diet. Although we assessed sweet preference using the gold standard, the Forced-Choice Paired-Comparison method, this approach does not provide information on "wanting" and "craving" for sweet taste. Our study also did not collect information on the hunger and satiety levels of the participants, which may affect the within-individual sweet preference throughout the day. Another limitation is that participants' anthropometrics were measured at different times and individual weight status may also fluctuate throughout the day. However, our primary focus was to test the association between sweet preference with dietary outcomes and only used BMI as a confounding variable when appropriate. Eating behavior and dietary outcomes were assessed using questionnaires. As with any self-reported data, the responses of these outcome variables are subjected to reporting bias. While the short Healthy Eating Index Questionnaire is a validated and reliable method to assess diet quality over a longer period of time compared to 24-hour dietary recalls and food diaries, it is not capable of estimating the average total calorie intake per day. Regular physical activity may influence eating behaviors and dietary outcomes; however, we did not collect these data and we acknowledge this limitation. In addition, most participants in the study were younger adults and college students free of chronic diseases. This is both a limitation and a strength: while the findings may not be generalizable to an older population or people living with chronic diseases, we were able to limit the heterogeneity of the data by focusing on a narrower age range.

Conclusions

Our findings suggest that sweet taste preference, not eating behaviors, is more likely to influence added sugars intake and diet quality in a young adult and early middle age population. Other factors, such as eating behavior, may be explored in future studies as moderators of the relationship between taste preference and diet. In addition, assessing preference for other sensory qualities (e.g., fat liking) may provide a more comprehensive picture of how taste preference affects diet and nutritional health.

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Author contributions
Conceptualization, M.M.C., and S.H.; methodology, M.M.C., E.R.P. and S.H.; validation, M.M.C.; formal analysis, M.M.C.; investigation, M.M.C. and F.G.; resources, M.M.C.; data curation, M.M.C., L.C., and F.G.; writing—original draft preparation, F.G. and M.M.C.; writing—review and editing, F.G., L.C., C.G., J.C., E.R.P., S.H., and M.M.C.; visualization, M.M.C.; supervision, M.M.C.; project administration, F.G.; funding acquisition, M.M.C. All authors have read and agreed to the published version of the manuscript.

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Data availability
De-identified data are available upon request from the corresponding author.

Declarations

Ethics approval and consent to participate
Study procedures were reviewed and approved by the Human Research Protection Program at the City University of New York (protocol #2023-0648-Brooklyn). The study was conducted in accordance with the guidelines of the Declaration of Helsinki, and participants provided written, informed consent prior to engaging in study procedures.

Informed consent
Informed consent was obtained from all subjects involved in the study.

Consent to publish
Not applicable.

Competing interests
The authors declare no competing interests.

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