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Miguel V. Crisostomo, Jr., MD
Celso V. Ureta, MD

Department of Otorhinolaryngology
Head and Neck Surgery

Salivary pH and Taste Sensitivity among Geriatric and Non-Geriatric Patients in a Tertiary Hospital: A Cross-Sectional Study

ABSTRACT

Objective: To evaluate the association of salivary pH and taste sensitivity among geriatric and non-geriatric patients in an otorhinolaryngology - head and neck surgery out-patient clinic.

Methods:

Design: Cross-Sectional Study
Setting: Tertiary Government Training Hospital
Participants: 40 otorhinolaryngology out-patients

Results: Of the 40 patients aged 24 to 92 years old (mean age 59.8 years), 21 were geriatric and 19 were non-geriatric. The mean salivary pH was 6.66 (range 5 to 8) and 6.63 (range 5 to 7) for geriatric and non-geriatric groups; the difference in mean salivary pH was not statistically significant ($p = .87$). The salivary pH in the geriatric group showed a negative correlation with age ($r=0.06$), while the salivary pH in the non-geriatric group had a positive correlation with age ($r=0.14$). Overall, increases in age among the non-geriatric group were correlated with increase in salivary pH which were not observed in the geriatric patients. In the geriatric group, among the 4 tastants, the strongest correlation between taste sensitivity and salivary pH was observed for quinine followed by sucrose and NaCl, but no correlation for citric acid. In the non-geriatric group, the strongest correlation between taste sensitivity and salivary pH was observed for NaCl, followed by quinine, citric acid and sucrose.

Conclusion: There was no significant difference between the mean salivary pH of geriatric and non-geriatric patients and both means were within normal. There was a negative correlation between age and salivary pH in the geriatric group, and a positive correlation in the non-geriatric group. Salivary pH had the strongest correlation with taste sensitivity for quinine and NaCl among geriatric and non-geriatric participants, respectively, but the reasons for, and significance of this cannot be inferred from the present study.

Keywords: *salivary pH; taste sensitivity; gustatory function; geriatric*

Salivary hypofunction is commonly believed to arise from age-associated intrinsic salivary gland dysfunction, with objective evidence that salivary glands undergo structural changes.[1] Decreased taste sensitivity and dry mouth are common complaints among the geriatric

Correspondence: Dr. Celso V. Ureta
Department of Otorhinolaryngology
Head and Neck Surgery
Veterans Memorial Medical Center
North Avenue, Diliman, Quezon City 1104
Philippines
Phone: (632) 8927 6426 local 1359
Email: enthns_vmmc@yahoo.com

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population.[2,3,4] They are commonly believed to arise from age-related intrinsic changes in taste receptors. Furthermore, chewing problems associated with tooth loss and the use of dentures in the geriatric population also interfere with taste sensitivity, along with reduction in saliva production.[2] Decrease in taste sensitivity may suppress appetite resulting in weight loss, malnutrition, impaired immunity and deterioration in medical conditions.[4,5]

Unfortunately, taste disorders in the geriatric population are commonly overlooked, as they are not considered critical to life. Data from the World Health Organization and global trends in aging indicate that the proportion of the population aged 65 and older is expected to increase by 10% in the next 2 decades.[6] In the Philippines, people aged 60 years old and over made up 6.8 percent of the 92.1 million household populations in 2010, higher than the 6.0 percent recorded in 2000.[7] As otolaryngologists, we should address issues related to taste among this ageing population. Because taste sensitivity has been related to dry mouth, the relationship of taste sensitivity and salivary pH is an important area of inquiry. However, to the best of our knowledge, based on a search of MEDLINE (PubMed) and HERDIN using the keywords "salivary pH" and "taste sensitivity" we found no study evaluating the association of salivary pH and taste sensitivity in the Philippines.

In order to explore such a relationship, this study aims to evaluate the association of salivary pH and taste sensitivity among geriatric and non-geriatric patients in an otorhinolaryngology-head and neck surgery out-patient clinic.

METHODS

With hospital research committee approval, this cross-sectional study was conducted at the out-patient clinic of the Department of Otorhinolaryngology-Head and Neck Surgery of our hospital from January 1, 2015- December 31, 2017. A sample size of 65 was calculated using the formula $n = Z^2P(1-P)/d^2$ where n is the sample size, Z is the statistic corresponding to level of confidence, P is expected prevalence, and d is precision (corresponding to effect size). $n= [(1.65)(0.6)(1-0.6)]/0.01^2$

Considered for inclusion were patients seen at our out-patient clinic who were more than 15 years old and could read, write and converse in Filipino and/or English. Excluded were patients with chronic illnesses such as diabetes mellitus and hypertension, on multiple (2 or more) maintenance medications, had been diagnosed with allergic rhinitis or sinusitis with or without nasal polyposis, had a respiratory infection within the previous month or nasal congestion at the time of examination, had dental problems or dentures, were smokers, or had a history of head injury. Written informed consent was obtained from all patients. All eligible patients were clinically assessed and classified as non-geriatric for those less than 65 years old and geriatric for those 65 years old and above.

Determination of Salivary pH

The pH of the saliva was determined using pH paper obtained from the Sugar Regulatory Board (North Avenue, Quezon City, Philippines). Fresh saliva was collected in a 50ml Pyrex beaker (Sigma-Aldrich, Belman Laboratories, Singapore) using the spit method and the pH was determined immediately by dipping the pH paper into the saliva.[8]

Determination of Taste Perception

Taste perception of the four (4) basic tastes (sweet, salty, sour, bitter) was assessed using solutions of sucrose, sodium chloride (NaCl), citric acid and quinine prepared from medical grade powder (Merck Life Science, India). Taste function or sensitivity tests were conducted using tastant adsorbed filter paper strips (taste strips) according to the method of Muller.[9] Four aqueous solutions of the compounds were prepared using serial dilutions with the following concentrations: sweet (0.4, 0.2, 0.1, 0.05g/ml), salty (0.25, 0.1, 0.04, 0.016g/ml), sour (0.3, 0.165, 0.09, 0.05g/ml), and bitter (0.006, 0.0024, 0.0009, 0.0004g/ml). Deionized water was used to prepare the solutions to ensure comparability between different study centers. Whatmann # 1 filter papers (Sigma-Aldrich, Belman Laboratories, Singapore) of approximately 3.8x3.8 cm were soaked in the different concentrations of tastants. The papers were randomly placed on the dorsal aspect of the tongue and patients were asked to identify the taste. The procedure was repeated for each tastant using the sip-and-spit method where participants rinsed their mouth with distilled water then expectorated at the start of the session and before each new trial. Only one investigator conducted the procedure throughout the course of the study.

The deidentified data were collected from clinical examination and recorded in MS Excel for Windows v. 10 (2013, Microsoft Corp., Redmond, WA, USA). The Pearson correlation coefficient was derived and computed using scatter plot. Descriptive analysis used central tendency and dispersion measures (mean and range) and inferential statistics included a two-sample Welch's T-test (gen-info.osaka-u.ac.jp/MEPHAS, Japan) for two means to compare the average difference of patients in the two treatment arms that were considered as independent samples. A p-value of less than .05 was considered statistically significant.

RESULTS

A total of 40 participants met inclusion criteria and completed this study. Their mean age was 59.8 years old with a range of 24 to 92 years old. Twenty-one patients (52%) were geriatric and 19 patients (48%) were non-geriatric. There were 12 males (57%) and 9 females (43%) in the geriatric group while there were 11 males (58%) and 8 females (42%) in the non-geriatric group.

The mean salivary pH among the geriatric group was 6.66 with a range of 5 to 8 while the mean salivary pH in the non-geriatric group was 6.63 with a range of 5 to 7. The difference in mean salivary pH of the two groups was not statistically significant (p = .87) using Welch's t test.

There was a negative correlation between age and salivary pH in the geriatric group (Pearson r=0.06), while there was a positive correlation between age and salivary pH in the non-geriatric group (r=0.14). A scatterplot summarizes the results. *(Figure 1A, B)* Overall, increases in age among the non-geriatric group were correlated with increase in salivary pH which were not observed in the geriatric patients.

Among the 4 tastants in the geriatric group, the strongest correlation between taste sensitivity and salivary pH was observed for quinine (r=0.40) followed by sucrose (r=0.26) and NaCl (r=0.17). There was no correlation between taste sensitivity and salivary pH for citric acid (r=0) *(Figures 2A-D)*. In the non-geriatric group, the strongest correlation between taste sensitivity and salivary pH was observed for the tastant NaCl (r=0.38) followed by quinine (r=0.25), citric acid (r=0.17) and sucrose (r=0.12). *(Figures 3A-D)*

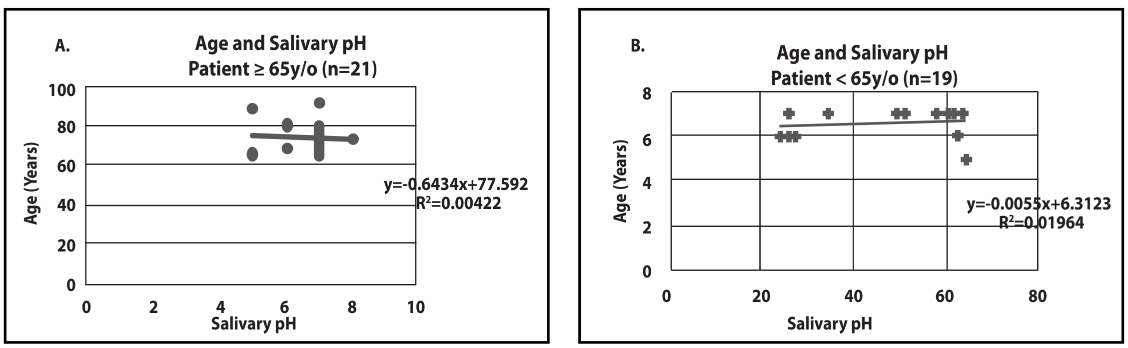

Figure 1. Relationship Between Age and Salivary pH and; **A.** Geriatric and; **B.** Non-Geriatric

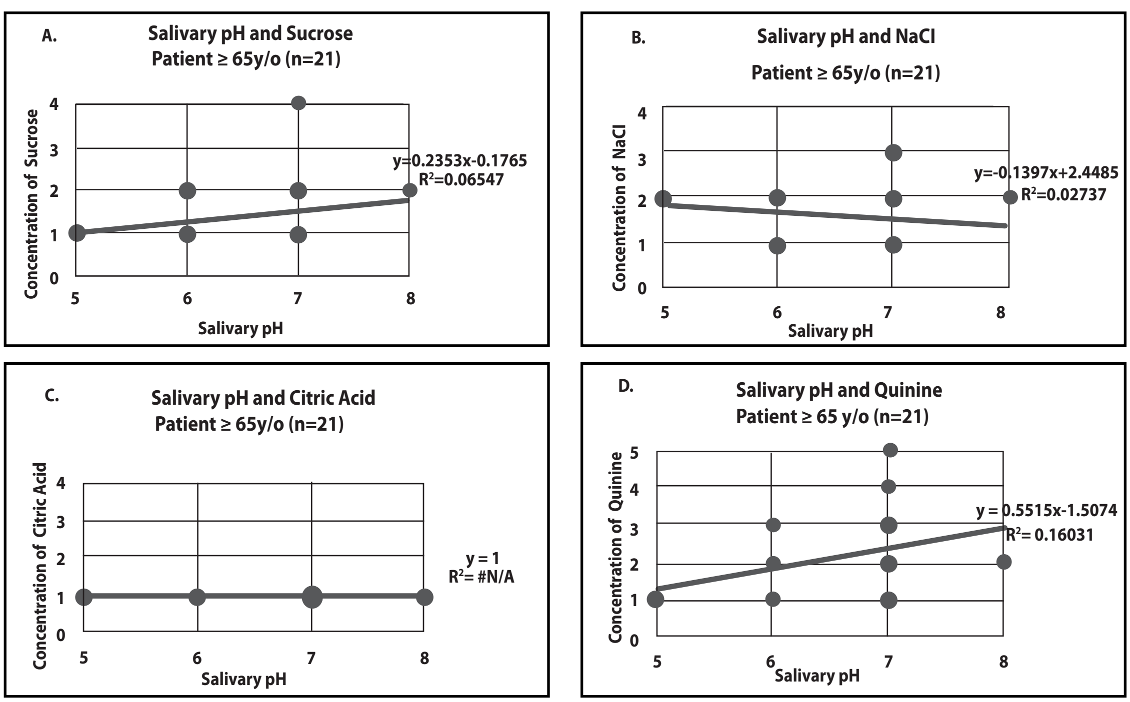

Figure 2. A-D. Relationship between Salivary pH and Tastants in the Geriatric Group

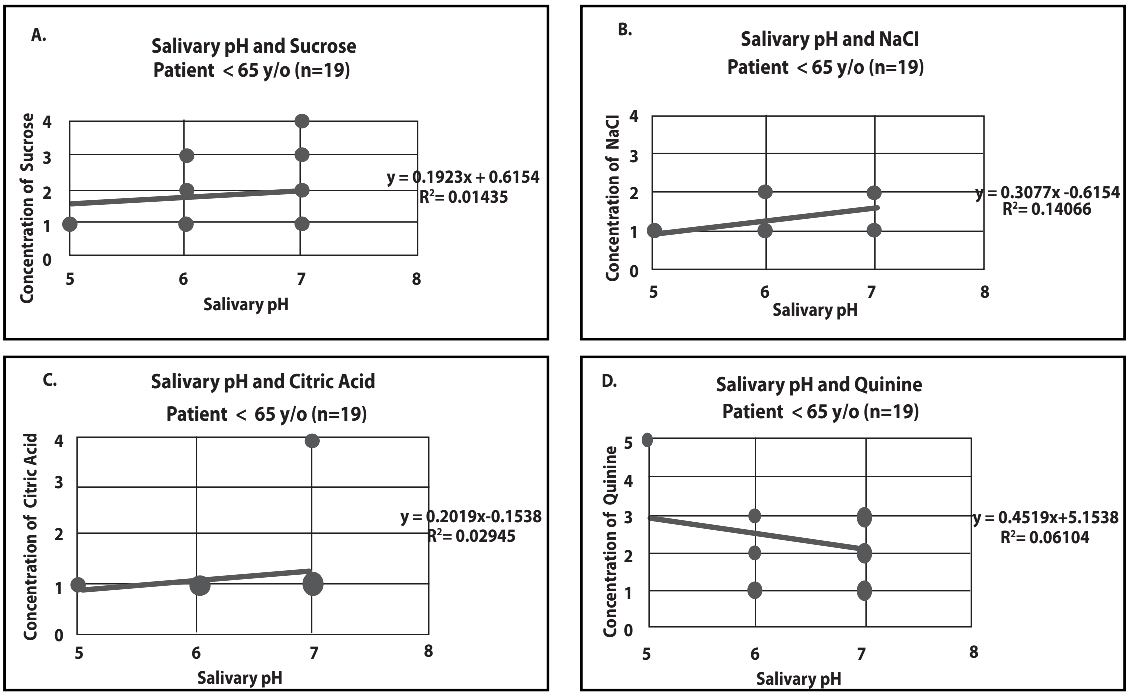

Figure 3. A-D. Relationship between Salivary pH and Tastants in Non-geriatric Group

DISCUSSION

In this study, the strongest correlation between taste sensitivity and salivary pH in the geriatric group was observed for quinine, followed by sucrose and NaCl, compared to NaCl followed by quinine, citric acid and sucrose in the non-geriatric group. There was no correlation between taste sensitivity and salivary pH for citric acid.

The mean salivary pH among Filipino geriatric and non-geriatric groups was observed to be within the normal range similar to findings reported by other studies.[1] In the geriatric group the salivary pH tended to decrease with age, whereas in the non-geriatric group, the salivary pH tended to increase with age. This decrease in salivary pH with age in our study contrast with the findings of Brawley where the geriatric group tends to have more alkaline normal resting saliva.[11] However, our results are only based on a small sample population that did not meet our projected sample size.

The small variations in salivary pH between geriatric and non-geriatric groups may be explained by variations in diet and activities they engaged in (although we did not investigate these diets and activities in our study). Moderate exercise or activity and certain diets (e.g. sialogogues) increase saliva flow rate.[11] An increase in salivary flow rate is associated with a higher bicarbonate concentration, and, thus, higher salivary pH.[11]

In our study, the taste sensitivity of the non-geriatric group was higher (lower taste threshold) at lower salivary pH for NaCl than those in the geriatric group. Among the 4 tastants in the non-geriatric group, the taste sensitivity for NaCl had the strongest correlation with salivary pH (r=0.38). Since the taste receptor is usually adapted to the salivary environment, i.e. the gustatory receptors are continuously stimulated by low levels of salt ions, we normally do not recognize a salty taste in saliva.[1] In order to detect salty taste sensation, Sodium ion (Na^+) is slightly raised above the salivary sodium concentrations with which the taste receptor is continuously stimulated.[12,13] In contrast, the higher detection threshold for NaCl in the elderly can be a result of atrophy or degeneration of taste receptor due to old age.[14] Furthermore, xerostomia, endemic in the geriatric group, and chewing problems due to loss of teeth affect taste and may increase detection threshold to taste stimulus.[15]

In the geriatric group, there was higher taste sensitivity at lower salivary pH for quinine than the non-geriatric group. Bitter taste as elicited by alkaloid quinine is the most sensitive of all taste qualities.[16] In our study, the geriatric group had higher taste sensitivity for bitter than the non-geriatric group. The sensitivity to some bitter tastes is a heritable trait.[16] One of the most widely studied is the genetically mediated sensitivity to the bitter taste of 6-n-propylthiouracil (PROP) and its association for greater sensitivity to bitter taste.[16] This finding is supported by anatomical studies showing that tasters for bitter had the most fungiform papillae, the largest number of taste buds and the highest density of taste buds per papilla.[16] Instead our findings can be viewed in hedonic dimension with stimuli divided into those that are preferred and those that are disliked.[1] Unfortunately, in our literature search, we found no study explaining the different findings in taste sensitivity between geriatric and non-geriatric.

Sour taste as elicited by citric acid has lower detection threshold in the general population. Weak acid such as citric acid is a very effective salivary stimulant which induces large volume of saliva.[1] This increase in salivary flow rate is associated with higher bicarbonate concentration which neutralizes the acid and hence increases in salivary pH and consequently diminishes sour taste perception.[1] In this study, the taste sensitivity for citric acid showed no correlation with salivary pH among the geriatric group. Various mechanisms have been proposed to serve in the detection of sour taste.[1] These include acid-sensing ion channels (ASICs), hyperpolarization-activated cyclic nucleotide-gated (HCN) channels, and two pore domain K^+ channels (K2P).[16] Despite numerous studies, a definitive description of sour receptors and mechanisms remains controversial.[16]

This study has several limitations. First, we did not achieve our target sample size of 65 and our findings have to be interpreted in this context. Our study population could have been better-defined, accounting for such variables as diet (sialagogues), physical activity, oral mucosa condition and dental status. Our source population consisted of otorhinolaryngologic out-patients, and even with our exclusion criteria, may not fairly represent the larger population of persons with no otorhinolaryngologic or other problems. These factors affect the internal and external validity of our study, and future studies should consider improvements in these areas.

In conclusion, our study found that the mean salivary pH among Filipino non-geriatric and geriatric groups was not significantly different, and within normal range. There was a negative correlation between age and salivary pH in the geriatric group and a positive correlation in the non-geriatric group. The strongest correlation between taste sensitivity and salivary pH was observed for quinine in the geriatric group, and for NaCl in the non-geriatric group. However, the reasons for, and significance of this cannot be inferred from the present study.

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