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Original article

Correlation between salivary zinc levels and salivary volume on taste disorders in elderly patients

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ABSTRACT

Background: *Taste disorders often occur in the elderly, which can have serious consequences on their health status. Zinc and saliva volume have a role in maintaining taste acuity, especially in the elderly.* ***Purpose:*** *This study was to determine the correlation between salivary zinc levels, salivary volume, and taste disorders in elderly patients.* ***Methods:*** *This was a cross-sectional research. Elderly patients with and without taste disorders were included in this study. Salivary zinc levels were measured using the Atomic Absorption Spectrometry (AAS) method. Salivary volume was measured using the spitting method. The correlation between salivary zinc levels, salivary volume, and taste disorders was analysed using the chi-square test. Multivariate analysis was performed to control for confounding variables with logistic regression.* ***Results:*** *Based on our findings, no significant correlation was determined between the levels of zinc in saliva and taste disorders. However, there was a significant correlation between salivary volume and taste disorders. Salivary volume and smoking were determined to be associated with taste disorders.* ***Conclusion:*** *This research showed that salivary zinc levels were not correlated with taste disorders; on the contrary, salivary volume was correlated with taste disorders. Smoking was determined to be a confounding variable on taste disorders in elderly patients.*

Keywords: *elderly; salivary volume; salivary zinc; taste disorder*

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INTRODUCTION

Worldwide, there has been a rapid increase in the number of older individuals, both in developed and developing countries. 'Elderly' has been defined as someone who is 60 years old and above. In Indonesia, the number of elderly people is estimated to increase from 23.66 million in 2017 to 33.69 million in 2025.[1]

The elderly often complain of reduced taste, sometimes having no taste for certain types of food. This is commonly referred to as ageusia. This complaint often occurs with ageing and is related to a decrease in the number of taste cells on the tongue, which affects the sense of taste and is marked by a decreased taste sensation. These changes will naturally have consequences, one of which is reduced appetite and enjoyment in eating.[2–6]

Zinc as a micronutrient has been determined to play an essential role in taste acuity. As a person gets older, the zinc concentration in the body decreases, which in turn can cause taste problems in the elderly; therefore, zinc intake should be of concern as it affects appetite and ultimately affects the quality of life for them.[5,6] The reference value of zinc content in saliva is 88–135 µg/L.[7]

In general, the sense of taste has been considered to be less important than the other senses because decreased function or taste disturbance is rarely fatal and does not require special medical attention. However, disturbance in the sense of taste can reduce the enjoyment of life, thereby making the patient uncomfortable as it affects their ability to enjoy food, drinks and pleasant aromas; furthermore, this disorder also affects the patient's ability to recognise harmful chemicals, which can have serious consequences.[8]

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In addition to nutritional intake that is often deficient, there are other factors that can affect the sharpness of taste, namely systemic diseases that often occur in the elderly in the form of neurological diseases; cancer; kidney, lung, and endocrine disorders; rheumatoid diseases; gastrointestinal diseases; cardiovascular disorders such as hypertension; and drugs that elderly patients need to take for treating their illnesses. Anti-hypertensive drugs have been identified as being widely and routinely consumed by elderly patients, and one of their side effects is that they can interfere with taste acuity. Other factors that have to be considered are drinking alcohol, poor oral hygiene and tobacco consumption, which is a habit of elderly men.[4,9] The purpose of this study was to analyse and determine the effects of salivary zinc levels, salivary volume and confounding variables such as zinc intake, hypertension and smoking on taste disorders in elderly patients.

MATERIALS AND METHODS

The selection of study subjects was by means of consecutive sampling, consisting of 50 subjects each with and without taste disorders. The research subjects were elderly patients at the Babatan Health Centre in Bandung City with the following inclusion criteria: age š 60 years, willing to be research subjects and able to provide informed consent; having complaints of taste disorders and not having complaints of taste disorders; being able to open their mouths as wide as two to three fingers; and without cognitive impairment, as tested in the Mini-Mental State Examination (MMSE) where the test score > 24. Confounding factors such as zinc intake and hypertension were obtained from secondary data, while smoking habits were obtained from interviews. This study has received ethical clearance from the Ethics Committee of the Faculty of Medicine, Padjadjaran University, Bandung number: 1233/UN6.KEP/EC/2019 with the principles of respect for human dignity; respect for privacy and confidentiality; and respect for justice, inclusiveness, beneficence, and non-maleficence.

The sample was collected from the subjects using the spitting test method, i.e. saliva collection by measuring the total saliva flow rate, without stimulation, for five minutes. The stopwatch was activated at one-minute intervals during saliva collection; the subject was then asked to spit into the measuring cup. This was continued for a period of five minutes.[10] The collected saliva sample was then measured for zinc levels using the Atomic Absorption Spectrometry (AAS) method. The taste stimulation threshold was measured for sweetness (0.01 M and 0.1 M sucrose), saltiness (0.01 M and 0.1 M NaCl), sourness (0.00032 M and 0.0032 M citric acid) and bitterness (quinine 0.000008 M and 0.00008 M) by placing a drop on the tongue according to the region of taste.[11] Bivariate analysis used the chi-square test, while multivariate analysis used logistic regression with p-value < 0.05.

RESULTS

This study consisted of 100 respondents with an age range of 60–99 years. The respondents comprised 36 men and 64 women. The distribution of research subjects, based on age, shows that the predominant age group is 60–69 years. The correlation between salivary zinc levels, salivary volume and taste disorders in the elderly can be seen in Table 1.

In this study, the average salivary zinc levels were determined to decrease in both respondents, with and without taste disorders. Statistically, there is no significant correlation between salivary zinc levels and taste disorders. The average volume of saliva in the two groups of respondents was considered normal; however, respondents with taste disorders experienced a higher decrease in salivary volume. In this statistical test, there was a significant correlation between salivary volume and taste disorders.

In this study, we measured several confounding factors that can influence taste disorders, namely zinc intake, hypertension and smoking. The results of statistical analysis show that there is a significant correlation between zinc intake, smoking and taste disorders, but no significant correlation was determined between hypertension and taste disorders. The effects of zinc intake, hypertension, and smoking on taste disorders have been summarised in Table 2.

The results of the multivariate logistic regression statistical test found that the volume of saliva, and smoking had a significant effect on taste disorders. Individuals with a salivary volume < 1.45 mL/5 minutes are 3.23 times more at risk of developing taste disorders, after controlling for confounding variables – zinc intake, hypertension, and smoking. The correlation between salivary volume and taste disturbance has been determined to be controlled by confounding variables (zinc intake and smoking), as can be seen in Table 3.

Table 1. The correlation between salivary zinc levels, salivary volume and taste disorders in the elderly

Variable	Taste disorders		p-value
	Yes n=50	No n=50	
Salivary Zinc (µg/L)			
Mean	57.690	66.196	
Median	37.396	37.655	
Range	0.100–304.405	0.100–589.231	
< 88	44 (88%)	39 (78%)	0.183
88–135 or more	6 (12%)	11 (22%)	
Salivary Volume (mL/5 minutes)			
Mean	1.5	1.9	
Median	1.4	1.5	
Range	0.1–4.5	0.7–7.3	
< 1.45	28 (56%)	18 (36%)	0.045*
≥ 1.45	22 (44%)	32 (64%)	

Note: This analysis uses the chi-square test, * = Significant (p < 0.05)

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Table 2. The correlation of confounding variables – zinc intake, hypertension, and smoking – on taste disorders

Variable	Taste Disorders		p-value
	Yes n = 50	No n = 50	
Zinc Intake			
Insufficiently	50 (100%)	44 (88%)	0.027[b]*
Sufficiently	0 (0%)	6 (12%)	
Hypertension			
Yes	27 (54%)	18 (36%)	0.070[a]
No	23 (46%)	32 (64%)	
Smoking			
Yes	24 (48%)	8 (16%)	0.001[a]*
No	26 (52%)	42 (84%)	

Note: This analysis uses the [a]chi-square test, [b]Fisher's exact test, * = Significant ($p < 0.05$)

Table 3. The correlation between salivary volume and taste disorders with controlled confounding variables (zinc intake and smoking)

Variable	Multivariate Logistic Regression	
	Adjusted OR (95% CI)	p-value
Salivary Volume < 1.45 mL/5 minutes	3.23 (1.25–8.37)	0.016*
Insufficient zinc intake	18.08 (0.88–369.64)	0.060
Smoking	5.30 (1.86–15.11)	0.007*

Dependent Variable: Taste Disturbance, * = Significant ($p < 0.05$)

DISCUSSION

In this study, a difference was determined in the average levels of zinc saliva in respondents with taste disorders and without taste disorders. Watanabe, et al. observed that patients with taste disorders had lower levels of zinc saliva when compared to healthy patients.[6] In this study, the respondents were divided into two groups: with and without taste disorders. Like their study, this research was also conducted on elderly respondents; however, the number of respondents in this study was larger. In this study, other metallic elements were not measured. Meanwhile, Selow, et al. in their research showed that there was no significant difference in salivary zinc levels in subjects of various age ranges.[12] Their study measured zinc levels in respondents aged 18–59 years old, while in this study, we only measured zinc levels in respondents aged 60 years and above. Some of the factors that can influence the low zinc levels in this study are advanced age, low zinc intake by all study respondents, and smoking, which inhibit zinc absorption in the digestive tract.

There was a difference in the average volume of saliva among respondents with taste disorders compared to those without. The average volume of saliva among respondents who experienced taste disorders was found to be lower than those of the respondents without taste disorders. The volume of unstimulated normal saliva is 0.29–0.41 mL per minute. The volume of normal saliva obtained in five minutes is 1.45–2.05 mL.[13,14] Decreased salivary secretion usually occurs with age, but can be attributed to systemic diseases such as diabetes mellitus or hypertension, drugs, and radiotherapy in the neck and head area.[15,16] Salivary secretion in hypogeusia subjects is significantly reduced when compared to normal subjects.[17] Hershkovich and Nagler's research showed that the salivary flow rate in subjects with taste disorders was lower than in controlled group, but it was not statistically significant.[18] They conducted a study on respondents aged 15–88 years by comparing a healthy group to a group with taste disorders, burning mouth syndrome, and xerostomia. In accordance with research conducted by Hershkovich and Nagler, healthy respondents have a greater volume of saliva than respondents who have complaints of taste disorders. Hershkovich and Nagler also took sialochemical measurements in the form of Na, K, total protein, albumin, uric acid, lysozyme, amylase, Ig M, Ig G, Ig A and Sig A but in this study no sialochemical measurements were made.[18]

In this study, the results of the multivariate logistic regression statistical test showed that zinc levels in saliva did not have a significant correlation with taste disorders. This is in contrast to the Shatzman and Henkin study, where it was shown that there was a decrease in zinc levels in the saliva of patients with taste disorders.[19] Their study, by giving zinc therapy, showed an increase in zinc levels after therapy with improved taste function. In this study, no such method was used. The results of research conducted by Watanabe, et al. showed that there was a decrease in zinc levels in saliva in subjects with taste disorders.[6] Their study was the same as this study, in that there was no zinc therapy or supplementation.

Salivary volume has a significant relationship with taste disturbances according to the literature, which indicates that the saliva function includes the transport of taste substances and the protection of taste receptors.[16] This study differs from the study conducted by Watanabe, et al., which showed no significant association between saliva volume and taste disturbances. The difference may occur because of the fairly large age range of the respondents in their study when compared to this study, which was conducted only with the elderly. The results of the research conducted by Pushpass, et al. showed that salivary flow and elasticity were reduced in older persons, and this may play a role in impaired taste function.[20] In this study, a significant correlation between salivary volume and smoking was determined as the smoking process has been proven to effect changes in salivary secretion, leading to decreased salivary secretion that in turn can cause taste disturbances. Smoking has a significant correlation as a confounding variable to taste disturbances, as smoke and heat caused by smoking affect the action of papillae and taste buds found on the tongue. The smoke and heat of the cigarette will eventually make the papillae on the dorsal tongue dull, thereby killing the gustatory cells. These gustatory cells play a role in taste

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sensitivity in humans because if their function is disrupted the result will be a decrease in taste sensitivity.[21]

In this study, smoking can be one of the causes of decreased zinc levels in saliva, because smoking can inhibit the process of zinc metabolism in the digestive tract. The results showed that 73% of study respondents had zinc salivary levels below 88 µg/L and as many as 32% of study respondents had a history of smoking. In addition, Chéruel, et al. showed that there was a decrease in the threshold of taste stimulation between respondents who smoked and those who did not smoke.[21] Their study was conducted on smoking and non-smoking respondents, and the changes that occurred after respondents stopped smoking were observed, without measuring zinc levels. However, this study did not focus on respondents who smoked but rather on measuring their salivary zinc levels. Based on the literature, continuous cigarette use can cause injury to the mucosal lining of the digestive tract as well as inflammation. Histological observations of the digestive tract in experimental animals showed bleeding from the postcapillary veins that led to damaged tissue function. Another form of damage caused by cigarette smoke occurred with ethanol-induced gastric damage that resulted in decreased prostaglandin E2, increased myeloperoxidase activity, and increased accumulation of neutrophils in the gastric mucosa.[22]

This study has several limitations, namely the effect of high respondent subjectivity. This study did not intervene with zinc supplementation so salivary zinc levels before and after supplementation could not be compared. This study did not analyse confounding factors for menopause in elderly women. Thus, this study concludes that there is no correlation between salivary zinc levels and taste disorders in elderly patients. However, there is an association between salivary volume and taste disorders in elderly patients. This study also shows that among the three confounding variables (zinc intake, hypertension and smoking), smoking is highly correlated with taste disorders in elderly patients. It is necessary to do further research on taste disorders with zinc supplementation.

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