

Associations between taste sensitivity, preference for sweet and salty flavours, and nutritional status of adolescents from public schools

Associação entre sensibilidade gustativa, preferência aos sabores doce e salgado e estado nutricional de adolescentes

Marize Melo dos SANTOS¹
Camila Santos MARREIROS²
Herika Brenda Santana da SILVA³
Ana Raquel Soares de OLIVEIRA¹
Kyria Jayanne Clímaco CRUZ¹

ABSTRACT

Objective

This study aimed to investigate the associations between taste sensitivity, preference for sweet and salty flavours, and nutritional status of adolescents in public schools.

Methods

We used a cross-sectional study involving 1,036 adolescents of both sexes, aged 10-19 years. Preference for sweet or salty flavours and preference for foods high in sugar or sodium were evaluated. Measurements of body mass index and taste flavour intensity recognition were conducted.

Results

Most participants were unable to identify the flavours and/or intensities, and only 18.0% of participants were able to correctly identify both the flavour and intensity of the samples. Most participants (82.1%) preferring

¹ Universidade Federal do Piauí, Centro de Ciências da Saúde, Programa de Pós-Graduação em Alimentos e Nutrição. Campus Universitário Ministro Petrônio Portela, Bloco 13, Ininga, 64049-550, Teresina, PI, Brasil. *Correspondência para/* Correspondence to: MM SANTOS. E-mail: <marizesantos@ufpi.edu.br>.

² Universidade Federal do Piauí, Centro de Ciências da Saúde, Departamento de Nutrição. Teresina, PI, Brasil.

³ Universidade Federal do Piauí, Centro de Ciências da Saúde, Departamento de Estatística. Teresina, PI, Brasil.

sweet foods had low sensitivity to this taste, just as a large proportion of individuals preferring saltiness (82.3%) were less sensitive to salt ($p < 0.001$). Preference for saltiness was associated with pre-obesity.

Conclusion

We found an association between a preference for sweet or salty flavours and nutritional status, highlighting the importance of poor food choices in the development of obesity and other chronic diseases.

Keywords: Adolescents. Nutritional status. Taste perception.

RESUMO

Objetivo

Este estudo teve como objetivo investigar a associação entre a sensibilidade gustativa, a preferência pelos sabores doce e salgado e o estado nutricional de adolescentes em escolas públicas.

Métodos

Estudo de natureza transversal, envolvendo 1 036 adolescentes de ambos os sexos, com idade entre 10 e 19 anos. A preferência pelos sabores doce e salgado e por alimentos ricos em açúcar ou sódio foi avaliada. Medidas do índice de massa corporal e testes de reconhecimento de gosto-intensidade foram conduzidos.

Resultados

A maioria dos participantes foi incapaz de identificar os sabores e/ou intensidades e somente 18,0% dos participantes foram capazes de identificar corretamente o sabor e intensidade das amostras. A maioria dos participantes (82,1%) preferiram alimentos doces e tiveram baixa sensibilidade a esse gosto, bem como uma grande proporção de indivíduos que preferem salgado (82,3%) eram menos sensíveis ao sal ($p < 0,001$). A preferência pelo gosto salgado foi associada com excesso de peso.

Conclusão

Foi encontrada uma associação entre a preferência pelos sabores doce e salgado e o estado nutricional, destacando a importância de escolhas alimentares pobres no desenvolvimento de obesidade e outras doenças crônicas.

Palavras-chave: *Adolescentes. Estado nutricional. Percepção gustatória.*

INTRODUCTION

Human feeding behaviour can be influenced by several factors; psychological, social, economic, and sensory aspects play a decisive role in this behaviour. Among the sensory characteristics of the food, taste is the chief determinant of food choice [1]. Food preferences and aversions that are developed during childhood and adolescence are determined by the sensory characteristics of food [2] and are related to food choices throughout life [3,4]. In this sense, changes in taste sensitivity can influence preferences and dietary choices, contributing to changes in the nutritional status of adolescents [1]. Food preferences, in turn, seem to induce changes in taste sensation because excessive intake of sweet and savoury foods reduces sensitivity to these flavours [5].

Identification of taste sensitivity has been considered an important tool for understanding the complexity of adolescent food behaviour, and changes in taste sensation can contribute to forming unhealthy eating habits [1], promoting weight gain and obesity, as well as other chronic diseases in adulthood [6,7]. Obese individuals have differential taste sensitivity compared to eutrophic people. Overberg *et al.* [8] have shown that obese people are less able to identify flavours, particularly saltiness, umami, and bitterness. However, sensory education can promote the formation of healthy eating habits, since it encourages adolescents to taste different foods, and provides tools for making better food choices. These types of programs need to be integrated at the school, community, and family levels [9,10].

The objective of this study was to investigate the association between taste sensitivity, preference for sweet and salty flavours, and the nutritional status of adolescents from public schools in the city of *Teresina, Piauí*.

METHODS

This was a descriptive, cross-sectional study using a quantitative approach, which was carried out in public schools in the city of *Teresina (PI)*, from February-May, 2015. The study included 1,036 adolescents of both sexes aged 10-19 who were present in the surveyed schools on the days when the questionnaires were applied. The study was approved by the Ethics Research Committee of the *Federal Universidade Federal do Piauí*, nº 406.353. Participants provided Informed Consent, including consent from parents and/or guardians according to the regulatory guidelines for research involving human beings, Resolution MS/CNS nº 466/12 [11].

One-tenth of the city's municipal and state public schools were selected by random sampling, for a total of 20 schools located in five district areas of the city of *Teresina (PI)*. Two classes from each school with students from the corresponding age group were randomly selected. All of the students in these classes who were present on the day of the survey were invited to participate. Absent students, students without the consent of their parents or guardians, and those who refused to participate, were excluded from the sample. The study also excluded smokers, adolescents with a disease or illness (e.g., fever, flu, sore throat, etc.), and anyone using drugs during the data collection period, since these conditions could interfere with flavour detection [12].

Survey questions included demographics and preferences to various sweet or salty foods. These included hamburgers, ham, soda, popcorn, pizza, stuffed cookies, cheese, lollipops, chewing gum, potato chips, chocolate milk, salty snacks, chocolate, crackers, chocolate cake, sausage, ice

cream, instant noodles, hot dogs, mortadella, popsicles, and condensed milk. The food options also included the Brazilian dishes *feijoada* (a black bean and meat stew), *bolo salgado* (salty cake), and *brigadeiro* (chocolate truffles).

For the taste intensity recognition test, mineral water solutions were prepared with refined sugar concentrations of 2.0% and 4.0% for the sweet taste test, and table salt concentrations of 0.2% and 0.4% for the salty taste test. The flavours were presented at random, with the more concentrated samples offered first for both flavours [13]. The solutions were presented to participants, with each concentration presented in duplicate. Each participant was asked to identify the flavour and difference in intensity of the samples, and to order them in ascending or descending order according to the sensory attribute being assessed. Between tests, participants rinsed their mouths with water [13]. There was 100.0% accuracy in the identification of at least one of the two flavors. Participants who correctly identified the flavour and sample intensity were considered as 'approved', and those who were not able to correctly identify the taste, intensity or both were 'disapproved'.

Anthropometric measurements were taken in duplicate and presented as averages. Weight was measured using a portable digital balance (Techline TEC-130, *São Paulo*, Brazil) with a maximum capacity of 150kg and 0.1kg precision. Height was measured using a 2m inelastic extension tape affixed vertically to the wall. Body mass index was calculated from the weight (kg) of the participant divided by their height (m) squared (kg/m²). Classifications were done using BMI percentiles for age and sex, according to the reference distribution of the World Health Organization [14].

Data were analysed using Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, United States) for Windows, v.20.0. Pearson's Chi-square (χ^2) tests and simple correspondence analyses were performed to assess the associations between variables. Significant associations were considered when $p < 0.05$.

RESULTS

The study included 1,036 adolescents of whom 53% were women. The average age of participants was 13 years, with 45% being 10-12 years old, 30% aged 13-15, and 25% aged 16-19.

In the taste intensity recognition test, there was a significant difference between those students both sexes who had successfully identified flavour intensity and those who did not. Most participants could not identify the flavours and/or intensities, and only 17.7% and 19.0% of male and female participants, respectively, were able correctly to identify both the flavour and intensity of the samples (Table 1).

Among the adolescents preferring sweet flavours, 82.1% were not sensitive to the sweet

samples. Of the participants partial to salty flavours, 82.3% were not sensitive to the salty samples ($p < 0.001$; Table 2).

We found a significant association between a preference for the analysed flavours and nutritional status, as well as pre-obese individuals with a preference for salty flavours (Table 3).

Correspondence analysis between flavour preferences and nutritional status of adolescents showed an association between normal weight and preference for sweet flavours with 70% confidence and between overweight and preference for salty flavours with 94% confidence.

We found a significant association between taste sensitivity to the salty samples and nutritional status ($p = 0.041$). Most participants with thinness

Table 1. Distribution of adolescents from public schools in *Teresina* (PI), Brazil (2015), according to sensitivity to sweet and salty flavours and according to sex.

| Variable | Male | | | Female | | |
|--|------|----------------|---------|--------|----------------|---------|
| | n | % [†] | p | n | % [†] | p |
| <i>Taste and intensity test (sweet)</i> | | | | | | |
| Approved | 111 | 28.1 | <0.001* | 120 | 26.5 | <0.001* |
| Disapproved | 284 | 71.9 | | 332 | 73.5 | |
| <i>Taste and intensity test (salty)</i> | | | | | | |
| Approved | 89 | 22.5 | <0.001* | 128 | 28.3 | <0.001* |
| Disapproved | 306 | 77.5 | | 324 | 71.7 | |
| <i>Taste sensitivity</i> | | | | | | |
| Taste correctly identified, intensity incorrectly identified | 171 | 35.7 | <0.001* | 213 | 38.4 | <0.001* |
| Taste and intensity incorrectly identified | 223 | 46.6 | | 236 | 42.6 | |
| Taste and intensity correctly identified | 85 | 17.7 | | 105 | 19.0 | |

Note: [†]Percentage of total individuals by sex; *Pearson's Chi-square test (χ^2).

Table 2. Association between taste sensitivity and food preference for sweet and salty flavours. *Teresina* (PI), Brazil (2015).

| Food preference | Taste sensitivity | | | | | | | | | | |
|-----------------|-------------------|------|-------------|------|--------|-------|----------|-----|-------------|--------|-------|
| | Sweet | | | | | p^* | Salty | | | | |
| | Approved | | Disapproved | | p^* | | Approved | | Disapproved | | p^* |
| n | % | n | % | n | | % | n | % | | | |
| Sweet | 81 | 17.9 | 371 | 82.1 | <0.001 | 147 | 32.5 | 305 | 67.5 | <0.001 | |
| Salty | 150 | 38.0 | 245 | 62.0 | | 70 | 17.7 | 325 | 82.3 | | |

Note: *Pearson's Chi-square test (χ^2).

Table 3. Association between preference for sweet and salty flavours and nutritional status of adolescents from public schools in Teresina (PI), Brazil (2015).

| Nutritional status | Flavour preference | | | | p* |
|--------------------|--------------------|------|-------|------|--------|
| | Sweet | | Salty | | |
| | n | %† | n | %† | |
| Thinness | 34 | 60.7 | 22 | 39.3 | 0.002* |
| Normal range | 411 | 55.4 | 331 | 44.6 | |
| Pre-obesity | 60 | 39.0 | 94 | 61.0 | |
| Obesity | 45 | 53.6 | 39 | 46.4 | |

Note: †Percentage of total individuals in each nutritional status group; *Pearson's Chi-square test (χ^2).

Table 4. Association between taste sensitivity and nutritional status of adolescents from public schools in Teresina (PI), Brazil (2015).

| Nutritional status | Taste sensitivity | | | | | | | | p* | |
|--------------------|-------------------|------|-------------|------|-------|----------|------|-------------|------|-------|
| | Sweet | | | | p* | Salty | | | | |
| | Approved | | Disapproved | | | Approved | | Disapproved | | |
| | n | %† | n | %† | | n | %† | n | | %† |
| Thinness | 17 | 37.0 | 29 | 63.0 | 0.263 | 6 | 13.0 | 40 | 87.0 | 0.041 |
| Normal range | 156 | 25.6 | 454 | 74.4 | | 173 | 28.3 | 439 | 71.7 | |
| Pre-obesity | 37 | 30.3 | 85 | 69.7 | | 26 | 21.3 | 96 | 78.7 | |
| Obesity | 21 | 30.4 | 48 | 69.6 | | 14 | 20.3 | 55 | 79.7 | |

Note: †Percentage of total individuals in each nutritional status group; *Pearson's Chi-square test (χ^2).

(87.0%), weight in normal range (71.7%), pre-obesity (78.7%) and obesity (79.7%) were disapproved on taste sensitivity to the salty samples (Tabela 4).

There was a greater preference among participants for sweet flavours (53.10%); however, with respect to food, most of the surveyed adolescents preferred *brigadeiro*, hamburgers, soda, popcorn, pizza, stuffed cookies, and hot dogs (Table 5).

DISCUSSION

This was the first study to associate taste sensitivity, preference for sweet and salty flavours, and the nutritional status of adolescents. High percentages of participants were insensitive to the two flavours, regardless of sex. High intake of foods with added sucrose and sodium may have contributed to the participants' difficulty in identifying the corresponding flavour's intensity,

since excessive intake of these nutrients seems to favour reduction in taste sensitivity of adolescents [5]. From our study, adolescents preferred sweet flavours, which may be due to formation of dietary habits during breastfeeding and supplementary feeding, when a larger amount of sweet foods are offered. The literature shows that children and adolescents consume large amounts of sweet foods, consistent with our findings [15,16].

This study has found that adolescents with sensitivity to sweetness prefer salty flavours, and those sensitive to saltiness prefer sweet flavours. This result confirms changes in taste sensitivity of these individuals, which can be attributed to inadequate feeding caused by frequent consumption of processed foods with high sugar, sodium, and fat content, and low consumption of natural foods. The surveyed students were not sensitive to their preferred flavours, suggesting

Table 5. Foods liked or disliked by adolescents from public schools in *Teresina* (PI), Brazil (2015).

| Foods | Preference or rejection | | |
|------------------------|-------------------------|----------------|----------------|
| | n | % [†] | p [*] |
| <i>Brigadeiro</i> | | | |
| Like | 797 | 77.0 | <0.001 |
| Dislike | 238 | 23.0 | |
| <i>Hamburger</i> | | | |
| Like | 766 | 73.9 | <0.001 |
| Dislike | 270 | 26.1 | |
| <i>Ham</i> | | | |
| Like | 592 | 57.3 | <0.001 |
| Dislike | 441 | 42.7 | |
| <i>Soda</i> | | | |
| Like | 852 | 82.2 | <0.001 |
| Dislike | 184 | 17.8 | |
| <i>Popcorn</i> | | | |
| Like | 652 | 62.9 | <0.001 |
| Dislike | 384 | 37.1 | |
| <i>Pizza</i> | | | |
| Like | 916 | 88.4 | <0.001 |
| Dislike | 120 | 11.6 | |
| <i>Stuffed cookies</i> | | | |
| Like | 719 | 69.4 | <0.001 |
| Dislike | 317 | 30.6 | |
| <i>Hot dog</i> | | | |
| Like | 779 | 75.2 | <0.001 |
| Dislike | 257 | 24.8 | |

Note: [†]Denotes percentage for each food type; ^{*}Pearson's Chi-square test (χ^2).

that excessive exposure to a flavour seems to contribute to reduced sensitivity [5].

We found an association between food preference and nutritional status. Our correspondence analysis showed that normal-weight individuals preferred sweet flavours, while the overweight adolescents preferred salty flavours. The salty foods preferred by the evaluated teenagers, like hamburgers, pizza, and hot dogs, are sources of simple carbohydrates and saturated fats, which can contribute to obesity and associated diseases. Other studies have found that obese adults consume large amounts of foods with added salt, and that these foods contribute large proportions of the energy content in their diets. Researchers

suggest that altered sensitivity to salty flavours can influence the feeding behaviour of obese individuals [17-19].

In this study, we also found an association between taste sensitivity to the salty samples and nutritional status. We observed that participants with thinness showed highest percentage of disapproval in this test. This result confirms previous results of this study because we found that most individuals with thinness preferred sweet flavours. Thus, this scientific evidence confirms the existence of changes in taste sensitivity of these individuals.

This study's limitations include a lack of data on food consumption that could explain the observed reduced taste sensitivity. More studies on the complex mechanisms involved in adolescents' taste sensitivity and food preferences are needed to further elucidate the influence of these factors on their food choices and nutritional status.

CONCLUSION

The adolescents evaluated in this study had low sensitivity to sweet and salty flavours. Adolescents with sensitivity to sweetness prefer salty flavours, and those sensitive to saltiness prefer sweet flavours, evidencing changes in taste sensitivity of these individuals. We found an association between a preference for sweet or salty flavours and nutritional status, and an association between sensitivity taste and nutritional status, highlighting the importance of poor food choices in the development of obesity and other chronic diseases.

CONTRIBUTORS

CS MARREIROS, HBS SILVA, ARS OLIVEIRA and KJC CRUZ have participated to the analysis and interpretation of data of the manuscript. MM SANTOS participated in the conception, design, development and the review of the paper.

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Received: July 14, 2016
Final version: October 25, 2016
Approved: December 19, 2016

