

A Study on Dietary Intake Categories and Fasting Blood Glucose Serum Among Adults with Type 2 Diabetes Mellitus

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Abstract--- *Lifestyle & diet management is needed in adults with T2DM. Usually, adults with T2DM had low diet compliance, their intake either lower or higher than their requirements. However, dietary intake is a main factor contribute in fasting blood glucose (FBG) level in T2DM patient. The aim of this study was to investigate the difference between dietary intake categories and FBG level in T2DM patients. This study used cross sectional design with total sample size 30 T2DM patients from three public health centres in Yogyakarta. Dietary intake was collected with multiple 24h-recall and divided into three group based on comparison with subjects' nutrient requirements. The FBG level was assessed once at the end of study. From this study, we could see that majority of the subjects had insufficient dietary intake, except fat and sucrose. We also found that the higher level of dietary intake of the subjects, the higher levels of their FBG. FBG levels increased as the subjects consumed food more than their needs, but no significant difference among three groups statistically. This study suggested all the health center to assess diet compliance in T2DM patients periodically so they could attain normal blood glucose.*

Keywords--- *blood glucose, Dietary, Diabetes Mellitus.*

I. INTRODUCTION

Globally, the percentage of adults with type 2 diabetes mellitus (T2DM) increases in every year. In 1980, people living with T2DM were about 4.7% and it was raising to 8.5% in 2014 [1]. T2DM is characterized by hyperglycemia, a condition of raised blood glucose level. When hyperglycemia occurs and not well managed, many complications can be develop in T2DM patients, such as macro and/or microvascular complications, that threaten T2DM patients' health [2]. Therefore, T2DM patients should be aware and control his/her blood glucose level in normal level.

According to Association of Indonesian Endocrinology (PERKENI), one of the main diabetes treatment is managing the patient's diet. People with type 2 diabetes mellitus should manage the amount (Jumlah), feeding schedule (Jadwal), and type (Jenis) of their food intake. In Indonesia, these eating pattern called 3J (Tepat Jumlah, Tepat Jadwal, dan Tepat Jenis). However, eating pattern or diet that emphasizing in appropriate portion sizes and type of food can help to achieve and maintain individualized blood glucose in T2DM patient [3].

Previous study showed that the quantity (amount) of energy intake in T2DM patients should be appropriate with their energy need. A study conducted by Chen et al. has explained that T2DM patients with energy intake higher than needed was associated with a faster deterioration of adiposity, insulin sensitivity, and β -cell function [4]. High carbohydrate include sugar-sweetened (sucrose, high fructose) food/beverages, and high fat diet is associated with increasing blood glucose level in T2DM patients.

Compliance to diet recommendations is an important thing for T2DM patients. A study has presented that the diet recommendations compliance in T2DM patients was inadequate, and it might increase the complications toward T2DM disease [5]. Another study conducted by Risnasari has reported that more than half respondent in that study were not obedience to diet (56.14% respondents). Risnasari also showed that there was correlation between diet obedience and T2DM complications (such as cataract, gangrene, hypertension, kidney dysfunction, and heart disease) [6].

The main objective of this study was investigating the relationship between dietary intake and fasting blood glucose level in adults with type 2 diabetes mellitus who has received nutrition counseling about diet for T2DM patients.

II. METHODOLOGY

This study was using cross sectional design. The sample size, considering previous study, was calculated at 30. The subjects were recruited by purposive random sampling from three public health centers in Yogyakarta. The inclusion criteria were 30-60 years old T2DM patients, live in Yogyakarta, member of PROLANIS (Program Pengelolaan Penyakit Kronis, a program for chronic disease patients, held by Ministry of Health) and has received nutrition counselling from nutritionist in their public health centers. The exclusion criteria were pregnancy and complication (ex: hypertension and dyslipidemia).

The dietary intake taken with multiple 24-h recall forms (twice at weekend and twice at weekday). The 24-h recall was collected once a week. Anthropometry and fasting blood glucose was assessed at the end of dietary data collection. All of those data were analyzed by STATA 13.0.

III. RESULTS AND DISCUSSIONS

a. Subjects' Characteristic

The mean age of the subjects was 52.6 ± 6.78 years old. This study consisted of 9 males (30%) and 21 females (70%). The mean BMI was 27.9 ± 3.97 kg/m². Based on their BMI, we could divide the subjects' nutrition status into three categories, normal (23.3%), overweight (20%), and obesity (56.7%). All of the subjects in this study has received nutrition counselling from their public health centers.

Table 1. Characteristic of the Subjects

	n	%
Age (years old)		
< 40	2	6,7
40-49	8	26,7
> 50	20	66,6
Sex		
Male	9	30
Female	21	70
Nutrition Status		
Normal	7	23,3

Overweight	6	20
Obesity	17	56,7
Nutrition Counseling		
Yes	30	100
No	0	0

3.2 Subjects' Diet Compliance

From anthropometry data, we can obtain the subjects' nutrition requirements. Energy requirement was calculated with PERKENI formula. Carbohydrate requirement has been considered 60% of total energy need. For protein and fat, consecutively, around 15% and 20% of total energy need. According to PERKENI, fiber should be consumed 25 g/day and sucrose could be consumed maximal 5% of energy need.

The dietary intake of the subjects collected with multiple 24-hour recall method (twice at weekend and twice at weekday). The subjects' dietary intake then compared with their dietary requirements. Their comparison was categorized into three categories, low (their intake were $\leq 80\%$ from their need), appropriate (their intake were 81-120% from their need), and high (their intake were $\geq 120\%$ from their need)[7]. The mean of subjects' dietary needs and intakes was presented in Table 2, while the intake categories in Table 3. Table 3 showed that majority of the subjects had intakes lower than their needs, except fat intake.

Table 2. Dietary Needs & Intakes of the Subjects

	Requirement (mean \pm SD)	Intake (rmean \pm SD)
Energy (kcal)	1531,84 \pm 343,1	1282,05 \pm 426,8
Carbohydrate (gram)	229,78 \pm 51,5	179,28 \pm 59
Protein (gram)	57,44 \pm 12,9	43,07 \pm 15,7
Fat (gram)	34,04 \pm 7,6	45,84 \pm 18,8
Fiber (gram)	25	9,02 \pm 3,9
Sucrose (gram)	19,15 \pm 4,3	13,46 \pm 9,6

Table 3. The Categories of Subjects' Intakes

	N	%
Energy		
Low	10	33,33
Appropriate	19	63,34
High	1	3,33
Carbohydrate		
Low	14	46,67
Appropriate	15	50
High	1	3,33
Protein		
Low	20	66,67

Appropriate	9	30
High	1	3,33
Fat		
Low	2	6,67
Appropriate	9	30
High	19	63,33
Fiber		
Low	29	96,67
Appropriate	1	3,33
Sucrose		
Appropriate	25	83,33
High	5	16,67

Based on Table 3, this study presented that majority of our subjects had lower dietary intake than their requirement (except fat intake). However, poor intake can affect people's daily life and wellbeing, such as fatigue, tiredness and less productivity. In addition, chronic insufficient intake may cause hypoglycemia in T2DM patient. Hypoglycemia is a condition that plasma glucose concentration decrease, <70 mg/dL. Hypoglycemia relates to functional brain failure, since glucose is the important fuel for the brain. It can lead to serious condition, such as coma and death in T2DM patient [9]. This study presented that only one subject had higher intake than recommendation in energy, protein, and carbohydrate intake. Meanwhile, more than half subjects had high intake of fat. Many of them still consumed fried food, although they knew that they should avoid it.

Result in the present study showed that the subjects who participated in this study had low diet compliance. Previous research has shown that T2DM patients had better adherence for drug treatment than for lifestyle modification [14]. Another study presented that only one-third of T2DM patients were aware about the importance of managing their diet [5]. Patient with T2DM also often report difficulty to planning their daily intake, therefore they prefer to control their blood glucose only with drug. Many factors related to patient diet compliance, such as demographic (low socioeconomic and level of education, ethnic minority), psychological (health beliefs, higher levels of stress and maladaptive coping), social factors (family and social support), medical system and disease-treatment related factors (chronic disease) [5]. Some subjects explained that their blood glucose rise more when consuming more foods/beverages (with/without sweetener), so they felt afraid and reduced their intake. It occurred because T2DM patients felt uncertainty about the right portion size. Similar case occurred in a previous study, personalized experience of dietary habits and his/her laboratory values was a reason of food abstinence [15]. It is necessary for all health workers to give recommendations with regard to how to put their recommendations into practice in daily life, for example diet recommendation and its portion size [15]. In T2DM patients, the right portion size can prevent hypoglycemia. Besides that, lack of self-control also be shown by several subjects. They still cooked and consumed sugar adding beverages (tea, coffee, and syrup), fried food, and unhealthy snack (high sodium like crackers, chips, etc). Those foods & beverages may increase patients' blood pressure, as high as blood glucose, therefore raise their risk of macro/microvascular complications (heart disease, kidney disease, retinopathy, neuropathy, etc) development.

3.3 Subjects' Diet and Fasting Blood Glucose

The mean of fasting blood glucose (FBG) level on this study's subjects were $135,03 \pm 48,5$ mg/dL. This study analyzed the relationship between subjects' dietary intake and FBG level using Kruskal Wallis and Mann Whitney test. Table 4 showed that higher energy, carbohydrate, protein, fat, and sucrose intake in the subjects might increase their fasting blood glucose level. On the other hand, higher fiber intake might reduce FBG level in the subjects, although there was no significant difference in FBG levels in the low, appropriate, or high dietary food groups (all nutrients).

Table 4. Dietary Intake and Fasting Blood Glucose

	N	Fasting Blood Glucose (mg/dL)	<i>p-value</i>
Energy			
Low	10	114 (48)	0,617 ^a
Appropriate	19	118 (27)	
High	1	153	
Carbohydrate			
Low	14	110,5 (46)	0,513 ^a
Appropriate	15	122 (110)	
High	1	153	
Protein			
Low	20	114 (60,5)	0,617 ^a
Appropriate	9	118 (22)	
High	1	153	
Fat			
Low	2	118 (56)	0,855 ^a
Appropriate	9	117 (40)	
High	19	118 (49)	
Fiber			
Low	29	118 (40)	0,386 ^b
Appropriate	1	104	
Sucrose			
Appropriate	25	111 (46)	0,231 ^b
High	5	130 (32)	

a. Kruskal Wallis Test (median(IQR))

b. Mann Whitney Test (median(IQR))

Type 2 diabetes mellitus (T2DM) is a chronic disease caused by insulin resistance. The prevalence of T2DM is increasing globally. In Indonesia, T2DM is one of ten major causes of death and its prevalence increasing every year [8]. The T2DM patients usually suffers with hyperglycemia, marked by their FBG level > 126 mg/dL. Lifestyle, including diet, is an important factor influencing blood glucose level. This study presented that there was no difference FBG level effect among low, appropriate, and high fat intake, but consuming excessive dietary fat, especially saturated fatty acid (SFA) and trans fatty acid (TFA), can impair insulin sensitivity and enhance hepatic glucose production. It leads to hyperglycemia in T2DM patient [10]. Excessive amount of fat intake also can stimulate inflammatory marker secretion, like tumor necrosis

factor α (TNF- α), that may aggravate complication in T2DM patient. For fiber intake, only one subject who had appropriate amount of dietary fiber. Increasing dietary fiber intake is important because dietary fiber has beneficial effect to improve insulin sensitivity, induce binding of bile acid (lowering cholesterol mechanism), and colonic fermentation (short chain fatty acid production and gut hormone) [11]. This study showed that subject who had more macronutrient intake, their FBG levels also increased, although there was no statistically difference among low, appropriate, and high food intake groups. The result was similar with study conducted by Ardyana, there was no association between diet and FBG status. Not only food intake, but also physical activity, level of stress, duration of disease, and others are affecting FBG level [12,13]. Unfortunately, this study only collected subjects' dietary intake data.

IV. CONCLUSION

From this study, we can conclude that there was no statistically difference between dietary intake categories with FBG levels in adults with T2DM. However, the dietary compliance in T2DM patient was considering low, thus it could affect their FBG level. We may suggest to inform patients about dietary recommendation (right portion size using household measurement) and the negative effect of reducing intake. Assessing patients' dietary knowledge and compliance, include their reason of disobedience, periodically is also required to obtain normal blood glucose.

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