

## RESEARCH ARTICLES

# Tongue coating index as a risk factor of decline of taste sensitivity in the elderly population

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### ABSTRACT

The elderly had various oral health issues, one of which is taste sensitivity. Taste sensitivity is highly affected by a person's health, medication, eating habits, nutritional status, and oral hygiene. As an important organ for the sense of taste, the tongue can be covered in a white coating of debris, bacteria, and dead cells. To clean the tongue coating, one can do tongue brushing procedure, but this practice is not common among the elderly, especially in Indonesia. This cross-sectional study involved 114 older adults (n= 114) in the Special Region of Yogyakarta (Daerah Istimewa Yogyakarta- DIY), Indonesia, who were selected using stratified random sampling. The participants first signed the informed consent before undergoing an interview and going through oral clinical examination. This research particularly measured the tongue coating index and taste sensitivity level by way of statistically analyzing both variables to determine the correlation between tongue coating index and taste sensitivity level using three-drop-method. Data from 114 subjects were presented descriptively using table and graphic. Most of the subjects 90.53% (103 subjects) had a coated tongue with various degree. The correlation statistic between tongue coating index and taste sensitivity level showed the statistically significant correlation ( $p$ -value = 0.019) and the coefficient correlation was -0.216, which means that there was a negative and weak correlation between both. Elderly with a higher tongue coating index tended to have less taste sensitivity. This could be due to debris blocking taste buds, thereby reducing taste sensitivity.

**Keywords:** elderly; taste sensitivity level; tongue coating index

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### INTRODUCTION

The elderly population in Indonesia has been experiencing a considerable growth year by year. In 2012, Indonesia was ranked in top-third countries in Asia in terms of the elderly population.<sup>1</sup> The Special Region of Yogyakarta, is one of the aging provinces in Indonesia with the 2010 aging proportion of around 9.3% and projected to reach 14% in 2035 along with the escalating older adults population ages 65 and above.<sup>2</sup> As more people are living longer and getting older, there will be an increase in chronic conditions and illnesses that will influence both oral and systemic health.<sup>3</sup>

Aging is a natural process, but as humans growing old, they would experience sensory impairments such as olfactory and gustatory dysfunction, as well as oral motor problems including difficulty with mastication, speech, and

swallowing.<sup>3</sup> Some evidence showed that human chemosensory lessens with age. Taste loss in geriatrics caused by physiological changes and worsened by events is often associated with aging, such as polypharmacy and chronic disease.<sup>3-5</sup> Based on epidemiological study, the most common causes of taste disorders are drug use (21.7%), zinc deficiency (14.5%) oral disease (7.4%), and systemic diseases (6.4%).<sup>5</sup> These chronic impairments can directly affect oral health.<sup>3</sup> The elderly population who have problem with taste may eat less food or choose stronger flavors.<sup>4</sup> This condition leads them into malnourished condition or the condition of being at risk of malnutrition due to disturbances of appetite, poor food intake, or poor dietary quality.<sup>5,6</sup> The elderly with decreased taste sensitivity could have excessive food intake (sugar, salt) that can have an impact on their

overall health.<sup>7</sup> In this context, a study conducted by Jeon et al<sup>8</sup> found a strong relationship between taste sensitivity in the elderly and the Quality of Life (QoL).

Taste bud is an important sensory organ for humans in the tongue. The taste receptors are located around the small structures known as papillae found on the upper surface of the tongue.<sup>9</sup> The papillary structure of the tongue dorsum provides a large surface susceptible for the accumulation of oral debris and microorganisms.<sup>10</sup> This accumulation of oral debris and microorganism is known as tongue coating and could affect taste sensitivity. Evaluation of tongue coating status is necessary in assessing the effect of oral health care and motivating patients to clean their tongue.<sup>7</sup> The tongue coating can be cleaned by brushing the tongue using special device or simply using toothbrush; however, daily tongue cleaning is yet to become a concern amongst the elderly and is not part of daily oral care, especially in Indonesia. This study aims to find the correlation between the tongue coating index that would affect the oral hygiene and taste sensitivity level in the elderly.

## MATERIALS AND METHODS

This cross-sectional study was conducted in The Special Region of Yogyakarta (Daerah Istimewa Yogyakarta- DIY), Indonesia. The subjects for this study were recruited from the elderly population in nine subdistricts of this province (Kalibawang, Minggir, Turi, Mantrijeron, Jetis, Umbulharjo, Ngaglik, and Pakualaman) using stratified random sampling method. According to exclusion and inclusion criteria, 114 subject (n= 114) were selected and agreed to join this study by signing informed consent. The elderly groups (more than 60 years old) who were in good health and able to communicate well were included in this study, while individuals who were suffering for severe systemic disease, hospitalized, and in chemotherapy were excluded from this study. This study was approved by Research Ethic Committee, Faculty of Dentistry, Universitas Gadjah Mada (No.001480KKEP/FGK-UGM/EC/2018).

All participants had their clinical examination in Prof Soedomo Dental Hospital, UGM, DIY. Before enrolling in the examination, the participants were informed about the research purpose and relevant procedure. The participants who agreed to join the research signed an informed consent form before having the interview and clinical examination conducted by three trained dentists, each of whom was well calibrated between each other. The interview's objective was to gather general epidemiologic data and the clinical examination specifically as a way to measure tongue coating index (CTI) and taste sensitivity level.

The Tongue coating Index (CTI) measurement adopted the method from Shimizu et al<sup>11</sup> which evaluated dorsum of tongue visually. The tongue imaginary was divided into nine sections, and each section was scored with the following criteria: Score 0 for invisible tongue coating, score 1 for thin tongue coating and visible papillae of the tongue, and score 3 for a very thick tongue coating and invisible papillae of tongue. The total score was then divided by eighteen to obtain the percentage of the CTI. The score ranged from 0 to 100%, and this method was chosen because of its reliability and reproducibility.

Taste sensitivity level adhered to the three-drop-method used by Mueller et al<sup>12</sup> with the following concentration: sweet: 0.4; 0.2; 0.1; 0.05 g/ml sucrose, salty: 0.25; 0.1; 0.04; 0.016 g/ml sodium chloride, sour: 0.075; 0.041, 0.0225; 0.0125 g/ml citric acid; and bitter: 0.0015; 0.0006; 0.0002; 0.0001 g/ml quinidine sulphate. Three drop method was applied using a pipette that was placed at the middle of the tongue at approximately 1.5 cm distance from the tip. The sequence of administration was randomized across trials and started at the lowest concentration for each taste. The subjects were required to identify the taste. After every taste testing, the subjects rinsed their mouth by sipping plain water. Each taste was scored ranging from 0 to 4. Score "4" is for the lowest concentration and score "0" is provided when the subject could not identify the taste at all. The entire taste testing resulted in a sum of results for four tastes scored from 0 to 16.

The data obtained from the interview and clinical examination were inputted into computer to present the data descriptively using table and graph. To determine the correlation between tongue coating index and taste sensitivity level, the data were analyzed using Spearman's correlation test with the statistically significant correlation between two variables at  $p < 0.05$ .

## RESULTS

This research involved 114 subjects from 9 subdistricts in The Special Region of Yogyakarta. The characteristics of the subject are presented in Table 1.

From the Table 1, it is obvious that the subjects mostly did daily routine oral cleaning (brushing teeth) but only 23 subject (20.18%) had

a routine tongue cleaning. Tongue hygiene varies with majority (85 subjects/74.56%) having tongue coating index between 1-50%.

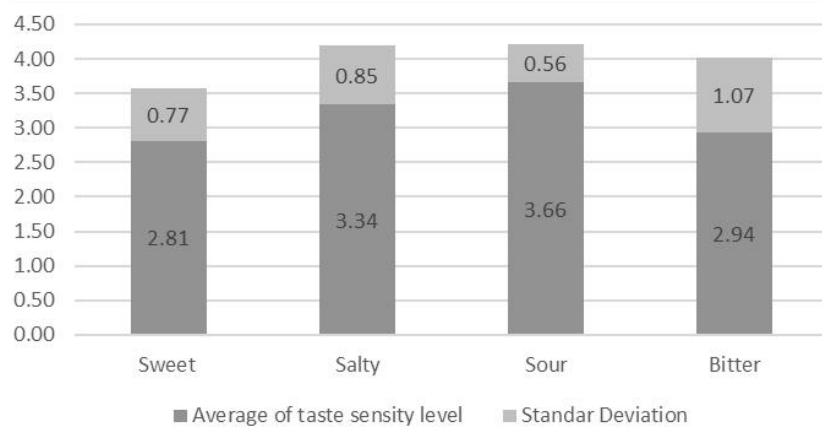
From Figure 2, of all taste sensitivity level of all subjects, it is apparent that sweet taste sensitivity ranked as the most significantly declining sensitivity with the average score of only 2.81 from maximal score of 4. It is followed by bitter taste and sour taste with a slightly higher score of taste sensitivity.

Table 2 presents that taste sensitivity level had higher score in subjects who had a clean tongue (TCI = 0%) and the lowest level of taste sensitivity was on the subjects with TCI of 51-100%, while the average salty taste was the lowest in the middle group (TCI = 1-50%).

To determine the correlation between tongue coating index and taste sensitivity level, Spearman's correlation test was performed for

**Table 1.** Characteristic of the Subjects

Age (Mean ± SD)	66.49 ± 5.36
Sex	
Male	35 (30.70%)
Female	79 (69.30%)
Education	
No formal education	19 (16.67%)
Elementary School	29 (25.44%)
Junior High School	13 (11.40%)
Senior High School	31 (27.19%)
College/University	22 (19.30%)
Brushing Teeth (at least twice daily)	
Yes	88 (77.19%)
No	26 (22.81%)
Cleaning Tongue	
Yes	23 (20.18%)
No	91 (79.82%)
Taste sensitivity problem (subjectively)	
Yes	1 (0.88%)
No	113 (99.12%)
Tongue coating index	
0%	11 (9.65%)
1-50%	85 (74.56%)
51-100%	18 (15.79%)



**Figure 1.** The average and standard deviation (SD) of each taste sensitivity level among subjects (Range from 0 to 4)

**Table 2.** The taste sensitivity level among three groups with the degree of tongue-coating

CTI	sweet	salty	sour	bitter	total
0%	4	4	4	3.5	15.5
1-50%	2.94	3.31	3.69	2.99	12.93
51-100%	2.47	3.36	3.58	2.81	12.22

**Table 3.** Relationship between Tongue Coating Index and Taste Sensitivity Level

Independent variables	Dependent variables	
	Correlation cefficient	Taste sensitivity level
Tongue coating index		-0.216
	p	0.019*

\*Significant if  $p < 0.05$

both data, and the result can be seen in Table 3. The tongue coating index and taste sensitivity level had a significant statistically correlation with p-value of 0.019 ( $p < 0.05$ ). The coefficient correlation was -0.216, which means that there was a negative weak correlation between both.

**DISCUSSION**

In this study, correlation coefficient between tongue coating index and taste sensitivity level showed a significant statistical correlation. The coefficient correlation showed a negative weak correlation between both. This result suggested that the elderly with higher score of tongue coating index have a tendency of lower taste sensitivity level. This result

happened because the existence of deposit/debris on tongue surface would cover taste papillae, thus decreasing taste sensitivity.<sup>7</sup> Tastant (the taste stimuli) should contact taste receptor cells, located in taste buds to start the tasting process.<sup>13</sup> The blockage of tongue papilla containing taste bud will interfere the tasting process. Based on this finding, we suggest that tongue cleaning play significant role in maintaining taste sensitivity. Routine mechanical tongue cleaning improves gustatory function.<sup>14</sup> Seerangaiyan et al study<sup>7</sup> also reinforced that tongue brushing can increase salty taste sensitivity. However, another study by Solemdal et al<sup>15</sup> found there is no correlation between taste sensitivity and coated tongue.

The differences between some studies might be attributed to different settings, subjects, study designs and methods used.

Decrease in taste sensitivity level amongst healthy elderly without medication in four basic tastes (sweet, salty, sour, and bitter) is usually mild and rare.<sup>3</sup> In this study, only one subject stated subjectively that he had problem with taste sensitivity and according to taste sensitivity test of four basic tastes, sweet taste had the lowest average score while other taste scored below 4, suggesting that some of the subjects had lower taste sensitivity in four basic tastes. On this account, a study by Sergi et al<sup>4</sup> found that the increasing taste thresholds in all tastes in the elderly population means the needs to pay higher taste concentration to be able to taste food. This study revealed that all basic tastes of the subjects were below 4, which indicated decreasing taste sensitivity. Sweet taste had the lowest score, which was similar with the result of the study conducted by Jeon et al<sup>8</sup> that compared taste sensitivity level between young adult and the elderly. In that study on the comparison of taste sensitivity level between young adult and elderly, taste sensitivity was revealed to be different only in sweet taste but other tastes (salty, sour, bitter, and umami) were the same.<sup>8</sup> The change in taste sensitivity in normal ageing without pathologic condition, medication, or other medical intervention is yet to be fully understood.<sup>5</sup> A study conducted by Pavlidis et al<sup>16</sup> showed a significant reduction in fungiform papilla density and vessel density in anterior tip of the tongue in non-smoking population of those over 60 years old. Both factors of Papillae atrophic is associated with the decreasing level of sweet taste, which is greater than that of other basic tastes.<sup>15</sup> In this study, sour taste was the taste with the highest score, which means that it as the easiest taste to recognize on minimal concentration with an average score of 3.66. A study by Neumann et al<sup>17</sup> concluded that the elderly people had lower perception of sweet and sour flavors than adult, so this study shows different result with the study regarding sour taste. In this study, sweet taste score showed

the lowest score while sour taste had the highest score. The different result was because tasting involving many factors, such as different eating habit and oral hygiene condition.<sup>4,15</sup> A person with poor oral hygiene have more oral bacteria proliferation activity and an acid production by the oral bacteria should interfere the sour tasting.<sup>15</sup> Food choices in the elderly tend to decrease in terms of sour and bitter food and to increase in sweet and salty taste.<sup>4</sup>

From this study, we found that most of the subjects (90.53%) had suffered from tongue coating even when 77.19% testified that they had routinely brushed their teeth twice a day and 20.18% constantly brush their tongue. This finding suggested that their daily oral cleaning needed further evaluation to make sure that the existing procedure is done properly. Results from previous study<sup>7</sup> showed that tongue brushing could increase taste sensitivity level. They also suggested that tongue brushing, which was accompanied by mechanical stimulation of the tongue surface might increase blood flow within tongue papillae to increase taste sensitivity.<sup>14</sup> Daily tongue cleaning (at least once a day) would have better impact on reducing tongue coating and improving taste sensitivity level than weekly (once a week, or not every day).<sup>18</sup> In conclusion, good oral health is needed to maintain gustatory function.<sup>15</sup> Routine tongue cleaning together with tongue brushing is also effective to reduce the number of oral bacteria to promote oral health.<sup>19</sup>

Finally, there were some limitations in our study that should be taken into consideration. Since this study design is cross sectional study, it could not explain causality between tongue coating index and taste sensitivity level. Further research with experimental design with the intervention to reduce tongue coating index and its effect on four basic taste sensitivity levels needs to be conducted to get better understanding of whether the tongue coating contributes to the declining taste sensitivity level. Furthermore, since tasting is a complicated process involving many factors, a study about factor that can contribute to taste sensitivity changing in the elderly should

be conducted more comprehensively since the declining taste sensitivity level have an impact on the general health and quality of life of the elderly.

## CONCLUSION

This research concludes that the higher index of tongue coating (a dirtier tongue) will decline the taste sensitivity level. The result and conclusion of this study shall serve as an encouragement to an elderly to do routine tongue cleaning procedure besides tooth brushing in their daily oral cleaning routine because taste sensitivity is an important aspect to maintain in the elderly given its related risk of malnutrition and its impact on general health as a way to ensure that the elderly can improve their quality of life.

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