ORIGINAL RESEARCH

Assessment of Correlation between Genetic Taste Perception Hormonal Fingerprint and Dental Caries Incidence in Schoolgoing Children: An *In Vivo* Study

Anika Kulshrestha[1], Preetam Shah[2], Chetana Jagtap[3], Smita Patil[4], Sanket Kunte[5], Shweta Chaudhary[6]

Abstract

Background: Genetic predilection toward sweeter cariogenic foods mediated by the *TAS2R38* gene, tested by phenylthiourea [phenylthiocarbamide (PTC)] compounds. Some individuals find it extremely bitter whereas some find it completely tasteless, being classified as a taster and a nontaster respectively. A majority of nontasters prefer foods with sweeter and stronger flavors, thus making them more susceptible to dental caries. Genetic taste perception is greatly influenced by prenatal androgen exposure represented by hormonal fingerprint, that is, ratio of second to fourth digit lengths (2D:4D ratio), thus making it a precise biomarker to quantify an individual's genetic taste perception and in turn their caries susceptibility.

Aim: To find a correlation of genetic taste perception with the hormonal fingerprint and dental caries prevalence in children.

Materials and methods: A total of 96 children were selected at random for the study and divided into two groups based on their gender. A genetic taste perception test was carried out using PTC strips, and they were classified as tasters and nontasters. Then, the hormonal fingerprint was recorded by calculating the ratio of the index finger and ring finger. Following this, decayed, missing, and filled teeth index (DMFT) was recorded.

Results: A strong positive correlation was observed among nontasters, with a preference for sweeter foods associated with a high caries index. Conversely, no relationship was found between genetic taste perception and the hormonal fingerprint.

Conclusion: The present study positively demonstrates an association of genetic taste perception and dental caries due to an increased preference for sweeter foods among nontasters. Although no correlation was found between the genetic taste perception, the hormonal fingerprint, and the dental caries status of an individual.

Keywords: Dental caries, Hormonal fingerprint, Genetic taste perception.

International Journal of Clinical Pediatric Dentistry (2024): 10.5005/jp-journals-10005-2893

Introduction

Dental caries is a widespread chronic infection caused by cariogenic bacteria that adhere to teeth, primarily comprising *Streptococcus mutans*. These microorganisms break down sugars into acid over time, demineralizing the tooth's structure, thus causing dental caries. As one of the most prevalent diseases in the world, it presents a significant healthcare challenge. This crippling dental condition affects almost the entire population.[1] By implementing proper preventative measures tailored to each individual's needs, this condition can be successfully prevented. To achieve this, it is first necessary to identify the interindividual differences that predispose some individuals to a higher incidence of caries.

Numerous studies have demonstrated that our dietary habits are genetically predetermined and consequently influence how someone experiences caries. The *TAS2R38* gene mediates the genetic influence on how bitter tastes are perceived. This gene controls the insensitivity to bitter tastes, such as 6-*n*-propylthiouracil (PROP) and phenylthiourea [phenylthiocarbamide (PTC)]. Some people find these substances to be very bitter, while others find them tasteless. These individuals can be classified as tasters and nontasters, respectively. Individuals who are categorized as tasters have a reduced tolerance for extremely potent flavors and prefer more delicate flavors. Most nontasters enjoy sweet and strong flavors in their cuisine. This preference increases the risk of dental caries in nontasters. Hence, the provision of this particular test proves to be an essential aid in identifying children at risk and giving them the necessary preventive treatments.[2]

A sexually dimorphic feature that is lower in males than in females is the ratio of second to fourth digit lengths (2D:4D ratio). Typically, the second (index) finger is shorter than the fourth (ring) finger. It is believed that prenatal sex hormone regimens have an impact on sexual dimorphism with regard to the 2D:4D digit ratio. A low (masculine) digit ratio may result from high prenatal androgen levels. According to the literature, prenatal androgens are exposed to the fetus while it is within the womb, and the concentration of this exposure determines how they perceive flavor, which in turn affects their oral health.[3]

[1–6]Department of Pediatric and Preventive Dentistry, Dental College and Hospital, Bharati Vidyapeeth (Deemed to be University), Pune, Maharashtra, India

Corresponding Author: Anika Kulshrestha, Department of Pediatric and Preventive Dentistry, Dental College and Hospital, Bharati Vidyapeeth (Deemed to be University), Pune, Maharashtra, India, Phone: +91 9643621290, e-mail: anikakulshrestha97@gmail.com

How to cite this article: Kulshrestha A, Shah P, Jagtap C, *et al.* Assessment of Correlation between Genetic Taste Perception Hormonal Fingerprint and Dental Caries Incidence in Schoolgoing Children: An *In Vivo* Study. Int J Clin Pediatr Dent 2024;17(6):690–694.

Source of support: Nil

Conflict of interest: None

The application of indicators like genetic taste perception and hormonal fingerprint helps to understand an individual's caries risk and apply appropriate preventive strategies.

Materials and Methods

Source of Data

The sample size was estimated using the data obtained from a previous study conducted by Lakshmi et al.[4] Considering the proportions among two groups (0.281 and 0.552), keeping the α error at 0.05 and power at 80%, the estimated sample size was 48 per group, making a total of 96 children recruited for the study. The study was conducted at Department of Pediatric and Preventive Dentistry, Dental College and Hospital, Bharati Vidyapeeth (Deemed to be University), Pune, Maharashtra, India. Children aged between 6 and 14 coming to the outpatient department (OPD) were selected randomly and assigned to a group based on their gender.

Inclusion criteria for the study included children between the ages of 6 and 14, children with stable mental health, children without a documented history of PTC allergies, and children not enrolled in any caries prevention initiatives. Exclusion criteria included children without parental consent, those with systemic diseases, those whose mental state was not stable, those taking antidepressants and antibiotics, children receiving orthodontic treatment, and children with overactive gag reflexes.

Study Design

Children coming to the dental OPD, meeting the inclusion criteria and with consenting parents, were divided into groups based on their biological gender, that is, male or female. The first test performed was the determination of their genetic taste perception using PTC strips (Trade Name: PL Precision Laboratories–PTC Test Paper). The child was asked to hold out their tongue, and the strip was placed on the anterior part and tip of the tongue due to the high concentration of filiform papillae in this region. Any sensation of bitter taste was considered a positive response, and the subject was classified as a taster. Nontasters gave a null response to the taste test and only perceived a paper-like taste sensation (Fig. 1).

The hormonal fingerprint was recorded using a vernier caliper, measuring from the midpoint of the ventral proximal crease of the digit to the tip of the digit of the right hand. In cases where multiple creases were present, the lowermost crease was used for measurement. The 2D:4D ratio was calculated, followed by the distribution of subjects according to a low digit ratio if <1 and a high digit ratio if ≥1 (Fig. 2).

Following this, a brief diet history was recorded to determine the individuals' preference for sweeter foods and stronger flavors, along with a clinical examination. The caries experience [decayed, missing, and filled teeth index (DMFT)/deft index] was recorded, and subjects with a total DMFT/deft score of >5 were considered to have a high caries rate. Both of these parameters were recorded last to eliminate the risk of operator bias.

Data was analyzed using Statistical Package for the Social Sciences version 23 software, keeping the level of significance at 5%.

Results

The majority of the population belonged to the taster group (54%). Females showed a higher percentage of tasters (64.6%) compared to males (43%), although the difference was statistically insignificant (Table 1).

Around 97.7% of nontaster subjects showed a significant preference for the consumption of sweeter and stronger flavors, compared to 32% of tasters with these dietary preferences (Table 2).

The association of caries status with taste perception showed that 22 nontaster subjects (50%) had severe caries status, whereas 21 taster subjects (40.4%) had low caries status. Twenty nontaster subjects (45.5%) had moderate caries status, whereas 19 taster subjects (36.5%) had moderate caries status. This difference in caries status between taster and nontaster subjects was significant (Table 3).

The digit ratio comparison between males and females showed a nonsignificant difference. The association of caries status with digit ratio revealed that the majority of subjects with a high digit ratio had either low caries (33.3%) or moderate caries (42.4%); whereas, the majority of subjects with a low digit ratio had either moderate caries (39.7%) or severe caries (41.3%) status. However, this difference in caries status between subjects with high and low digit ratios was nonsignificant (Tables 4 and 5).

Fig. 1: Testing for genetic taste perception using commercially available PTC strips

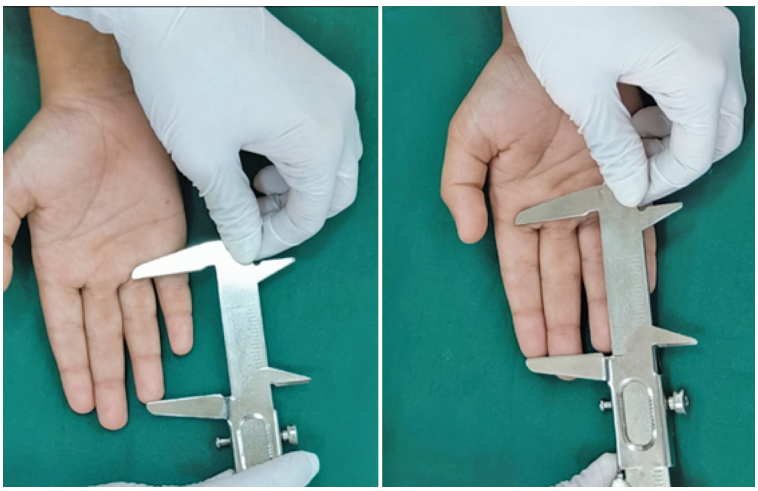

Fig. 2: Measurement of hormonal fingerprint

Table 1: Gender based distribution of genetic taste perception

Group		*Nontaster*	*Taster*	*p-value*
Female	*n*	17	31	0.065
	%	35.40%	**64.60%**	
Male	*n*	27	21	
	%	**56.30%**	43.80%	
Total	*n*	44	52	
	%	45.80%	54.20%	

Chi-squared test; Bold values indicate higher percentage of female tasters

Table 2: Association of genetic taste perception and preference of sweeter foods

Sweet likers		*Disliker*	*Liker*	*p-value*
Nontaster	*n*	1	43	<0.001*
	%	2.30%	**97.70%**	
Taster	*n*	35	17	
	%	**67.30%**	32.70%	
Total	*n*	36	60	
	%	37.50%	62.50%	

Bold values indicate higher percentage of nontasters showing a higher preference for sweeter foods; *signifies a statistically significant difference

Table 3: Association of genetic paste perception with caries status

Group		*Low*	*Moderate*	*Severe*	*p-value*
Nontaster	*n*	2	20	22	<0.001*
	%	**4.50%**	45.50%	50.00%	
Taster	*n*	21	19	12	
	%	**40.40%**	36.50%	23.10%	
Total	*n*	23	38	34	
	%	24.20%	40.00%	35.80%	

Chi-squared test; Bold values indicate low caries prevalence in nontasters; *signifies a statistically significant difference

The comparison of digit ratio with the taste test showed that the majority of taster subjects had a high digit ratio (66.7%), whereas the majority of nontaster subjects had a low digit ratio (52.4%) or severe caries (41.3%) status. However, this difference in the taste test between subjects with high and low digit ratios was nonsignificant.

Table 4: Association of caries status with digit ratio

Digit ratio		*Low*	*Moderate*	*Severe*	*p-value*
High	*n*	11	14	8	0.161
	%	33.30%	42.40%	**24.20%**	
Low	*n*	12	25	26	
	%	19.00%	39.70%	**41.30%**	
Total	*n*	23	39	34	
	%	24.00%	40.60%	35.40%	

Chi-squared test; Bold values indicate higher caries prevalence in children with low digit ratio

Table 5: Association of digit ratio and genetic taste perception

Digit ratio		*Nontaster*	*Taster*	*p-value*
High	*n*	11	22	0.088
	%	33.30%	**66.70%**	
Low	*n*	33	30	
	%	**52.40%**	47.60%	
Total	*n*	44	52	
	%	45.80%	54.20%	

Chi-squared test; Bold values indicate association of high digit ratio with taster status

Discussion

Dental caries is a posteruptive bacterial infectious illness that negatively impacts the mineralized dental tissues through a gradual demineralization process. It is said to be one of the most prevalent oral ailments in the world and the primary cause of tooth loss. Dental caries is caused by a combination of physical, biological, environmental, and behavioral factors related to a person's lifestyle, such as the quantity and strains of cariogenic bacteria, low salivary flow, and an individual's exposure to insufficient fluoride, poor oral hygiene, and food preferences. Each of these elements impacts individuals distinctively.[5] Saliva has been proposed as a potential biomarker after a recent study by Hegde et al. revealed a link between organic-inorganic components of saliva and dental caries.

It is essential to find a biomarker useful for caries risk assessment that is consistent and stable throughout life.[6]

The aim of this study was to find associations of certain biomarkers that may play a role in increasing an individual's susceptibility to dental caries. The biomarkers chosen for the study were hormonal fingerprint (2D:4D ratio) and genetic taste perception.

Globalization-related advances have led to an extraordinarily high incidence of poor eating habits worldwide, particularly in low- and middle-income countries. This has, in turn, elevated morbidity and mortality due to oral health-related problems, primarily dental caries and its sequelae. Prevention of these issues involves designing and implementing public health preventive programs aimed at modifying consumption behaviors and understanding the factors that influence dietary preferences and meal selection.[7] Individual food preferences are important predictors of food intake[8,9] and are highly influenced by taste perception and taste preference. The frequency of carbohydrate consumption may be significantly influenced by inherited behavior and taste thresholds. The tendency of kids to reject certain foods may be influenced by genetic sensitivity to taste.[10] Studies have identified a number of risk factors for dental caries, including a cariogenic diet, a high concentration of cariogenic bacteria, low socioeconomic position, and the influence of taste perception, which may affect food preference or rejection. Thus, being aware of a person's preferences may make it easier to recognize children who are at a greater risk for developing dental caries.[2] Genetic taste perception can be determined by testing for the *TAS2R38* gene, which is responsible for bitter taste perception. Fox, in 1931, noticed that some people find the taste of the chemical molecule PTC to be extremely bitter, while others find it to be tasteless.[11] Two compounds used for this test are PROP and PTC. Bufe et al. found that the association with *TAS2R38* haplotypes was stronger for PTC than for PROP.[12]

There are various methods to test for PTC sensitivity. Early experiments used PTC crystals directly on the tongue in some cases, PTC solutions in others, or PTC-soaked paper that was subsequently dried.[13,14] In the present study, the participants comprised children aged 6–14, who lack the ability to differentiate between two taste sensations that are very close to each other in terms of bitterness. Thus, the PTC-soaked paper method was used instead of the threshold method.

In this study, the gender-based distribution of genetic taste perception showed a higher percentage of female tasters than males in line with the findings by Karmakar et al.,[15] Duffy et al.,[9] Drewnowski et al.,[16] and Dusseja et al.[17] This may be attributed to the presence of more fungiform papillae among females than in males, although the difference was statistically insignificant. As for consumption behaviors, 97.7% of nontasters had a preference for sweeter and stronger-flavored foods, in contrast with only 32% of sweet-liking individuals in the taster group. The nontaster subjects also showed a significantly higher level of dental caries compared to the taster subjects, which can be attributed to the preference for sweeter foods by nontasters, in conjunction with studies done by Shetty et al.,[18] Lakshmi et al.,[4] Karmakar et al.,[15] and Dusseja et al.[17] These findings suggest a strong positive correlation between genetic taste perception and dental caries, which can be attributed to the preference for sweeter foods by non-taster group participants.

An additional biomarker chosen for the study was the hormonal fingerprint, that is, 2D:4D ratio, a prospective marker for prenatal hormone exposure as well as the expression of the homeobox (HOX) and androgen receptor genes. According to the data, the 2D:4D ratio can be an essential determinant of how prenatal sex hormones act on the body, brain, and behavior, in addition to taste perception. The results of the present study reveal a nonsignificant difference in digit ratio in males and females in contrast to studies by Manning et al.,[19] Fink et al.,[20] Lakshmi et al.,[4] Verma and Hegde,[21] and Dusseja et al.[17] Most of the participants with low to moderate caries status belonged to the high digit ratio group, whereas the majority of those with low digit ratios showed either severe or moderate caries. However, these differences were statistically nonsignificant, as also found by Pallepati and Yavagal[22] in his cross-sectional survey. Upon comparing the digit ratios and genetic taste perception, the majority of tasters had a high digit ratio, whereas the majority of nontaster subjects showed a low digit ratio. However, the difference was statistically insignificant. These results are in line with the study conducted by Pallepati and Yavagal[22] and in contrast to the studies conducted by Verma and Hegde,[21] and Lakshmi et al.,[4] who found that children with low digit ratio had more caries incidence than those with high digit ratio.

Conclusion

The present study positively demonstrates an association between genetic taste perception and dental caries due to an increased preference for sweeter foods among nontasters. However, no correlation was found between genetic taste perception, the hormonal fingerprint, and the dental caries status of an individual.

Clinical Significance

The study presents a new approach and technique that can effortlessly add a new dimension to chairside caries risk assessment tools. A simple strip test can aid in designing preventive strategies, modifying diets, and providing specialized treatment, as well as scheduling recall visits for not just oral health but also the overall health and well-being of tiny tots.

Orcid

Anika Kulshrestha https://orcid.org/0000-0001-7224-1266

References

1. Arshad AI, Ahmad P, Dummer PMH, et al. Citation classics on dental caries: a systematic review. Eur J Dent 2020;14(1):128–143. DOI: 10.1055/s-0040-1703419
2. Lin BP. Caries experience in children with various genetic sensitivity levels to the bitter taste of 6-n-propylthiouracil (PROP): a pilot study. Pediatr Dent 2003;25(1):37–42.
3. Rajawat A, Majeti C, Podugu UK, et al. Association of hormonal fingerprints and dental caries: a pilot study. J Conserv Dent 2020;23(4):337–340. DOI: 10.4103/JCD.JCD_367_20
4. Lakshmi CR, Radhika D, Prabhat M, et al. Association between genetic taste sensitivity, 2D:4D ratio, dental caries prevalence, and salivary flow rate in 6–14-year-old children: a cross-sectional study. J Dent Res Dent Clin Dent Prospects 2016;10(3):142–147. DOI: 10.15171/joddd.2016.023
5. Kazeminia M, Abdi A, Shohaimi S, et al. Dental caries in primary and permanent teeth in children's worldwide, 1995 to 2019: a systematic review and meta-analysis. Head Face Med 2020;6(16):22. DOI: 10.1186/s13005-020-00237-z
6. Hegde MN, Attavar SH, Shetty N, et al. Saliva as a biomarker for dental caries: a systematic review. J Conserv Dent 2019;22(1):2–6. DOI: 10.4103/JCD.JCD_531_18

7. Diószegi J, Llanaj E, Ádány R. Genetic background of taste perception, taste preferences, and its nutritional implications: a systematic review. Front Gene 2019;10:1272. DOI: 10.3389/fgene.2019.01272
8. Glanz K, Basil M, Maibach E, et al. Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. J Am Diet Assoc 1998;98(10):1118–1126. DOI: 10.1016/S0002-8223(98)00260-0
9. Duffy VB, Hayes JE, Davidson AC, et al. Vegetable intake in college-aged adults is explained by oral sensory phenotypes and TAS2R38 genotype. Chemosen Percept 2010;3(3-4):137–148. DOI: 10.1007/s12078-010-9079-8
10. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. Pediatrics 1998;101(3 Pt 2):539–549.
11. Fox AL. The relationship between chemical constitution and taste. Proc Natl Acad Sci U S A 1932;18(1):115–120. DOI: 10.1073/pnas.18.1.115
12. Bufe B, Breslin PA, Kuhn C, et al. The molecular basis of individual differences in phenylthiocarbamide and propylthiouracil bitterness perception. Curr Biol 2005;15(4):322–327. DOI: 10.1016/j.cub.2005.01.047
13. Hartmann G. Application of individual taste difference towards P.T.C. in genetic investigations. Ann Human Genet 1939;9(2):123–135. DOI: 10.1111/j.1469-1809.1939.tb02202.x
14. Lawless H. A comparison of different methods used to assess sensitivity to the taste of phenylthiocarbamide (PTC). Chem Senses 1980;5:247–256.
15. Karmakar P, Arora R, Patel C, et al. Caries risk in children of Udaipur City, India using genetic taste sensitivity to 6-n-propylthiouracil. J Int Soc Prev Community Dent 2016;6(6):523–528. DOI: 10.4103/2231-0762.195508
16. Drewnowski A, Henderson SA, Barratt-Fornell A. Genetic taste markers and food preferences. Drug Metab Dispos 2001;29(4 Pt 2):535–538.
17. Dusseja SH, Rao D, Panwar S, et al. Determining caries risk susceptibility in children of Udaipur city with genetic taste sensitivity and hormonal fingerprint. J Indian Soc Pedod Prevent Dent 2021;39(1):36–41. DOI: 10.4103/jisppd.jisppd_527_20
18. Shetty V, B L P, Hegde AM. PROP test: prediction of caries risk by genetic taste perception among the visually impaired children. Spec Care Dentist. 2014;34(1):34–40. DOI: 10.1111/j.1754-4505.2012.00307.x
19. Manning JT, Scutt D, Wilson J, et al. The ratio of 2nd to 4th digit length: a predictor of sperm numbers and concentrations of testosterone, luteinizing hormone and oestrogen. Hum Reprod 1998;13(11):3000–3004. DOI: 10.1093/humrep/13.11.3000
20. Fink B, Neave N, Manning JT. Second to fourth digit ratio, body mass index, waist-to-hip ratio, and waist-to-chest ratio: their relationships in heterosexual men and women. Ann Hum Biol 2003;30(6):728–738. DOI: 10.1080/0301446031000162015 3
21. Verma P, Hegde AM. Digit ratio and dental caries: a sexually dimorphic trait. Int J Clin Pediatr Dent 2018;11(1):1–6. DOI: 10.5005/jp-journals-10005-1474
22. Pallepati A, Yavagal PC. Assessment of 2D:4D ratio among 14–16 year old school students with different genetic sensitivity to bitter taste of 6-N propylthiouracil – A cross sectional survey. Glob J Res Anal 2018;7:82–84.