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Relationship between Skeletal Maturity, BMI Percentile and Dental Caries Experience among Taster and Non-taster Children

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Ability of an individual to taste phenylthiocarbamide (PTC) substance divides the population in tasters and non-tasters. The objective of this study was to investigate the relationship between the taste ability for PTC substance with BMI percentile, skeletal maturity and dental caries experience within taster and non-taster children of age 8-12 years.
Hypotheses: Tasting ability for PTC affects the BMI percentile, skeletal maturity and dental caries experience and emerge as a useful caries risk assessment tool.
Evaluation of Hypotheses (Materials and Method): One hundred children of 8-12 years were randomly selected and their taste perception was assessed using PTC sensitivity test. Radiovisiography (RVG) of middle phalanx was obtained to determine the skeletal maturity by using Rajgopal and Kansal modification 2005. Anthropometric measurements were recorded to obtain BMI value and then BMI percentile was calculated using CDC Pediatric growth charts. For dental caries assessment, deft/DMFT scores were recorded.

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Results: The non-tasters had early skeletal maturation, higher caries experience and higher BMI percentile than the tasters.

Conclusion and Clinical Relevance: PTC Sensitivity is a genetically controlled trait showing strong association with dental caries. From the results of this study we can conclude that the genetic ability of tasting PTC affects the BMI percentile, skeletal maturity and dental caries experience. Thus it can emerge as a useful caries risk assessment tool helping in planning the preventive measures and interceptive orthodontics in children.

Keywords: Phenylthiocarbamide (PTC); skeletal maturity; body mass index (BMI) percentile; DMFT/deft index.

1. INTRODUCTION

The taste perception plays a very vital role in our everyday life. Chemical senses are the way in which we perceive taste and smell which are unique to the individual. Taste can be described as four basic sensations: sweet, sour, salty and bitter. Two newly described taste sensations are umami (meaty or delicious) and tasting amino acids and fatty acid texture [1,2].

The ability or inability to taste the bitterness of the Phenylthiocarbamide (PTC) substance is one of the most important genetic markers that study human evolution in taste perception and its effect on dietary habits associated with some important food-related diseases [3-5]. Depending on the phenotypic pattern of PTC tasting, humans can be divided into two main groups, either tasters or non-tasters. The frequency of non-tasters varies widely from population to population. The inherited sensitivity of tasting PTC and similar other substances may contribute to the observed variability of individuals in their food intake habits and dietary behaviour toward some types of food items [5-7]. Consequently, these differences will impact their susceptibility of infection with some important food-related diseases in humans [7-9]. For early detection and monitoring of caries, taste has valuable roles in our lives in health and disease [10].

Dental caries is a multifactorial disease presenting one of the major public health problems (WHO, 2017). It is caused by a combination of different genetic, as well as environmental factors [11]. Many genes influence the development of risk for caries [12-13]. Studies have showed that high sugar intake reflects a preference for sweet substance among a majority of children [14]. Although, a physiological mechanism that affect a child's craving for sweet substance has not been well documented [15]. The rapid secular rise of ECC supports significant sweet intake in promoting caries risk, presumably the genes interact along with sweet intake associated with difference of caries risk in individuals. One such genetic factor is bitter taste perception, mediated by the TAS2R38 gene [16]. Few studies have suggested that there may be a relationship between the phenotypic patterns of PTC tasting and dental caries, especially among children in the school age [17] and this trait could be used as a sign of early childhood caries (ECC) detection [18-19]. This has opened a new epoch to the potential for the pathogenic-related functions of this trait. Tasting ability can also have an effect on the dietary habits of children.

Eating habits established early in life leads to chronic life style disorders such as obesity, which is hard to overcome as child comes of age. Childhood obesity is increasing rapidly worldwide and is one of the most serious public health challenges of the 21st century [20]. There are also evidences that dental development is accelerated in children who have increased BMI percentile [21].

Diet and nutrition plays the key role in the growth and development of a child. Thus we can expect the influence of PTC tasting ability on the skeletal maturation of a child. An understanding of growth events is of utmost importance in the practice of clinical orthodontics as it has influence on diagnosis, treatment planning, and the eventual outcome of the orthodontic treatment. Determination of skeletal maturation and dental development is important in the initial phase of orthodontic treatment, especially in growth modification therapies.

From the literature reported it is certain that there is some association of PTC sensitivity to skeletal maturity, dental caries and the BMI percentile. If this correlation is strong enough in various populations, then we can utilise the PTC sensitivity as an emerging reliable caries risk assessment tool which can aid us for early preventive measures and also plan growth modification treatments accordingly. But there is scarcity in literature in this regard. Also in authors knowledge no such study has been performed in the population of North Maharashtra. Thus this study was planned and carried out to investigate the relationship between the taste ability of phenylthiocarbamide (PTC) substance with BMI percentile, skeletal maturity and dental caries experience in children of age 8-12 years.

2. MATERIALS AND METHODS

150 children from the age group 8-12 years were randomly selected from the nearby schools. Out of them 100 children who provided the ascent and their parents also gave the consent were selected in the study (n=100).

Exclusion criteria: Children with any gross oral pathology, chronic diseases, malignant disease, immunological conditions or any medical condition which have an effect on taste sensation or had history of allergy to PTC were excluded.

The investigator obtaining DMFT/deft scores, BMI percentile and skeletal maturity of children was blinded to the result of their PTC sensitivity test. PTC sensitivity was performed by the investigator who was blinded to the results of other investigations.

To calculate BMI of children, their height in cm^2 and weight in kg was obtained. BMI was calculated using the formula

$$\frac{\text{Weight (kg)}}{\text{Height (cm)}^2 \times 10{,}000}$$

BMI percentile was calculated by CDC Pediatric Growth Charts for boys and girls.

A comprehensive clinical examination was performed by a trained examiner with the assistance of a recorder. Caries were determined according to the World health organization's criteria (1997). The number of decayed, missing, and filled teeth in permanent (DMFT) and in primary dentition (deft) were recorded and the DMFT/deft scores were calculated.

The skeletal maturation stage was determined by using Rajgopal and Kansal modification 2005. RVG of middle phalanx was obtained. This skeletal age was compared with their chronological age. According to comparison, these children were categorised as early maturation, normal maturation or late maturation.

For PTC Sensitivity test, child was first asked to wash his/her mouth with fresh water to avoid any prior bitter or other taste. The paper (Precision Laboratories PTC test paper) was placed on the dorsum of the tongue for about 30 seconds to elicit the bitter sensation. Children who said it tasted like paper/no taste were categorised as non-tasters. Those who said it tasted bad or yucky or bitter were categorized as tasters. Ambiguous/conflicting responses were retested at a later time to verify or conclude to categorize them.

Statistical analysis: Statistical Package for Social Science (SPSS) version 21 for Windows (Armonk, NY: IBM corp.) software was used to analyse the data. Statistical analysis was done by using tools of descriptive statistics such as proportion/ percentage for representing categorical scale data & mean, standard deviation for representing quantitative data. Probability of accepting alpha error was set at 5%, $p < 0.05$ considered as significant. Power of the study was set at 80%. Pearson Chi square test was used to find out if significant difference exists between taster and non–taster in relation to skeletal maturity type and BMI category distribution. Unpaired 't' test used to compare dental caries status between tasters and non–tasters.

3. RESULTS

Nearly equal sex distribution was seen in the samples; also they were divided in 4 groups according to age which showed almost equal distribution in both males and females. In the given population, tasters were more (58%) than the non-tasters (42%). All the groups showed more tasters than the non-tasters (Table 1).

Since single examiner determined the BMI percentile, skeletal maturity and dental caries experience of the children, intra examiner reliability was conducted prior to start of the study on a pilot sample. Intraclass correlation coefficient was found to be satisfactory (>0.8) for both parameters i.e. dental caries measurement and determination of skeletal maturity. For BMI, height and weight was recorded on a standardised, calibrated machine. When BMI percentile was plotted in CDC pediatric growth charts, 67 children were under normal category. Out of these 44(65.6%) were tasters whereas 23(34.4%) were non-tasters. Number of children in underweight category was 10, of which maximum children were tasters ie. 80%. In overweight category, 74% children belonged to non-taster group whereas; only 26% children belonged to taster group. Out of the study samples, 6 children were obese, of which 4(66.7%) were non-tasters and 2(33.3%) were tasters (Table 2) (Graph 1).

Dental caries experience was significantly higher in non-tasters than tasters. Mean deft score for tasters was 4.8±1.86 and for non-tasters 6.1±2.31. Also, mean DMFT score for tasters and non-tasters was 3.1±1.29 and 4.3±1.94 respectively (Table 3) and (Graph 2).

Table 1. Taster vs. Non-taster distribution in study population

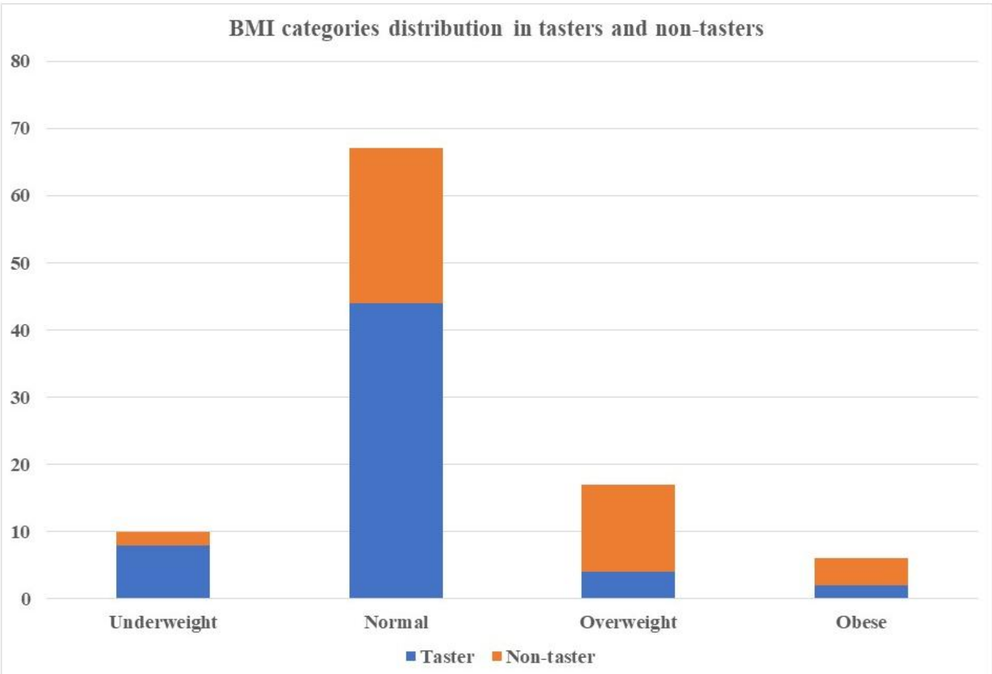
	TASTER n (%)	NON-TASTER n (%)	TOTAL n (%)
8-9 years	14 (63.6%)	8 (36.4%)	22 (22%)
9-10 years	14 (56%)	11 (44%)	25 (25%)
10 -11 years	16 (55.17%)	13 (44.83%)	29 (29%)
11-12 years	14 (58.3%)	10 (41.6%)	24 (24%)
Total	58 (58%)	42 (42%)	100 (100%)
	Chi square test value = 6.098, p =0.046*		

**p < 0.05 is significant*

Table 2. BMI categories distribution in tasters and non -tasters

	Taster n (%)	Non-taster n (%)	Total n (%)
Underweight	8 (80%)	2 (20%)	10 (10%)
Normal	44 (65.6%)	23 (34.4%)	67 (67%)
Overweight	4 (26%)	13 (74%)	17 (17%)
Obese	2 (33.3%)	4 (66.7%)	6 (6%)
Total	58 (58%)	42 (42%)	100 (100%)
	Chi square test value = 20.26, p = 0.017*		

**p < 0.05 is significant*

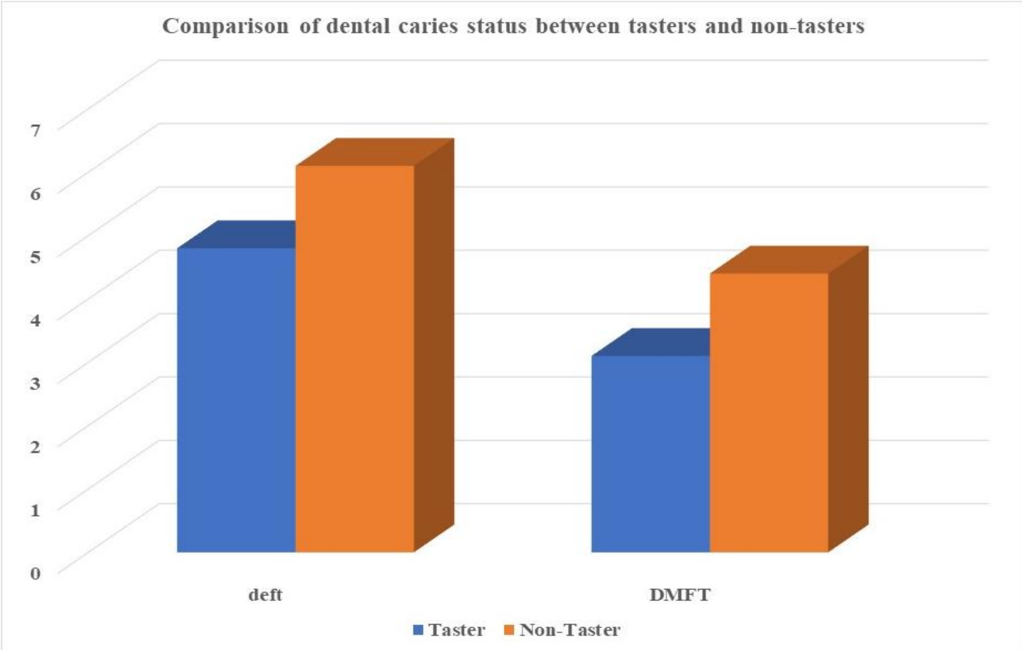


Graph 1. BMI categories distribution in taster and non-taster

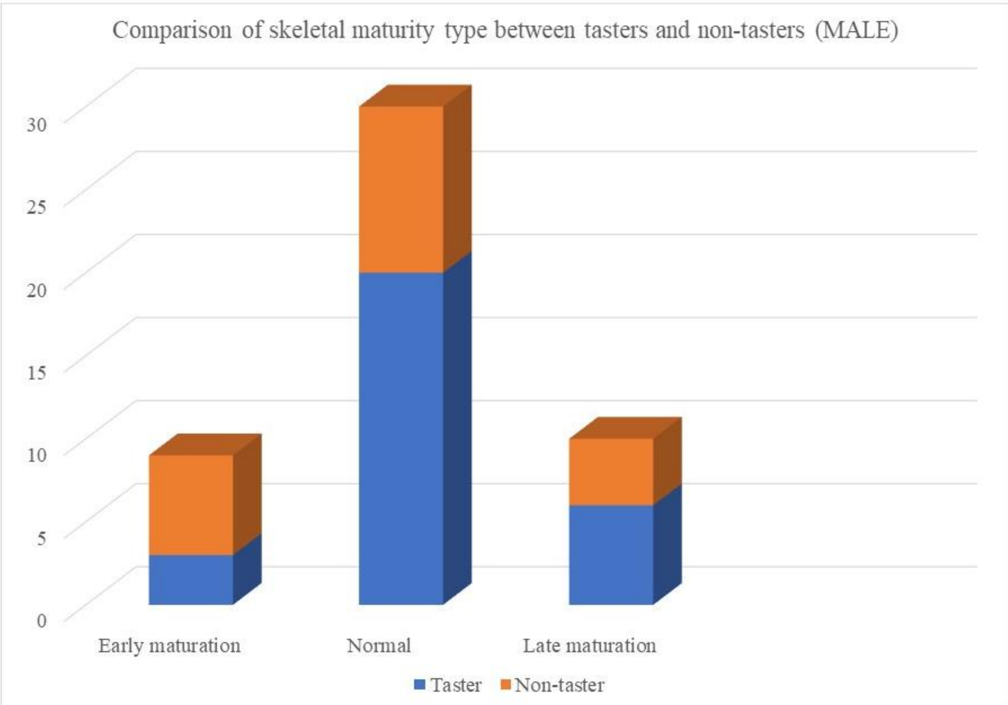
Table 3. Comparison of dental caries status between tasters and non –tasters

	Taster Mean (SD)	Non-taster Mean (SD)	Unpaired t test	p value, Significance
dmft	4.8 (1.86)	6.1 (2.31)	t = - 14.05	p = 0.001*
DMFT	3.1 (1.29)	4.3 (1.94)	t = -9.83	p =0.021*

$p < 0.05$ is significant



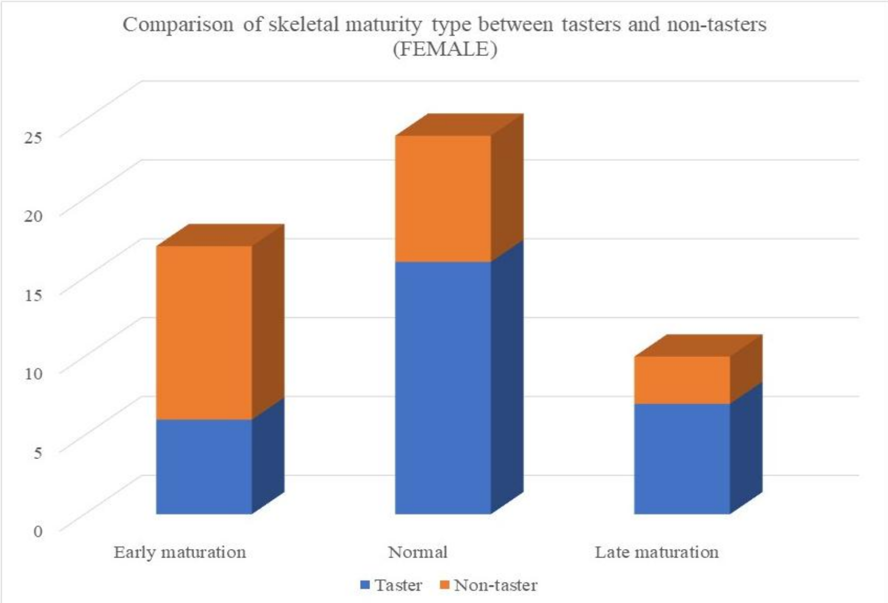
Graph 2. Comparison of dental caries status between tasters and non-tasters



Graph 3. Comparison of skeletal maturity type between tasters and non tasters(Male)

Table 4. Comparison of skeletal maturity type between tasters and non –tasters

	BOYS		GIRLS		Total
	TASTER	NON -TASTER	TASTER	NON -TASTER	n (%)
Early maturation	3 (10.35%)	6 (30%)	6 (20.7%)	11 (50%)	26 (26%)
Normal	20 (69%)	10 (50%)	16 (55.2%)	8 (36.4%)	54 (54%)
Late maturation	6 (20.65%)	4 (20%)	7 (24.1%)	3 (13.6%)	20 (20%)
Total	29	20	29	22	100 (100%)



Graph 4. Comparison of skeletal maturity type between tasters and non tasters(Female)

Half of the girls in the non-taster group showed early skeletal maturation than their chronological age. In 36.4% of girls skeletal maturation was according to their chronological age. Only 13.6% had late maturation. In tasters group 55% girls had normal skeletal maturation, 20.7% had early maturation and 24.1% showed late maturation. For boys, this difference was not that significant. In non-tasters group, 50% boys had normal maturation, 30% had early maturation and remaining showed late maturation. Boys in taster group showed 69% normal maturation, 10.35% early maturation and 20.65% late maturation. But compared to non-tasters, boys in taster group showed late maturity. Thus overall result from skeletal maturation for both boys and girls suggest that tasters had late maturation and non-tasters show early maturation; the difference being more elucidative in girls (Table 4) and (Graphs 3 & 4).

4. DISCUSSION

Time and now the importance of genetics have been evoked but the vague and incomplete understanding of its role has made pioneers of dental research to take a peek into this huge potential trove. Genes influence many aspects of eating behaviour, including taste sensitivity, preferences and rejections for food and meal patterns. Inherited behaviour and taste thresholds may play an important role in the frequency of carbohydrate intake [22]. PTC is a member of the large family of anti thyroid molecules which occurs naturally in many foods and is ingested by humans in varying amounts. Although it has a bitter taste to most people, there is a sizeable minority in the population who either cannot taste it or require higher concentrations to recognize its presence. This difference between individuals is genetically determined, where non-tasting depends on homozygosity for a recessive allele [23].

This study was carried out to see the taste perception among young children and finding its relation with their dental caries status, skeletal maturation and BMI percentile. Children less sensitive to the bitter taste of PTC were directly associated with a higher BMI percentile i.e.

evidence suggesting bitter tasting ability may be related to body mass index (BMI). Present study found a significant association between BMI percentile and PTC sensitivity for children. In the overweight and obese category higher percentage of children belonged to non-taster group, whereas in underweight category more of the children belonged to tasters group. This significant linking of taste perception to body weight may be associated with the dietary carbohydrate intake or rejection. High preferences of fatty food may develop the risk of obesity. Trigeminal input has the ability to perceive textural cues (creaminess and oiliness), which are less in non-tasters. Non-tasters have fewer taste buds to stimulate trigeminal input and hence need high quantity of food to get the same level of satisfaction seen in the tasters [24]. A study conducted by Hegde and Sharma also reported that obese and overweight children were mostly non-tasters and they preferred the sweet and fatty foods [19]. Similar result was reported by Keller et al. [24].

Dental caries thought to be a dietary-related disease; children's dietary habits largely influence their risk of developing caries. Tooth decay is a major global health problem and is estimated to affect about 60-90% of school children and many adults [12]. The results of the current study indicated that there was a significant difference in the prevalence of tooth decay among tasters and non-tasters. Non-tasters had significantly higher DMFT/deft score than tasters. Tasters might avoid sweet food because their oral sensations are too intense and thus less pleasant to accept the intensely bitter, strong sweet substances thus making tasters less prone to tooth decay. This could also be attributed to the number and distribution of fungiform papillae on the tongue. The number of fungiform papillae is related to genetic variation in the ability to taste. Tasters have a higher growth of fungiform papillae as compared to non-tasters [23]. On the other hand, the non-taster children prefer a higher concentration and higher frequency of sugar intake compared to children who are tasters, making them more susceptible to dental caries [16]. Studies done by Furquim et al. [18] and Pidamale [25] also showed that non-tasters were more likely to have tooth decay than tasters. Wendell et al. [26] found that AVI/AVI (non-tasters) genotype have been more susceptible to caries and explained this by food preferences and food habits. Yildiz et al. [11] found that many environment and genetic factors including TAS2R38 (A49P), and CA6 (T55M) gene polymorphism, interact with each other and explained higher DMFT scores in Turkish adults on this basis. This relationship of PTC tasting and dental caries has been studied at molecular level [26]; the results showed that people with the genotype AVI may be more likely to develop dental caries than the PAVs who may be more protected. Also, different immunity response had been found among different types of both genotypes of TAS2R38 (PAV, AVI) against bacteria causing respiratory infections [27-28] and dental caries [29].

Every individual follows his or her own biological clock of maturation. Skeletal maturity assessment involves radiographic inspection of the developing bone and their initial appearance, sequential ossification, and related changes in shape and size. Thus, the skeletal maturity indicators provide an objective diagnostic evaluation of maturity stage in an individual. In an attempt to determine the best indicator of maturity, various authors have reported different maturity indicators. These include biological age or physiological age, chronological age, [30,31] height, weight, [32,33,34] frontal sinus [35], sexual maturation [32] hand-wrist maturity [36], cervical vertebrae [37] dental eruption, MP3 evaluation, dental calcification [38] and biomarkers [39]. In 1982 Hagg and Taranger developed a skeletal maturity indicator involving the assessment of certain specified stages of the three epiphyseal bones: middle phalanges and distal phalanges of third finger (MP3 and DP3) and distal epiphysis of radius (R). Rajgopal and Kansal in 2005 modified the stages of MP3 in the Hagg and Taranger method. This made the method more reliable, reproducible and is an improved version that describes distinct changes in the metaphyseal region. Also it provides an advantage of minimum exposure to X-rays. Children were categorised as late, normal or early in maturation according to study done by Javangula PT et al. [40] on the South Indian population. The results of the present study depict that non-tasters had early maturation than the tasters. Based on the results of study conducted by Hedayati and Khalafinejad17it is clear that increasing BMI percentile accelerates dental age and may affect treatment timing such as that in serial extraction or space maintenance.

The present study determines that PTC sensitivity reveals many aspects regarding the growth, development, maturation and even the dental caries experience of a child. The results of a study done by Verma P et al. [41] suggested that there was an increase in the caries experience and S. mutans levels among the group of non tasters as compared to tasters and also tasters tended to be sweet dislikers and non tasters liked the sweets more.

If the dental caries have such a strong association with the taste perception then we can think of utilising the PTC sensitivity as a potential caries risk assessment tool. Also, it is a genetically determined trait which can be easily assessed at an early age, hence can guide the pedodontist to plan the preventive approach for the child accordingly. As this trait has shown significant relation with body weight, it can steer the pedodontists to provide suitable diet counselling keeping in mind the tasting ability of the child. This can help to avoid childhood obesity, especially in non-tasters. For the success of orthodontic treatment, it is very important to understand the growth pattern of a child. Utilisation of growth spurts marks a cornerstone for growth modification orthodontic treatments. As PTC sensitivity has shown association with the skeletal and dental maturation, it can aid the dentists to plan early orthodontic interventions in the non-tasters to utilise the early growth spurt in them.

Further studies with larger sample size and in different populations of the world must be conducted to understand this genetic trait in detail and its effects on various aspects of a growing child. Taste perception can evolve as a promising augment to enhance the dental treatments for a child.

5. CONCLUSION

There exists a relationship of tasting ability with dental caries experience, skeletal maturation and BMI. Just by a simple PTC test at early age we can improve our clinical practice in many ways. Within the limitations of this study, we can conclude that, in the given population, tasters were more than the non-tasters. Also, dental caries experience was higher among the non-tasters compared to tasters. BMI percentile of tasters was lower than the non-tasters. Skeletal maturity was earlier in non-tasters than tasters, which was more significant in girls.

CONSENT

Informed consent was obtained from the parents and ascent from the participants.

ETHICAL APPROVAL

After obtaining the Institutional Ethical Clearance the study was conducted.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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