

The Correlation between Body Mass Index (BMI) and Salivary PH on Type 2 Diabetes Mellitus Patients in Work Area of Health Center III North Denpasar

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Abstract The existence of epidemiological transitions and the shift of infectious diseases into non-infectious diseases cause high degenerative and chronic diseases such as Diabetes Mellitus (DM). There are several types of diabetes mellitus, but of all types, type 2 diabetes mellitus is DM, which has the highest prevalence of around 90-95% of all DM patients in the world. The increase in the number of people with Type 2 DM is caused by many factors, such as excessive weight or overweight and obesity. Determination of more nutritional status or overweight can be seen from the Body Mass Index (BMI). High BMI is associated with blood sugar instability and the potential for complications such as micro vascular complications, namely neuropathy. Neuropathy causes problems in the sympathetic and parasympathetic nerves which will have an impact on changes in the salivary acidity. The aim of the study was to determine the correlations of BMI and salivary pH on Type 2 DM patients in Work Area of Health Center III North Denpasar. This study was a correlation study with a cross sectional approach. The sample in this study amounted to 41 participants chosen by consecutive sampling technique. Data collection was done by measuring height, weight, and salivary pH. Correlation analysis used Pearson Product Moment with a confidence interval of 95% ($\alpha = 0.05$). The results of the Pearson Product Moment statistical test indicated that the correlation coefficient $r = -0.398$, and the Sig. value 0.010 ($p < 0.05$). This result indicated that there was a weak negative correlation between BMI and salivary pH on Type 2 DM which means the higher BMI value, the lower salivary pH on Type 2 DM

Index Terms— Body Mass Index, Salivary pH, Type 2 Diabetes Mellitus

I. INTRODUCTION

Globalization causes many changes in all aspects of life today. Changes in the health sector caused a high transition to chronic disease and degenerative disease, one of them is Diabetes Mellitus (DM). DM can be defined as a group of metabolic syndrome manifested by hyperglycemia caused by abnormal secretion of insulin or abnormality of the insulin's function [1] [2]. DM is a chronic disease that needs continuous treatment and adequate support to prevent further complications [3]

Epidemiologic studies that already done showed that DM prevalence relatively increasing in all over the world. According to the World Health Organization (WHO), in 2016 Indonesia was ranked 4th for the highest prevalence of DM after India, China, and the United States of America. In Indonesia, the DM prevalence is higher in the urban area (1.9%) rather than in the rural area (1.0%) [5]. Denpasar City was ranked 5th as the region in Bali which has the most people that live as a survivor of diseases (3.590 survivors) [6].

Ninety-five percent of DM survivor was diagnosed as Type 2 DM. The high prevalence of type 2 DM can be affected by many factors, one of them is overweight or obesity factor. The overweight or obesity status on type 2 DM patients can be determined by their BMI index. High BMI value IMT (>25 kg/m²) usually indicated that the patient has a high blood glucose level. This fact is parallel with a study done by Adnyan, Mulyati, and Isworo that found an individual with high BMI has a higher value of leptin compare with the individual with lower BMI index [7]. Leptin plays an important role in increasing fat concentration on the human body [4]. This leptin mechanism becoming one factor for an individual with high BMI index usually have higher blood glucose level and become more prone to be DM type 2 survivor than individual with lower BMI index.

High IMT value usually associated with various health problems. One of them is oral health problem, such as caries and xerostomia that commonly happen on high IMT individual [8]. Oral health problem in high IMT individual can happen due to high composition of adipose tissues on their parotid gland that affecting the saliva's flow [9]. The high amount of macrophages on the high IMT individual also decreasing saliva's flow and saliva's pH. Macrophages can increase the production of the inflammatory cells. These processes possibly cause damage to the parenchyma tissue on the salivary gland [10]. DM also associated with microvascular complications such as neuropathy. Neuropathy causes sympathetic and parasympathetic nervous system disorder that also affecting saliva's pH [11].

The level of the saliva's pH plays an important role in the health of the oral cavity. Low saliva's pH (5,2-5,5) can provide a perfect environment for the development acidogenic bacteria (*Streptococcus mutans* and *Lactobacillus*) and increasing tooth demineralization process, while a high saliva's pH can increasing the colonialization of bacteria that increasing the calculus formation in the oral cavity [12].

Public Health Center III in North Denpasar is a public health center that plays an important role in the health of four regions in North Denpasar. There were 763 cases (83 new cases, 679 old cases) of type 2 DM in May 2018 was reported. The cases of these type 2 DM were higher than type 2 DM cases that happen on Public Health Center II North Denpasar (287 cases, 126 new cases, and 161 old cases). An interview conducted before the study also showed that five of eight type-2-DM patients (62.5%) were often experiencing an oral health problem, such as stomatitis and xerostomia.

II. METHOD

This was a quantitative study using a cross-sectional approach to analyze the correlation between BMI and saliva's pH on Type 2 DM patients in Public Health Center III North Denpasar.

The study population is all Type 2 DM patients in Public Health Center III North Denpasar. Forty-one participants

finally were chosen based on the consecutive sampling technique.

Data collection was done through height measurement (cm) using a calibrated body weight scales, weight measurement (kg) by using a height measuring tape, and saliva pH measurement using a calibrated pH meter. An interview was also conducted to collect the participant's demography data (name, age, duration of DM diagnosis, and type of diet). The blood glucose level from the random blood sugar test profiles for each participant was collected based on the medical report on the Public Health Center III North Denpasar.

III. RESULT AND ANALYSIS

This study conducted on March 20th until April 20th in Public Health Center III North Denpasar.

Participant's Characteristic

TABLE I
PARTICIPANT'S CHARACTERISTIC

Participant's Characteristic	Frequency (n)	Percentage (%)
Age (years old)		
36-45	1	2.4
46-55	7	17.1
56-65	15	36.6
>65	18	43.9
Gender		
Male	23	56.1
Female	18	43.9
Duration of Type 2 of DM's Diagnosis (Years)		
<5	13	31.7
5-10	9	22.0
>10	19	46.3
Diet Type		
Vegetarian	1	2.4
Non Vegetarian	40	97.6
Physical Activity (Minutes/Day)		
<30	20	48.8
≥30	21	51.2
Random Blood Test's Result		
<150 mg/dl	14	34.2
150-200 mg/dl	11	26.8
>200 mg/dl	16	39.0

Based on Table 1, the majority of the participants were >65 years old (43.9%), male (56.1%), already diagnosed as DM patient for >10 years (46.3%), non-vegetarian (97.6%), the level of the physical activity were ≥30 minutes/day (51.2%), and the level of blood glucose from the random blood glucose test was >200 mg/dl (39.0%).

The Distribution of Participant's Characteristic Based on BMI

TABLE II
DISTRIBUTION OF PARTICIPANT'S CHARACTERISTIC BASED ON BMI

BMI (kg/m ²)	Frequency (n)	Percentage (%)	Mean ± SD
<17.0	1	2.4	
17.1-18.5	1	2.4	24.60 ± 4.46
18.6-25.0	19	46.4	

>25.1-27.0	8	19.5
>27.0	12	29.3
Total	41	100

Table 2 showed that the mean of participant's BMI was 24.60 kg/m². Twenty participant's BMI (48.8%) were above the normal range, where there were 8 participants (19.5%) with overweight, while 12 participants were obese (29.3%).

Participant's Distribution Based on Saliva's pH

TABLE III
PARTICIPANT'S DISTRIBUTION BASED ON SALIVA'S PH

Saliva's pH	Frequency (n)	Percentage (%)	Mean ± SD
<5.60	10	24.4	6.14 ± 0.7
5.61-7.00	29	70.7	
>7.00	2	4.9	
Total	41	100	

Based on Table 3, the saliva's pH of the twenty-nine participants (70.7%) were in normal range. The mean of the participants' pH was 6.14.

The Correlation between BMI and Saliva's pH on Type 2 DM Patient in Public Health Center III North Denpasar

TABLE IV
CORRELATION BETWEEN BMI AND SALIVA'S PH ON TYPE 2 DM PATIENT

Variable	R	r ²	p-value
Correlation between BMI and Saliva's pH	-0.398	0.158	0.010

Based on Table 4, the correlation coefficient (r) was -0.398 with Sig. value= 0,010 (p<0.05). This result indicated that there was a negative weak correlation between BMI and saliva's pH on type 2 DM patients. The higher the BMI value, the lower saliva's pH will appear on the type 2 DM patient. Statistical analyses also showed that the r² value was 0.158. This result means that 15.8% of the saliva's pH on the type 2 DM patient would be affected by their BMI.

IV. DISCUSSION

Nutritional imbalanced between intake and recommended dietary allowance would lead to nutritional problems, underweight or overweight problems. BMI is one nutritional status parameter. Type of food consumed can affect nutritional status. This study showed that 40 participants (97.6%) were non-vegetarian. Non-vegetarian participants are consuming higher animal protein compare with vegetarian participants. Animal protein is consist of higher cholesterol and fatty acids than plant protein [13]. This was the reason for the higher BMI on the non-vegetarian compare with the vegetarian.

The result showed that most (48.8%) the BMI of the participant was above the normal range. High IMT on DM patients can cause various health problems, especially oral health problems such as periodontal diseases, caries, and

xerostomia. The individual with high IMT has a high concentration of saliva bacteria. This condition makes the change of the activity of sialic acid, phosphorus, protein, immunoglobulin, and peroxide which made the saliva's flow decreasing [14].

The individual with high IMT usually has lower saliva's flow compare with the individual with lower IMT [15]. The low saliva's flow on the individual with high IMT can happen due to a high composition of adipose tissues on their parotid gland that affecting the saliva's flow [9]. A high amount of macrophages on the high IMT individual also decreasing saliva's flow and saliva's pH. Macrophages can be increasing the production of the inflammatory cells. These processes are possible causes damage to the parenchyma tissue on the salivary gland [10] [16].

A high composition of adipose tissues in parenchyma on parotid gland also causes the ductus and acini on the salivary gland becomes smaller and decreasing the salivary flow [17]. An individual with obesity also has a high concentration of macrophages. Macrophages would stimulate the production of the inflammatory cells such as Leptin and IL-1Ra. The inflammatory process on the individual with obesity happens continuously. This process was causing damage to the parenchyma cells in the salivary gland [10]. These parenchyma cells contained sinus elements that produce secret and using secretory ducts to transfer the secret out of the body. These inflammatory processes block the ducts and decreasing the flow of the saliva.

Saliva's flow becoming one important indicator that affecting caries lesion and oral health problem. Low saliva's flow will be decreasing the buffer capacity so that the saliva's pH would be decreasing. The level of saliva's pH in DM patients is usually acid or under the normal range. This could happen due to the high level of blood glucose. The blood glucose level increasing the diuretic process and decreasing extracellular fluid. These processes affected saliva production [18].

DM also causes some changes in the microvascular and neuronal systems that affecting the function of human organs. Microvascular changes cause the salivary gland's abnormal response to the neural and hormonal stimulation. Saliva secretion is controlled by autonomy nervous system, so neuropathy and angiopathy also can cause abnormality on the saliva function and change the flow of the saliva in the oral cavity. The decrease in the saliva's flow can decrease the level of saliva's pH [12]. The low level of saliva's pH can be increasing the development of aciduric bacteria or acidogenic bacteria (*Lactobacillus* and *Streptococcus mutans*). This condition makes the some oral troubles such as dry mouth, taste disorder, mucosal inflammation, burning mouth, tooth demineralization, difficulty on chewing, speech disorder, candidiasis, periodontal diseases, and caries[18] [19].

The weak correlation between BMI and saliva's pH can be affected by many uncontrolled factors during the study. Circannual rhythm is one factor that can be affecting the saliva's pH. Circannual rhythm causes different saliva flow

during the summer and the winter. In the summer, the flow and the volume of the saliva will decrease, so the saliva's pH also decreasing. While in the winter the flow and the volume of the saliva would increase [20].

V. CONCLUSION

This study found that there was a negative and weak correlation between BMI and saliva's pH on type 2 DM patients in Public Health Center III North Denpasar. This result indicated that the higher the BMI, the lower saliva's pH would appear on type 2 DM patients. A further study related to the correlation between the saliva's pH and DM complications that possibly happens needed to be conducted.

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