PHENYLTHIOCARBAMIDE (PTC) TASTER STATUS IN SOUTH INDIAN ADULT MEDICAL STUDENTS
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ABSTRACT

BACKGROUND
The objective of this study was to determine Phenylthiocarbamide (PTC) taster status in adults who are studying medicine and its relationship with anthropometric variables such as Body Mass Index (BMI), Body Fat Percentage (BFP) and pleasantness of sugar, salt, and fat. A total of 112 subjects rated the intensity of Phenylthiocarbamide and sodium chloride (NaCl) solutions using the labelled magnitude scale. For pleasantness evaluation, it was used with concentrated lemon juice (sugar) and mashed potato (salt and fat). The subjects were classified as non-tasters (n=32), medium-tasters (n=31) and super-tasters (n=49). In this study, no relationship was found between phenylthiocarbamide taster status and age, sex, weight, body mass index, and pleasantness. Although genetic markers may influence the degree of liking of certain foods, one must consider that the mechanisms influencing eating behaviour in humans are complex, and that psychological, social, and economic factors play a key role in response to food.

KEYWORDS
Phenylthiocarbamide, Body Mass Index, Body Fat Percentage, Pleasantness.


INTRODUCTION: Food intake habits depend on physiological, psychological, social, and genetic factors that influence meal timing, food preference, quantity of food intake, and food selection. Food preference and food intake depends precisely on its taste, thereby directly influencing eating habits. However, not all humans perceive taste in exactly the same way. The density of taste papillae on the tongue, genetic differences in taste receptors or sensitivity of taste receptors, constituents of saliva, and other factors all contribute to an individual's taste perception and subsequent food preferences.

Fox et al., in 1931 synthesised a bitter chemical compound and named it as phenylthiocarbamide (PTC).¹ which has been widely used for genetic and anthropological studies.² Within and between human populations, the bitter-taste perception is a classically variable trait.³ According to Mendelian law, the inability to taste PTC is a simple recessive trait.⁴-⁶ wherein the individuals with two recessive alleles (tt) are non-tasters for PTC and individuals with one dominant allele (Tt) or two dominant alleles (TT) are tasters for PTC. The prevalence of taste blindness (i.e. a lack of sensitivity to or an inability to taste bitter chemicals) ranges from 3 % in West Africa to 6–23% in China and 40 % in India; 30 % of the white North American populations has taste blindness.⁵ Kim et al., have identified a small region on chromosome 7q harbours, a gene that encodes a member of the TAS2R bitter taste receptor family.²

A major locus on 7q35-q36 and a secondary locus on chromosome 16p have been localised by genome scan for PTC taster gene.¹⁰ Buze et al¹¹ demonstrated that alleles of hTAS2R38 codes for functionally different receptor types that directly affect perception of bitterness containing compounds. There are many diseases associated with variations in taste perception. However, researchers suggested that lipid metabolism involved in the aetiology of congenital heart diseases may be affected by tasting ability.¹² A preference for sweet and high-fat food was observed to decrease with increasing perception of bitter taste.¹³ and further research highlighted relations between bitter compound–tasting ability and body mass index (BMI; in kg/m2), adiposity levels, and risk factors for cardiovascular disease.¹⁴,¹⁵

The availability of genetic markers for tasting ability may offer insight into individual’s risk of predisposition to childhood obesity or obese traits. Hence in the present study we made an attempt to analyse the interaction between PTC taster status and onset of obesity in adult medical students, Mumbai, Maharashtra.

MATERIALS AND METHODS: The study is a cross-sectional randomised study among adult medical students from urban areas of Mumbai city. A total number of 300 adults aged range from 18-25 years from a Medical College, Mumbai city was selected for this study during years 2011-2012. The body weight was measured without shoes using a measuring scale, and height to the nearest centimetre was taken. Body Mass Index (BMI) was calculated as weight in kilograms divided by height (in meter squared). The adults whose weight was more than 85th percentile (weight or BMI) for the age and sex were considered as overweight/obese.¹⁶

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Physical activities were recorded with the help of questionnaire specially designed for them. The informed written consent was taken from volunteers and also from Institutional Ethical Committee (IEC). Adults for control group were selected based on the BMI calculation, growth charts and family without any history of obesity, hypertension and diabetic conditions. Food preference was recorded based on the questionnaire specially designed for this study. Information about socioeconomic factors and medical history of the family was recorded. Modified method of Harris and Kalmus was used to assess the PTC taster and non-taster phenotype.

With their consent, the subjects were asked to taste the PTC solution of different concentrations 0.25%, 0.025% and 0.0025% and the results were recorded in the pro-forma. PTC super tasters, tasters and non-tasters were recorded based on their taste sensitivity at different dilutions, non-tasters (n=32), medium-tasters (n=31) and super-tasters (n=49). Lemon juice and mashed potato were chosen because these types of food are familiar to the population, and both are convenient vehicles to manipulate the intensity of several attributes.

Sensory analysis was carried out in the morning with an interval of at least 2 hours between the last meal and the test. The tests were performed at the Physiology Laboratory of TN Medical College, Mumbai Maharashtra, India. Statistical analysis was performed using SPSS statistical software 18.0. Logistic regression was performed to assess the association of tasting ability with different variables and obesity as covariates. Case-control status was used as a dependent variable and obesity as covariates. Results were presented as frequency, mean, standard deviation, and minimum and maximum values.

The logistic regression analysis was done at all combination to establish specific relation of food habit and overweight/obesity, the odds ratio were significant for all the variables like consumption of junk food, bakery product, meat and chicken, fat and oily food at least 4 days/week. The 95% confidence intervals for the effect of unhealthy food habits on overweight/obesity were significant. This analysis suggests that the high caloric unhealthy food habit is one of the possible risk factor in causing overweight/obesity.

Comparisons of the means of anthropometric variables and gender among the three taster groups were performed using the Kruskal-Wallis test. The Student-Newman-Keuls test was used to determine group differences in mean ratings. Nonparametric analyses of repeated ordinal categorical data were performed to verify the relationship between PTC taster status and pleasantness. A value of p <0.05 was used as criterion for statistical significance.

**RESULTS:** A total of 112 individuals, majority of men (72%), aged between 18 to 25 years participated in the study (Figure 1). Age, weight, and BMI were similar across all groups. There were no statistically significant differences between age, weight, and body mass index in relation to PTC taster status or gender (p = 0.06), as can be seen in Table 1. A total of 68% of individuals had some degree of sensitivity, with the majority being super-tasters (42%) and in minor number of non-tasters (24%), as shown in (Figure 2).

<table>
<thead>
<tr>
<th>Variables (Criteria’s)</th>
<th>Odds ratio (95% C. I.)</th>
<th>Univariate</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice daily</td>
<td>2.655 (1.489;4.439)</td>
<td>0.002*</td>
<td></td>
</tr>
<tr>
<td>Wheat daily</td>
<td>0.613 (0.389; 0.989)</td>
<td>0.022</td>
<td></td>
</tr>
<tr>
<td>Vegetable daily</td>
<td>0.352 (0.160; 0.554)</td>
<td>0.001*</td>
<td></td>
</tr>
<tr>
<td>Meat &amp; chicken &gt;3 days/week</td>
<td>5.333 (3.313;8.618)</td>
<td>0.001*</td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Logistic Regression Analysis of Food Habit in Overweight/Obese and Control Population (C. I. = Confidence Intervals)

<table>
<thead>
<tr>
<th></th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakery product &gt;3 days/week</td>
<td>5.182 (2.546; 8.760)</td>
<td>0.001*</td>
<td></td>
</tr>
<tr>
<td>Junk food &gt;3 days/week</td>
<td>9.500 (5.458; 18.208)</td>
<td>0.001*</td>
<td></td>
</tr>
<tr>
<td>Fat and oily food &gt;3 days/week</td>
<td>4.042 (1.864; 6.564)</td>
<td>0.001*</td>
<td></td>
</tr>
</tbody>
</table>

* = significant

Fig. 3: Shows the Classification of Individuals by Level of Sensitivity to PTC

The upper limit of the confidence interval for non-tasters was 8.0 mm, approximately "weak" on the scale; the lower limit for the super-tasters was 69.9 mm, corresponding to "very strong", while medium-tasters fell between these values. Significant differences were found among the three groups (p <0.01).

Fig. 4: Mean Rated Pleasantness on a Seven-Point Category Scale as a Function of Sucrose Concentration in Lemon Juice by Taster Status

There was no significant interaction effect between PTC taster status and concentration of sucrose (p=0.14), salt (p=0.46), and fat (p=0.84); however, non-tasters preferred the 5% sugar orange juice assigning a mean pleasantness of 4.4, whereas medium- and super-tasters scored the 8% concentration with the highest values of 4.9 and 4.8, respectively, as shown in Figure 4.

Fig. 5: Mean Rated Pleasantness on a Seven-Point Category Scale as a Function of Salt Concentration in Mashed Potato by Taster Status

Regarding salt, non-tasters attributed the highest score (4.6) to the 1% concentration. Medium- and super-tasters preferred the 0.5% sample with a mean pleasantness of 4.8 and 5.2, respectively (Figure 5). For the 1% concentration, lowest scores were given regardless of taster status.

Fig. 6: Mean Rated Pleasantness on a Seven-Point Category Scale as a Function of Fat Concentration in Mashed Potato by Taster Status

With regard to fat, mean pleasantness responses for the non-tasters were highest for the 1.3% mashed potato (4.6), whereas medium- and super-tasters assigned the highest values to the 2.6% concentration (4.8 and 5.4, respectively), as shown in Figure 6. The most preferred samples were less clear considering the similarity of the three groups at all concentrations of 1.4% and above.

DISCUSSION: The LMS scale used in this study has a finite upper limit and provides individuals, especially super-tasters, with greater freedom of expression. Labelled scales allow better discrimination of levels of sensitivity. The cut-off points found for classifying PCT taster status in our sample were similar to those described in the literature found values of 77 mm for super-tasters and 9 mm for non-tasters. The distribution of phenotypes found in the present study was also consistent with that reported in the literature showing that although the frequency of non-tasters varies according to race and ethnicity, approximately 30% of the population have this characteristic.

Earlier studies found out a high incidence of non-tasters among patients with nodular goitre, congenital athyreotic, cretinism and dental caries. Sharma et al...
has reported a higher frequency of non-tasters in epileptic twins. In the present study, the prevalence of PTC taster status is high in case of non-obese adults when compared to overweight/obese. Recent studies showed that people who can taste PTC (Taster) are more sensitive to salt, sweet foods, sharp tasting foods, spicy foods, and alcohol. Tasters are also better in discriminating between high and low fat foods, such as various types of salad, etc. Anatomical studies reported that tasters actually have more taste buds than non-tasters.25

Keller et al stated that non-tasters like high fat diet more than low fat diet, whereas tasters show the lack of preference for food.30 Bartoshuk et al reported that the taste of sucrose is more intensively sweet to tasters than to non-tasters and tasters have high sensitivity to sweetener such as saccharin and neohesperidin dihydrochalcone.31 Food pattern and eating habits of the adults involves the information of the type of diet, frequency of non-vegetarian consumption, nature of food, frequency of consumption of stuff food, nutrient intake, etc. Even in our study, we found more non-tasters who are overweight/obese compared to tasters, which once again emphasises on the choice of food and its relation with obesity in general population when the PTC taster and non-taster were subjected for logistic regression analysis, the effect of adolescent obesity was not diluted showing an increase in odds by 20% and 39% per extra year in tasters and non-tasters respectively.

Bitter, sweet, and umami tastes are mediated by G-protein-coupled receptors (GPCRs). Bitter taste receptors are encoded by 25-30 TAS2R genes, located on chromosomes 12p13, 7q34, and 5p15.32 the ligand specificity of TAS2Rs appears to be quite broad, consistent with their roles in detecting thousands of bitter-tasting compounds. One of these, TAS2R38 has been extensively characterised in vitro, in vivo, and in human populations, and is responsive to the bitter stimuli phenylthiocarbamide (PTC), propylthiouracil (PROP), and to thiocyanates–bitter compounds found in brassica vegetables such as Brussels, sprouts and broccoli. Single nucleotide polymorphisms (SNP) located within a linkage disequilibrium block of these genes account for the association of taste, food preference and increase in weight.33

The statistically significant variation also holds good for consumption of balance diet, high caloric diet and physical exercise in obese adults and healthy adults. These results support that sensation in choice of food is very much diminished in non-tasters. Tasting ability is also likely to be influenced by many other sensory and proprioceptive pathways, and the probable result is that no single genetic marker has a great effect. In particular, other pathways are likely to include olfactory contributions to food preference, although digestive and cognitive factors may complicate the overall system and modify the ability to perceive bitter taste.34

The present study shows that overweight/obese adults were less likely to consume food like wheat, vegetable and fruits in their daily food which are highly nutritive whereas high consumption of bakery product, junk food, meat, chicken, fat and oily food in their diet was evident. As majority of overweight/obese adults being non-sensitive to salt, sweet foods, sharp tasting foods, spicy foods and high fat diet, they consume more bakery products, junk food and typically incorporate all of the potentially adverse dietary factors in a large portion size. Additionally, these foods tend to be low in fibre, micronutrients and antioxidants which is responsible for weight gain.35

Among non-obese adults, majority of them are PTC tasters and are very sensitive to some tastes especially bitter, sour, salty and sweet, etc. Hence, they avoid or restrict such foods. We also recorded the consumption of junk food, bakery food products in non-obese group are occasional or rare, and they showed high percent of physical activities. Increased frequency of non-taster allele is evident in adults with overweight/obese condition resulting in lack of preference for taste sensitivity in non-tasters. As phenotypic variation in PTC sensitivity is genetic in origin, this may represent a surrogate risk factor for the development of adolescent obesity.

CONCLUSION: PTC taster status was identified in the sample of Indian Adult Medical students who are in subjects evaluated. This study found no relationship between the level of sensitivity to PTC and age, sex, weight, BMI, and pleasantness. Although the genetic markers may influence the degree of liking and consumption of certain foods, one must consider that the mechanisms influencing eating behaviour in humans are complex and that psychological, social, and economic factors also play a key role in response to food. However, it is imperative that sensory response to foods be taken into account in nutrition education and intervention strategies. It is important to consider that there are no studies for the Indian adult population regarding PTC taster status, which reinforces the need for further research in this area which may be of use to public health workers improving the understanding behind the factors that drive food choices in prevailing adolescent obesity and its related diseases.

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