



Caries experience in children with various genetic sensitivity levels to the bitter taste of 6-n-propylthiouracil (PROP): a pilot study

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Abstract

Purpose: The objective of this pilot study was to determine the prevalence of coronal dental caries among children with different genetic sensitivity levels of taste, as determined by 6-n-propylthiouracil (PROP).

Methods: Coronal caries and restorations in permanent and primary dentition were evaluated in 150 healthy school-aged children aged 6 to 12 years. A filter paper containing 6-n-propylthiouracil was used to determine each subject's genetic ability to taste bitter and sweet substances. Supertasters perceived stronger tastes from a variety of bitter and sweet substances than both medium tasters and nontasters. The data were analyzed by ANOVA with Duncan's multiple range test, Mantel-Haenszel chi-square, multiple linear regression analyses, and Pearson's coefficient of correlation.

Results: The nontasters had more mean decayed, missing, and filled surfaces (dfs/DMFS) than tasters. The values of mean decayed and filled surfaces of primary dentition and mean decayed, missing, and filled surfaces of permanent dentition (dfs/DMFS) and mean decayed surfaces of primary dentition and permanent dentition (ds/DS) were significantly higher in nontasters than in medium tasters, and in medium tasters compared with supertasters. After adjusting for missing teeth, the data were expressed as a percentage of the available surfaces, and the significant differences in dfs/DMFS and ds/DS persisted ($r=-0.49$, $P<.001$ and $r=-0.51$, $P<.0001$ respectively).

Conclusions: After all associated factors were controlled, taste was the only independent variable significantly related to overall caries experience. The results of this study suggested an increased prevalence of overall caries experience in nontaster children. (*Pediatr Dent.* 2003;25:37-42)

KEYWORDS: DENTAL CARIES, TASTE, CLINICAL EPIDEMIOLOGY, CHILDREN

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Studies on the trends of untreated caries in children have indicated an improvement in dental health among US children since the 1970s.^{1,2} Despite recent declines in dental disease due to better dental awareness and prevention,³ the high prevalence of dental caries among school-aged children still poses a significant health problem in the United States. The development of dental caries is dependent on critical interrelationships between susceptible host/tooth surface, specific oral bacteria, and dietary carbohydrates.⁴ Therefore, higher and more frequent sugar intake in children may increase the risk of caries formation.

Attempts have been made to identify children with a high predisposition for dental caries, such as the level of mutans streptococci and lactobacilli,^{5,6} social-economic factors,⁷ past caries experience,⁸ and the frequency and amount of sugar intake.^{5,6,9,10} Several recent studies have indicated that children with high sugar intake have higher caries rates.^{5,6,11} Lehl et al, reported that a high decayed, missing, and filled permanent teeth (DMFT) index (>3) in a group of 4- to 12-year-old children is positively related to sweet score and total sugar exposures.⁹ In an investigation evaluating the relationship between dental caries and dietary

habit (3-day food intake diary) in 500 children with ages ranging between 2 and 13 years, Eronat and Koparal concluded that the prevalence of caries was increased by frequent and high sugar consumption.¹² Further, in a cross-sectional study, Garcia-Closas et al, suggested that a high intake of sweetened baked goods might be a determinant of caries prevalence in children with moderate-to-high salivary counts of *Streptococcus mutans*.¹¹

Studies have found that high sugar intake reflects a preference for sweet substances among a majority of children.^{9,13} However, the physiological mechanisms that affect a child's craving for sweet substances were not well documented. Inherited behavior and taste thresholds may play an important role in the frequency of carbohydrate intake. Genetic sensitivity to taste may be associated with a preference for or rejection of some foods by children.¹⁴

Sensitivity to taste is an inherited trait in children. Children can be supertasters, medium tasters, or nontasters, as determined by the subject's taste threshold.¹⁵ PROP (6-n-propylthiouracil) paper is a useful tool in determining genetic sensitivity to bitter and sweet tastes, as well as the burn sensation.¹⁶ In clinical practice, PROP is a medication used in the treatment of Grave's Disease (hyperthyroidism), and the therapeutic dosage is 150 to 200 mg daily for adults and 50 to 150 mg daily for children aged 6 to 10 years.¹⁷ However, PROP can be tasted at very low concentrations, and the filter paper used for taste research only contains approximately 1.6 mg of PROP. The subset of the population who rate PROP paper as intensely bitter are identified as supertasters.¹⁸ A supertaster child is able to perceive stronger bitter and sweet tastes, as well as more burn from oral irritants, compared to children who are medium tasters and nontasters.¹⁶ Anatomically, supertasters also have a higher density of taste receptors on the anterior portion of the tongue than nontasters.

Anliker's study evaluated 34 children aged 5 to 7 years.¹⁴ The tasters had less preference for food products (eg, cheese) with stronger tastes than nontasters. Since supertasters are able to perceive taste in a lower concentration of bitter or sweet substance than nontasters, food products with strong tastes may be perceived as too strong or unpleasant for supertasters. In contrast, nontasters may not be able to perceive the sweet or bitter taste in the same concentration as supertasters, and hence, require a higher concentration to perceive taste in the food products. Nontaster children may have a higher concentration and frequency of sugar intake compared to children who are medium tasters or supertasters, and are therefore, more susceptible to dental caries. Knowledge of an individual's taste threshold facilitates the identification of children who are at high risk for developing dental caries.

Most of the studies on taste and oral health have been conducted on older adults. There is a relative paucity of studies in the dental literature with respect to the relationship between oral health and taste in children. A child's

preference for sugar may lead to compromised oral health.^{5,6,11,12} The purpose of this pilot study was to determine the prevalence of supertasters and nontasters among a group of school-aged children and to contrast the prevalence of dental caries in children with different genetic sensitivity levels to the bitter taste of PROP. It was hypothesized that a higher prevalence of dental diseases would be observed among nontaster children compared to children who were medium tasters and supertasters.

Methods

A group of 150 children aged 6 to 12 years who had American Society of Anesthesiologists (ASA) physical status of I to II and stable mental condition and who were not taking any chronic medication were eligible for this pilot study. Informed consent forms were obtained from the parent or guardian prior to beginning the research procedure. Subjects consisted of a convenience sample randomly selected from consecutive children who were not in any acute dental distress and who were seeking a routine dental checkup at St. Barnabas Hospital's dental facilities.

A comprehensive clinical examination was performed by one examiner (B.L.) with the assistance of one recorder. The examiner was trained, and cross-examiner reliability was calibrated with another dentist among 7 subjects for the method of recording restorations and caries lesions.¹⁹ The kappa statistic for coronal-surface assessments was 0.88. All teeth were examined according to NIDR criteria²⁰ for surfaces with coronal-surface caries and restorations. The number of decayed, missing, and filled surfaces (dfs/DMFS) in the coronal portion of each tooth and the percentage of decayed, missing, and filled surfaces (dfs/DMFS%) were determined. Both primary and permanent dentitions were included. Interproximal caries was assessed with routine bitewing radiographs. Codes for sound teeth, primary caries, secondary (recurrent) caries, preventive restorations, permanent restorations, crowns, defective or temporary restorations, and unerupted/inaccessible areas were assigned to each coronal tooth surface. Soft tissue lesions and the simplified oral hygiene index (OHI-S) were noted.²¹ The dental examination was performed in a lighted operatory with direct visual inspection and tactile sensation with a dental explorer and mouth mirror.

Following data collection, the filter paper containing 6-n-propylthiouracil (Pfaltz-Bauer, Waterbury, Conn) was placed on the dorsal surface of the subject's tongue for 30 seconds to determine genetic ability to taste a bitter or sweet substance. When the bitter taste was at a maximum, each subject would rate the intensity of bitterness on the modified Green's scale²² and would be classified into groups of supertasters (>60), medium tasters (12-60), and nontasters (<12). Supertasters perceived stronger tastes from a variety of bitter substances, as well as sweet substances.

All cross-sectional data were entered into a database on Microsoft Excel and analyzed with the SAS software

program²³ using ANOVA with Duncan's multiple range test, Mantel-Haenszel chi-square, multiple linear regression analyses, and Pearson's coefficient of correlation. Differences were accepted as statistically significant at $P<.05$.

Results

Study population

The sample population was comprised of 150 healthy school-aged children aged 6 to 12 years (Table 1). Among these, 16 subjects were nontasters (11%) and 47 subjects were supertasters (31%). Supertasters accounted for approximately one-third of the sample population. Male subjects predominated in both the nontaster and medium taster groups, while female subjects made up the majority of supertasters. Among female subjects, supertasters composed more than one-third of the group. Most of the participants in this study were of Hispanic origin ($N=123$). The mean age was equivalent for nontasters (8 years), medium tasters (9 years), and supertasters (9 years). For nontasters, the mean number of natural teeth present was 23, and the mean OHI-S was 0.88. Supertasters tended to have more teeth (24) and better oral hygiene (OHI-S=0.26). However, the differences were not statistically significant.

Siblings

A total of 121 families participated in the study. Among these, 25 families had 2 or more siblings and 4 families had 3 siblings (Table 2). Within the sibling groups, half of the sibling pairs (13/25) were in the same taste category (3 pairs in the supertaster group and 10 pairs in the medium taster group). The mean age, level of taste, number of teeth, and overall caries experience were equivalent for the subset of the sample population with siblings and those in the single-sibling sample. Since the sample characteristics were similar among populations with and without siblings, the contrast of caries experiences among supertasters, medium tasters, and nontasters was only analyzed in the total sample population ($N=150$).

Supertasters vs medium tasters vs nontasters among the sample population

The prevalence of coronal caries experience was contrasted among supertasters, medium tasters, and nontasters by one-way ANOVA tests (Table 3). Both primary- and permanent-dentition surfaces were included in the data analyses. Five surfaces of each tooth were evaluated, and the number of decayed, missing, and filled

Table 1. Sample Characteristics of the Study Groups

	Nontasters N=16 (11%)	Medium tasters N=87 (58%)	Supertasters N=47 (31%)
Gender*			
M:F ratio	1.7:1.0	1.5:1.0	0.7:1.0
Male	10 (12%)	52 (63%)	20 (24%)
Female	6 (9%)	35 (51%)	27 (40%)
Race†			
Asian	0 (0%)	3 (3%)	1 (2%)
Black	1 (6%)	14 (16%)	6 (13%)
Hispanic	14 (88%)	69 (80%)	40 (85%)
White	1 (6%)	1 (1%)	0 (0%)
Age‡			
	8±2.0 (6-11)	9±1.9 (6-12)	9±2.0 (6-12)
Teeth§			
	22.9±2.2	23.7±2.1	24.3±2.0
OHI-S			
	0.88±0.7	0.54±0.7	0.26±0.6

*Mean value (percentage among three taster groups).

†Mean value (percentage among individual taster group).

‡Mean value±SD (range).

§Mean value±SD.

||Mean simplified oral hygiene index±SD (range 0-6; 0=excellent/6=poor).

coronal surfaces (dfs/DMFS) was determined. Overall caries experience (dfs/DMFS) was significantly higher for nontasters than tasters. Missing teeth of the primary dentition were not included in the analysis of overall caries experience due to potential bias caused by natural exfoliation of primary teeth.

Table 2. Siblings in Sample Population

Families in sample population	121
Families with siblings	25
Same taste category	13
Different taste category	12
Families with 3 siblings	4
Total no. of sample subjects	150

Table 3. Contrast of Coronal Caries Experience Among Nontasters, Medium Tasters, and Supertasters (mean±SD) by One-way ANOVA Tests with Duncan's Multiple Range Test

	Sample population (N=150)	Nontasters (N=16)	Medium tasters (N=87)	Supertasters (N=47)	P value and pearson (r) correlation coefficient
dfs/DMFS		18.19±13.3	8.87±10.6	1.00±1.7	
dfs/DMFS%	6.76±11.4	17.61±18.2	7.96±11.2	0.84±1.5	$P<.0001$ $r=-0.39$
dfs/DFS		14.75±8.4	7.09±7.1	0.89±1.6	
dfs/DFS%	5.35±7.5	13.81±10.8	6.28±7.0	0.74±1.4	$P<.001$ $r=-0.49$
ds/DS		9.75±6.4	3.79±4.0	0.45±0.9	
ds/DS%	2.91±4.0	8.48±5.6	3.26±3.5	0.38±0.8	$P<.0001$ $r=-0.51$
fs/FS		5.00±8.8	3.30±6.3	0.45±1.3	
fs/FS%	2.44±4.0	5.33±11.0	3.02±6.6	0.36±1.0	$P<.009$ $r=-0.21$
MS		3.44±6.8	1.78±4.8	0.11±0.7	
MS%	1.41±4.7	3.80±8.5	1.68±4.9	0.10±0.7	$P<.007$ $r=-0.22$

There was a pattern of increasing overall caries experience as the genetic ability to detect taste decreased ($r=-0.39$, $P<.0001$). The Pearson (r) correlation coefficient showed a negative (inverse) correlation between 2 variables (level of taste and dfs/DMFS index). After the adjustment for the missing teeth and expressing the caries experience as the percentage of available surfaces (dfs/DFS%), the significant difference persisted ($r=-0.49$, $P<.001$).

When the individual components of dfs/DMFS were assessed separately and expressed as a percentage of available surfaces, ds/DS% and fs/FS% were consistently greatest in nontasters, decreased in medium tasters, and were even lower in supertasters. The difference was statistically significant in ds/DS% ($r=-0.51$, $P<.0001$) among the 3 groups; however, Duncan's multiple range test revealed that the difference observed in fs/FS% was only significant between supertasters and nontasters ($r=-0.21$, $P<.009$). Nontasters also had a higher percentage of missing surfaces (MS%) than medium tasters and supertasters, and the difference was statistically significant between the nontaster and supertaster groups ($r=-0.22$, $P<.007$). After all associated factors (eg, age, gender, race, and OHI-S) were controlled, multiple linear regression analyses revealed that taste was the only independent variable significantly related to overall caries experience ($P<.0001$).

Discussion

In a recent Consensus Development Conference on the Diagnosis and Management of Dental Caries Throughout Life, convened by the National Institutes of Health,⁸ an expert panel pointed out that "effective dentistry requires early identification of children at high risk for extensive caries so that they may receive early and intense preventive intervention. Children at low risk also need to be identified to reduce unnecessary care and expenditures."⁸ The panel recommended that a task force for systemic research on caries-risk assessment be implemented. Studies have identified several indicators for an increased risk of dental caries (eg, low socioeconomic status and past caries experience); however, the influence of taste sensation, which leads to the preference for or rejection of food products, on dental caries in children was not well documented. Knowledge of an individual's taste threshold may facilitate the identification of children who are at high risk for developing dental caries.

This study determined and contrasted the prevalence of coronal caries experience among children who were supertasters, medium tasters, and nontasters. The majority of children who participated in this investigation were medium tasters (58%), followed by supertasters (31%) and nontasters (11%). All subjects received Medicaid benefits and were at or below the national poverty level. The results indicated, in general, that the overall caries experience was significantly higher for nontasters than tasters. There is a pattern of increasing overall caries experience as the genetic

ability to detect bitterness and, in some cases, sweetness of PROP paper decreased. While nontasters had twice as many decayed and filled surfaces (dfs/DFS) as medium tasters, the largest contrast was found between nontasters and supertasters.

In comparison to data from the Third National Health and Nutrition Examination Survey (NHANES III) conducted by the Centers for Disease Control, medium-taster children in the present study had a higher overall caries experience than a similar-aged group of subjects in the national survey, while the mean number of filled surfaces was equivalent among the 2 groups.²⁴

The mean number of untreated carious primary and permanent surfaces of medium tasters (3.79) of this study was higher than that of the US pediatric population at or below the poverty level (2.70; 2.44 for primary tooth surfaces and 0.26 for permanent tooth surfaces).^{1,2} This may be due to the inclusion of older children in the present study (between 6 and 12 years old) compared to those in the national survey (between 6 and 10 years old for primary tooth surfaces and between 6 and 11 years old for permanent tooth surfaces). Older children tended to have more dental caries than younger children.

There was also a difference in racial distribution among the sample population in the present study and NHANES. Eighty-two percent of subjects in the present study were Hispanic-American, while a majority of subjects in the NHANES were Caucasian-American of non-Hispanic origin (68%). One study has indicated that Hispanic-American children, especially those from lower-income households, are more likely than were their African-American and non-Hispanic white counterparts to have untreated caries.⁷

The data from this study also revealed a strong genetic component among sibling pairs within the same family. Among 25 sibling groups, half of the sibling pairs (13/25) were in the same taste category. Genetically, PROP tasting is produced by a dominant allele, T. Subjects with 1 dominant and 1 recessive allele (tT or Tt) or 2 dominant alleles (TT) are tasters. Those with 2 recessive alleles (tt) are nontasters.²⁵ PROP tasting is a useful instrument in determining an individual's genetic sensitivity to bitter and sweet tastes, as well as burn sensation.¹⁶ Barthoshuk et al, found that the bitter tastes of saccharin,²⁶ potassium chloride, sodium benzoate, and potassium benzoate²⁷ are greater for tasters than for nontasters. Later, studies with sweet substances showed that sucrose, saccharin, and neohesperidin dihydrochalcone were sweeter to tasters than to nontasters.²⁸ In the present study, bitterness is the most identified sensation among tasters. Several taster subjects indicated that the PROP solution actually tasted sweet. There were also a few nontaster children who indicated a preference for extremely spicy food.

Women are more likely to be supertasters than men. The anatomical data revealed that women have more fungiform

papillae and more taste buds than men.¹⁶ The gender distribution of subjects in the present study showed that more male subjects were in both nontaster and medium taster groups than female subjects. However, within the supertaster group, more than half of the subjects were female. Among female subjects, supertasters composed more than one-third of the group.

One limitation of the present study was that the racial, socioeconomic, and geographic distribution of the participating subjects might not be applicable to other populations of children. This study sample was predominantly Hispanic-American at or below the national poverty level living in the southern Bronx area of New York City. Another potential limitation of this study may have to do with the small sample size for nontaster children (N=16) as compared to children who were medium tasters (N=87) and supertasters (N=47). Further, there is little information on the ability of children to analyze complex sensitivity chemosensory stimuli in terms of the presence and magnitude of the components. James et al, compared the ability of 95 adults and 8- and 9-year-old children to estimate the sweetness of solutions of several substances using a magnitude estimation procedure alone. Their results indicated that similar response functions were produced by adults and children.²⁹ A modified Green's scale was the standard labeled magnitude scale used as a visual analog in the present study to determine the subject's genetic sensitivity level to the bitter taste of PROP.^{22,30}

The results of this investigation demonstrated statistically significant differences in coronal caries experience among supertaster, medium-taster, and nontaster children. Knowledge of an individual's genetic taste sensitivity may enhance the identification of children who are at high risk of developing dental caries. Hence, an early intensive preventive dental program can be effectively implemented in this group of children. Future investigations utilizing a more objective and precise genetic indicator of taste and using a more representative sample population, as well as correlating other associated factors (eg, behavior, weight, dietary habit, and salivary flow rate), are warranted in children.

Conclusions

After all associated factors (age, gender, race, number of teeth, and OHI-S) were controlled, multiple regression analyses revealed that taste was the only independent variable significantly related to the overall caries experience.

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ABSTRACT OF THE SCIENTIFIC LITERATURE



ASPIRATION IN INFANTS AND CHILDREN

The purpose of this article was to briefly review aspiration in infants and children. The definition of aspiration, its signs and symptoms as well as the mechanism of normal, safe swallowing are described. The consequences of the accidental entry of a foreign substance into the respiratory tract may be devastating, chronic, or subtle, ranging from sudden death to hoarseness. Precise coordinating mechanisms are crucial to prevent aspiration: raising of the soft palate, epiglottic tilt, cord closure, primary peristalsis of the esophagus and the tone and sequential relaxation of the upper and lower esophageal sphincters. Aspiration occurring during swallowing and during episodes of gastroesophageal reflux is also discussed.

Aspiration in preterm infants and older children with swallowing disorders as part of a generalized developmental or neurologic abnormality is described. Swallowing disorders may be the result of such events as hypoxic brain damage, intraventricular bleedings, central nervous system infections, neuromuscular diseases and oropharyngeal anomalies such as cleft palate and Pierre Robin syndrome. Appropriate diagnostic testing for aspiration is discussed.

Comments: Aspiration of liquids, solids and foreign bodies is of concern to the pediatric dentist. This brief article describes and reviews the mechanism of swallowing, types of children with swallowing dysfunctions and appropriate testing and referrals for these children. SS

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0 references; 4 articles for suggested reading