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The Effect of Body Mass Index on Viscosity, Flow Rate, and Saliva Buffer in Obesity Patients

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Abstract
Introduction: *Nutritional problems are a global epidemic in developed and developing countries. Poor nutrition can lead to obesity. Obesity is a state that exceeds the relative body weight of a person as a result of the accumulation of nutrients, especially carbohydrates, fats, and proteins. Saliva is an exocrine fluid that is released into the oral cavity through the salivary glands. Poor nutritional status can affect the secretion and composition of saliva, which involves an increase in the viscosity of saliva, which is it can affect the digestion of food and a person's quality of life. This study aims to determine the effect of body weight on salivary viscosity.* ***Methods:*** *This study used a descriptive-analytic method with a cross-sectional study design by comparing the viscosity of saliva in 51 study samples which were divided into 3 categories, underweight (n = 17), normal (n = 17), and obesity (n = 17). The saliva was collected by using the spitting method which was calculated using a viscometer on the sample in one take.* ***Results:*** *The result of the one-way ANOVA test presented a significant difference in salivary viscosity between the test groups with a value of P = 0.0001. The mean salivary viscosity in group 1 was 0.008. The mean salivary viscosity in group 2 was 0.01 and in group 3 was 0.017.* ***Conclusions:*** *The conclusion of this study is obesity can affect the increase of salivary viscosity higher than people with underweight and people with normal weight.*
Keywords*: Salivary, salivary viscosity, obesity.*

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I. Introduction

Nutritional problems are a global epidemic in developed and developing countries, including Indonesia. Overnutrition problems include overweight and obesity increases not only in the adult age group but also in children. According to Riskesdas data in 2018 shows that there are 21.8% of obese people in Indonesia. This figure continued to increase in Riskesdas 2007 by 10.5% and 14.8% in Riskesdas 2013.[1]

Obesity is a state that exceeds the relative body weight of a person as a result of the accumulation of nutrients, especially carbohydrates, fats, and proteins. According to Kemenkes, obesity occurs because the intake of energy and fat is higher than the energy expended, such as a lack of physical activity.[2]

Saliva is an exocrine fluid that is released into the oral cavity through the salivary glands. Generally, saliva plays a very important role in the oral health process. Saliva plays role in process of digestion of food, regulation of water balance, maintaining mucosal integrity, antibacterial activity, buffers, lubricants, protectors, cleansing, and anti-bacteria. [3]

The characteristic of saliva is determined by salivary glycoproteins, especially mucins. Viscosity is a viscous state that has associated with glycoprotein composition. Normal salivary viscosity is important for food digestion and motor functions such as chewing, swallowing, speaking, and retention in wearing removable dentures.[4]

Poor nutritional status can affect the secretion and composition of saliva, causing a reduced salivary flow rate which can affect the quality of life of an individual. Individuals who are obese have a different composition of salivary bacteria, alteration the concentration of sialic acid, phosphorus, protein, and immunoglobulin activity, as well as peroxidase which causes a decrease in the salivary flow rate, lead to caries, and periodontal disease.[5]

Obesity can alter the production and release of important defense cells, such as neutrophils, which are known as the first line of defense for periodontal tissue, and T and B lymphocytes, responsible for cellular and humoral responses. The inflammatory state is reflected by an increased circulating level of pro-inflammatory protein and occurs not only in adults but also in children and adolescents. Inflammatory mediators are secreted by the adipose tissue and the immune system, which can lead to a hyperinflammatory state.[4]

Based on the study conducted by Perez et al, it was shown a positive correlation between salivary osmolality and s-IgA in the obese group. This suggests, which has higher level of s-IgA in this group can affect salivary viscosity because obese individuals have a higher concentration of salivary protein compared to normal-weight individuals.[6]

Based on the research that has been done before, it has been known that obese people can affect the components of saliva. Currently, there are no studies that examine the relationship between obesity and salivary viscosity, so the authors are interested in investigating this problem.

II. Methods

The design of this study is descriptive-analytic with a cross-sectional approach. This study has been approved by Komisi Etik Penelitian Kesehatan (KEPK) Fakultas Kedokteran Universitas Sumatera Utara/ RSUP H. Adam Malik Medan through an Ethical Clearance Letter No: No: 222 / KEP / USU / 2021.

The study was carried out in the Oral Biology, Faculty of Dentistry North Sumatera University (USU). The sample in this study was 51 men and women aged 19-25 years, underweight, normal weight, and obese patients at Faculty of Dentistry North Sumatera University (USU) students who were in Medan and had good general health conditions with exclusion criteria, currently undergoing orthodontic treatment or using prostheses, taking drugs that affect the salivary flow, smoking, and having the systemic disease. The sample was divided into 3 groups.

This study was initiated by submitting a research permit application letter addressed to the Ethics Commission of the Faculty of Dentistry North Sumatera University, after that the dental faculty-student of USU, which have caries-free were given a questionnaire to obtain samples that found the inclusion and exclusion criteria. After expalantion was done, the subject was asked to sign informed consent.

Samples in inclusion and exclusion criteria were prepared to follow the research procedure. Saliva was collected at 09.00 - 12.00 WIB, the subjects did not eat or drink for two hours before the study began. The research subjects were asked to collect saliva with the spitting method for 5 minutes. Saliva was collected by the subject letting the saliva pool in the mouth and then spitting the saliva into a tube, then having it labeled. Furthermore, the measurement of salivary viscosity was carried out using the Oswald Viscometer to determine the flow time of saliva, then the measurement was carried out with a pycnometer to determine the density of the saliva, then calculating the salivary viscosity with the formula:

$$n_x = \frac{d_x \,.\, t_x}{d_a \,.\, t_a} \,.\, n_a$$

Note:

n_x = Salivary viscosity

d_x = Salivary density

t_x = Flow time of saliva

= Aquadest d*ensity*

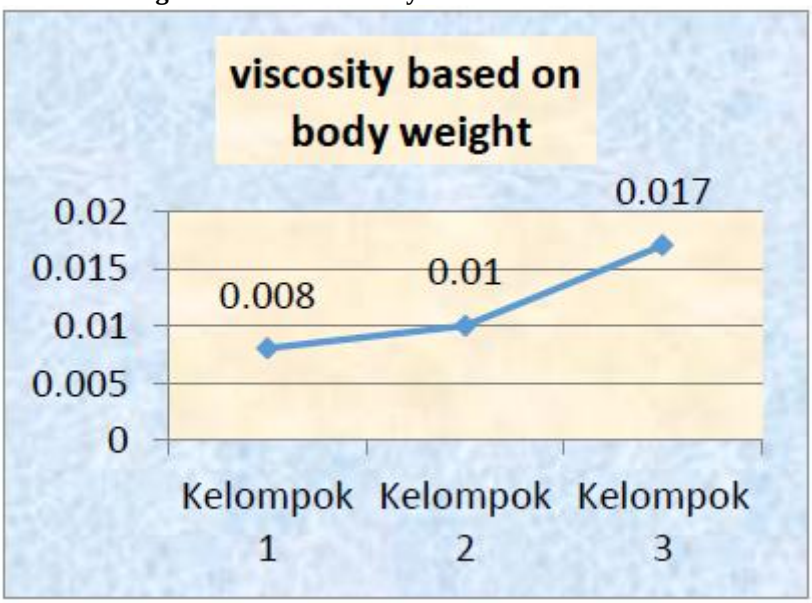
t_a = Flow time saliva

n_a*Squad*d viscosity

III. Results

The measurement of salivary viscosity was carried out using the Oswald Viscometer to determine the flow of saliva and the Pycnometer was used to measure the density of saliva. The measurement results in each group are distributed in Figure 1.

Figure 1. Saliva Viscosity Measurement Results



In Figure 1 it can be seen that the results of salivary viscosity measurement in group 1 was 0.0076 P, and group 2 was 0.0095 P, while in group 3 was 0.017 P. The results showed that the mean value of viscosity measurement in group 3 (obese patients) was higher than group 1 (people with thin body weight) and group 2 (people with normal body weight).

The results of this study were continued by a Oneway Anova statistical analysis to compare the mean viscosity of saliva between these groups.

Table 1. The results of the One Way ANOVA test comparison of the mean viscosity of saliva between groups

Groups	N	Mean ± SD	p-value
1	Under weigh	0,008 ± 0,000518	0,0001*
2	Normal Weight	0,01 ± 0,000471	
3	Overweight (obesity)	0,017 ± 0,00068	

In Table 1, it can be seen that there was a significant difference ($p < 0.05$) in the comparison of the mean viscosity of saliva from each group. The greatest viscosity was in group 3, the obese group with 0.017 P. In group 1 (underweight) the mean salivary viscosity was 0.008 P. Then in group 2 (normal weight), the mean salivary viscosity was 0.01 P. Furthermore, Post Hoc LSD test was used to determine the significance between one group and another.

Table 2. The results of the Post Hoc (LSD) test on the mean difference in salivary viscosity between groups

Groups	Variable	Mean ± SD	p-value
Underweight	Normal weight	0,00198235	0,0001*
	Obesity		
Normal Weight	Underweight	0,00960294	0,0001*
	Obesity		
Obesity	Underweight	0.00762059	0,0001*
	Normal weight		

Table 6 shows the results of the Post Hoc LSD test, there was a difference in the mean viscosity of saliva between groups. The statistical results showed that there was a significant comparison ($p < 0.05$) in group 1 with group 2 and group 3 and had a mean difference of 0.00198235 P. There is a significant difference in group 2 ($p < 0.05$) with group 1 and group 3, the mean difference was 0.00960294 P. There is a significant difference in group 3 ($p < 0.05$) with group 1 and group 2, the mean difference was 0.00762059 P.

IV. Discussion

A viscometer was used as a measuring instrument used to determine the viscosity of a liquid. This viscosity measuring instrument can measure the thickness of fluids accurately and specifically by predetermined standards. The Ostwald viscometer is one type of viscometer that is often used. The Ostwald viscometer requires fewer samples than other viscometers. The principle used is to measure the time it takes for the fluid to pass through two predetermined points on a vertical capillary tube.[7]

This study used 51 samples of saliva which were divided into three groups. Group 1 is an underweight person, group 2 is a normal weight person, and group 3 is an obese person. There is a relationship between the viscosity of the liquid and the length of the flow of the liquid, the relationship between both is directly proportional, which means that the greater the viscosity of a liquid, the greater the flow time. In otherwise, the smaller the viscosity of a liquid than the smaller the flow time of the liquid. Saliva is a fluid, which it has a viscous characteristic, each fluid has a different coefficient of viscosity. Viscosity can be expressed as the resistance to fluid flow which is the friction between the liquid molecules with one another. A type of liquid that was easy to flow, which is a low viscosity and conversely a material that is difficult to flow it has a high viscosity.[7]

Normal salivary viscosity is important for food digestion and motoric functions such as mastication, swallowing, and speech. The efficacy of saliva as a lubricant depends on the viscosity and alteration of the flow rate of saliva. When the viscosity of saliva increases, then the composition of water in saliva decreases and this will cause the saliva to become thicker.[8]

Body mass index is a statistical measurement of the body weight and height of an individual used to classify individuals based on body weight. BMI consists of four categories, underweight, normal weight, overweight, and obesity. A low BMI (underweight) indicates that the body weight is below normal because the calorie intake is lower than the daily calorie intake. A high BMI (overweight and obesity) indicates that there is excess body weight because the daily calorie intake is more than the actual need.[9]

In group 3, the sample of saliva in people with obesity had a high mean viscosity of 0.017 ± 0.00068 P. In obese people, there was an accumulation of adipose in the parenchyma of the parotid glands, causing ducts and acini in the salivary gland parenchyma. becomes smaller and causes the flow of saliva to decrease.[10]

Furthermore, obese individuals who were having high adipose also have high levels of macrophages. Macrophages will trigger the production of inflammatory cells such as leptin and IL-1Ra which will facilitate the inflammatory process. The inflammatory process in obese individuals occurs continuously, so it can damage the parenchymal tissue of the salivary glands which contains secretory elements in the form of acini, which is releasing the secrete and secretory ducts that will disrupt secretions and result in decreased salivary flow rate which affects the viscosity of saliva.[10]

This study is by the study conducted by Lindawati et al, who examined the effect of obesity on salivary flow rate and buffer capacity, which states that differences in body mass index have a relationship with a salivary flow rate affects salivary buffer capacity and salivary viscosity.[11] This statement is supported by Flink et al. which states that there is a significant relationship between BMI and salivary flow rate.[12]

Based on this study, it is suggested to measure the viscosity of saliva which is immediately carried out while taking it, so that there is no change due to temperature and time of saliva collection at midday to maximize saliva flow.

V. Conclusions

Based on the results of this study, it is known that there is a correlation between body weight and salivary viscosity in obese people. The body weight significantly affects salivary viscosity, $p = 0.0001$ ($p < 0.05$) where the higher increase is in group 3, obese patients with a mean is 0.017 compared with the group 1, underweight is 0.008, and people with normal body weight is 0.01.

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