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Restriction of Rice Portion and Consumption Pre-Meal Fruit with HbA1c Levels and Abdominal Fat for Type 2 Diabetes Mellitus Patient in Malang City

Pembatasan Porsi Nasi dan Konsumsi Buah Sebelum Makan dengan Kadar HbA1c dan Lemak Perut Penderita Diabetes Mellitus Tipe-2 di Kota Malang

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ABSTRACT

Background: Glycemic control is the basis for managing diabetes to prevent chronic complications in diabetes.HbaA1c levels reaching ≤7% is an indicator of achieving good glycemic control. The 3J principles (right type, amount, and schedule) in the pillars of meal management are not easy to apply, causing diabetes to have difficulty achieving glycemic targets.
Objectives: Analyzing rice portion restriction and pre-meal fruit with HbA1c levels and abdominal fat in people with diabetes in Malang City.
Methods: Experimental study type 'randomized controlled trial' with pre-posttest control group design involved 16 people with diabetes who were active in Prolanis activities at the Malang city health center. Respondents were randomly divided into 2 groups. HbA1c levels were taken 2 times, before and after the intervention. The t test and paired t test with a pvalue<0.05 were used to test the effect of the intervention on HbA1c levels, abdominal fat and abdominal circumference in people with diabetes for 3 months.
Results: Both forms of intervention can reduce HbA1c levels in diabetic patients. Limiting the portion of rice significantly reduced HbA1c levels (p=0.003) and visceral fat levels. However, determining the amount of rice with added pre-meal fruit did not significantly decrease visceral fat and abdominal circumference (p>0.05).
Conclusions: Limiting the portion of rice eaten by itself or combining it with pre-meal fruit may help diabetics lower their HbA1c levels.

INTRODUCTION

Disorders of carbohydrate metabolism are a major problem for diabetes mellitus (DM) or T2DM patients. Uncontrolled hyperglycemia conditions trigger damage to other organs such as the eyes, kidneys, nerves, heart and peripheral vascular system. Recently, glycemic variations in blood sugar levels, namely the pattern of rising and falling blood sugar levels, are more closely related to the incidence of diabetes mellitus complications1,2. Glycemic control +3month, as reflected by HbA1c levels, is still used as a standard for controlling blood sugar levels in T2DM patients. In addition, the results of examining HbA1c levels are the gold standard for assessing the response to medical and non-medical therapy in T2DM patients[1,2]. T2DM patients with poor glycemic control (HbA1c levels >6%) more easily experience diabetes complications and even death[3–5]. Eating management is an important part of the pillars of controlling diabetes mellitus. Intake of carbohydrate sources greatly influences changes in blood sugar levels, although intake of protein and fat sources also contributes to changes in blood sugar after eating if consumed in excessive amounts.[6,7]. Meal arrangements for T2DM patients in Indonesia have been regulated by the Indonesian Endocrinology Association (PERKENI), where the proportion of macronutrients in a day for diabetes sufferers is as follows: carbohydrates 45-65% of total energy, fat 20-25% of total energy and protein 0.8g/kgBB or 10% of total energy requirements[8].

Data from Malang City Health Profile show that the prevalence of T2DM patients continues to increase (2020-2022), where, on average the number of T2DM patients increases by 1.2% per year[9–11]. This shows that the application of food proportion recommendations is

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not easy to practice independently to achieve glycemic targets. Researchers around the world are currently still developing effective, efficient and appropriate eating management models for T2DM patients to control blood sugar after eating. Modifications to the order of eating, such as consuming vegetables or protein before eating rice, developed by researchers from Japan, show a slowdown in the spike in blood sugar levels after eating.[12–14]. The type of nutrient consumed before eating affects the process of gastric emptying, satiety, insulin secretion and other digestive hormones[15,16]. Apart from that, efforts to inhibit the performance of digestive hormones such as Gastric Inhibitory Polypeptide (GIP) and Glucagon-like Peptide-1 (GLP-1), which are related to insulin secretion by the enzyme Dipeptidyl Peptidase 4 (DPP4) are also being studied. Giving fruit before meals and/or in combination with physical exercise after meals can reduce the secretion of the DPP4 enzyme in T2DM patients[17,18].

Fruit is a recommended distraction for diabetes patients. The fiber, vitamins and antioxidants in fruit can affect a person's feeling of fullness and blood sugar levels[19–21]. The effects of manipulating the order of meal consumption (vegetables, fruit and protein before staple foods) on satiety and changes in postmeal sugar levels are being assessed. A study of young adults in Malaysia who consumed fruit before eating showed a satiety response compared to when fruit was consumed after eating[19]. Similar results were also found in a trial of consuming kiwi fruit before consuming cereal in adults in New Zealand where there was an increase in satiety and a decrease in glycemic response of almost 50%.[22]. Fiber can affect the viscosity of foods that have been eaten or have formed chyme. Thick chyme will slow digestion and absorption, causing a full effect and a slow increase in blood sugar[21]. Fiber has the ability to reduce the level of glucose absorption after eating so that the blood glucose response curve becomes lower and affects insulin demand[23].

Several studies related to limiting carbohydrate intake, especially in low-carbohydrate diets, have also had a positive effect on improving the response to blood sugar levels in T2DM patients[24–26]. However, PERKENI (2021) recommends that carbohydrate restrictions should not be <130 g/day to maintain stable blood sugar levels in T2DM patients. The T-style plate concept recommended by the Ministry of Health of the Republic of Indonesia for obese sufferers to lose weight can be adopted as a tool to limit carbohydrate intake in the main meal (rice)[27]. The T model plate is a concept for dividing types of food on a plate or lunch box which follows the rule of ½ portion of vegetables and fruit, ¼ portion of rice or cereal and ¼ portion of meat or its substitute (protein source). Studies implementing the T model eating concept for at least 3 months show improvements in HbA1c levels in T2DM patients[28,29]. In Indonesia, eating arrangements using the T-style plate concept are still aimed at obese sufferers, both teenagers and adults. It is necessary to study further how a simple eating management model that combines consuming fruit before meals with limiting portions of rice differs from the HbA1c and stomach fat levels of T2DM patients.

METHODS

Experiment studies were the type 'randomized controlled trial' by design*pre-post test control group.* This has been approved by the Malang Ministry of Health Polytechnic Research Ethics Commission with No: 488/KEPK-POLKESMA/2019. A total of 16 people who were participants in this research came from 3 Community Health Centers in Malang City with a number of health services for T2DM patients who are still below 80%. During the research, all participants continued to take anti-diabetes drugs from the Sulfonylurea class and metformin. Participants in this research must meet the inclusion criteria, including being aged 50-70 years, participating in the Elderly Program (Prolanis), having a BMI >23.5 kg/m^2, and exercising regularly 30-45 minutes/week. Meanwhile, the exclusion criteria included comorbidities such as hypercholesterolemia and heart disease, not smoking, not following a diet program or other forms of intervention that can affect blood sugar levels.

This research lasted for 3 months, from September to November 2019. The duration of this research referred to several similar studies regarding the provision of diet therapy in the form of carbohydrate restriction for 8-24 weeks which can change the HbA1c levels of T2DM patients[30–32]. Participants were randomly divided into 2 groups. HbA1c levels were taken 2 times, before and after the intervention. Limiting the portion of rice in this study uses a T-shaped plate divider. Group A (8 people) will apply the T-shaped plate concept by carrying a T-shaped plate divider. Group B (8 people) will apply the fruit consumption pattern before eating plus the model plate concept. T by carrying a T-shaped plate divider. On the first and last day of intervention, all participants will receive a breakfast menu with energy and nutrient content referring to Table 1.

Table 1. Composition of the Breakfast Menu Given to Diabetes Mellitus Patients as an Intervention

Menu	Portion (grams)
White rice	100
Tamarind vegetable soup	100
Balinese Spiced Eggs	50
Fried tofu	50
Ambon banana	50
Nutritional value per serving	
Energy 391.7 kcal	
Protein 14.8 grams	
Fat 16.8 grams	
Carbohydrates 48 grams	

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Menu	Portion (grams)
Fiber 4.4 grams	

In this study we calculated the number of samples needed for a parallel design trial comparing the application of the t model plate barrier with a combination of fruit consumption before meals and the application of the T model plate barrier to determine changes in HbA1c. Statistically significant differences were set at 95%, and test power at 80%. We estimate the effect size of changing the order of fruit eating with rice portion control to be a reduction in HbA1c of 1 ± 1.2% based on Goldstein's research[33]. Formula for calculating sample size (comparing 2 groups with quantitative data)[34] is as follows where Zα/2 = 1.96 (α = 0.05), Zβ = 0.842 (β = 0.80), standard deviation (SD) = 0.97% and d=effect size (difference between values average) = 1.8%.

$$n = \frac{2SD^2\left(\frac{Z\alpha}{2}+Z\beta\right)^2}{d^2}$$

$$n = \frac{2(1,2)^2(1,96+0,84)^2}{(1,8)^2}$$

n = 6.9

≅7 people per group

With consideration *dropped out* 10%, then the number of members will be 8 people per group.

Data collection on participant characteristics was carried out at the beginning of the first week of intervention. All participants will have their height (TB), body weight (BB), body mass index (BMI), level of visceral fat (VF) measured using *Body Composition Monitor*Model HBF-375 Karada Scan (China), and abdominal circumference with Onemed metline (China). In addition, blood pressure was measured using an Omron HEM 8712 (China) digital blood pressure meter. Food intake during the last 24 hours was collected by interviewing participants using form f*good recall*24 hours. Participants' food intake was monitored by enumerators twice a week via communication media (telephone, video or picture messages) or home visits for 3 months. Eating history is monitored on 1 working day (Monday-Friday) and 1 holiday (Saturday-Sunday) provided that it is not on adjacent days. Participants were also given a food intake monitoring book to record daily food intake. On days 2 to 89, participants will apply the consumption model according to the form of intervention in each group. Patients are provided with an eating guidebook containing the 3J eating principles (right schedule, right amount and right type), classification of food ingredients based on the glycemic index of food ingredients, specifications of fruit and vegetables that can be consumed freely or in limited quantities, use of t-style plate dividers and a list food exchange. Type A vegetables (very low calorie content) can be consumed freely, namely gambas (oyong), cucumber, fresh ear mushrooms, water pumpkin, watercress, radishes and tomatoes. Meanwhile, fruit with a low GI <55 includes pears, apples, dragon fruit and oranges and fruit with a medium GI: 56-65 includes bananas and papaya. HbA1c levels were measured 2 times for 3 months (1st day and 60th day), Kimia Farma laboratory staff came to the Community Health Center to collect blood specimens.

All data collected were entered into Microsoft Office Excel 2019, and statistical analysis was carried out using IBM SPSS Statistics version 25.0. Data were presented in the form of mean ± standard deviation (SD). Shapiro Wilk TestdUse it to find out whether the data is normally distributed or not. Parameter variations monitored between groups (A and B) were HbA1c levels, abdominal circumferencedVisceral fat will be tested using the Independent T-Test if the data is normally distributed. However, if the data was not normally distributed then statistical testing will be carried out using *Mann-Whitney U Test*Then the differences between treatments in each group will be analyzed using tests Paired Sample T Test if the data is normally distributed. However, on the other hand, if the data is not normally distributed, a test will be used *Wilcoxon*. The confidence level taken at 95% with a p value<5% is considered statistically significant.

RESULTS AND DISCUSSION

In the initial data assessment, it was found that all participants had physical activity that fell into the light category. The Directorate of Prevention and Control of Non-Communicable Diseases (P2PTM) of the Indonesian Ministry of Health states that light physical activity is daily activity that only requires a small amount of energy, namely <3.5Kcal/minute, such as walking leisurely, sweeping, cleaning floors, washing dishes, sewing, ironing. clothes, reading, writing or typing, driving, stretching or warming up exercises, fishing, and horse riding. A total of 16 people met the inclusion criteria and were willing to complete the intervention model for 3 months to participate in this study. All participants live around Mulyorejo Village, Malang City.

Table 2 shows the characteristics of participants based on several parameters. In terms of age, it was found that the age range of participants was between 50-60 years and, had been suffering from diabetes mellitus for 6-8 years and had a nutritional status of being overweight[35]. Fasting blood sugar levels in both groups A and B are still above the target for controlling fasting blood sugar levels based on PERKENI (2021) of 80-130 mg. The blood pressure values of all participants fell into the high normal category (130-139/85-89 mmHg)[36]. The condition of obesity that is often experienced by T2DM patients not only affects insulin resistance but also the elasticity of the arteries. Diabetes and hypertension are closely related because they both have similar risk factors, including impaired endothelial function, inflammation of blood vessels, arterial remodeling, atherosclerosis, hyperlipidemia and obesity[37,38]. El Meouchy et al. (2022) added that the close relationship between obesity and hypertension is related to the presence of abdominal fat, which affects the endocrine and immune systems of the body so that the chance of developing impaired insulin secretion, diabetes,

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hypertension and heart disease is greater[39]. A similar condition was also found in hospital patients in Bangladesh where the incidence of hypertension was more common in diabetes patients aged 60 years who had a fat-obese nutritional status, had suffered from diabetes for a long time, and lacked physical activity[40].

In terms of food intake, it was found that the average intake of energy and macronutrients, including carbohydrates, protein, and fat, for all participants was in the mild deficit category. Apart from that, it can be seen that there are statistically significant differences in the intake of energy, protein, fat and fiber in the two groups. The fiber intake of the majority of participants was still below the PERKENI recommendation, namely 25-30 g/day. All participants had low fiber intake with high fasting blood sugar levels. This condition is similar to diabetes mellitus patients in Kalimantan and Surakarta who have low fiber intake or below <20 g/day and also have poor glycemic control (HbA1c >6%)[41.42]. A study on diabetes sufferers who worked at PT. Telkom Indonesia shows that increasing vegetable intake for 12 weeks by 700 grams/day can improve HbA1c levels, body weight and cholesterol levels[43]. Apart from that, studies related to increasing the consumption of dates or raisins as much as 60 g/day for 12 weeks in diabetes sufferers showed there was no difference in HbA1c levels[44].

Table 2. Participant Characteristics Based on Intervention Group

Parameter	Group		*p-value*
	A (n=8)	B (n=8)	
Age (years)	53.88±9.22	60.25±6.54	0.13
BMI (kg/m2)	26.79±3.14	27.42±4.36	
Fasting blood sugar	174.63±28.24	172.38±37.60	0.89
Long suffering from diabetes	8.50±1.41	6.38±4.17	0.14
Systolic blood pressure (mmHg)	138.88±20,22	135±11.95	0.65
Blood pressure 61 metabolism (mmHg)	83±1004	83.13±12.23	0.65
24-hour food intake:			
Energy (Kcal)	1038.56±183.48	721.63±156.90	<0.05*
Carbohydrates (g)	122.01±3976	103.61±22.07	0.45
Protein (g)	40.79±14.85	27.59±8.32	<0.05*
Fat (g)	44.69±12.65	22.48±7.89	<0.05*
Fiber (g)	6.25±2.86	3.98±5.4	0.02*

Data are expressed as the mean±SD; The independent T test and Mann Whitney U test were used to compare variables between groups. The Independent T test is used for age, fasting blood sugar, duration of diabetes, systolic blood pressure, diastolic blood pressure, and energy intake, protein intake, fat intake and fiber intake during the last 24 hours. Mann Whitney U was used for BMI and carbohydrate intake. *p value<0.05 is considered significant

Changes in HbA1c levels in the two groups are presented in Figure 1. After 3 months of implementing the intervention model, a pattern of decreasing HbA1c levels in both groups was seen. The average HbA1c level in group A before implementing the T-plate eating model was 8.7±1.3% while group B which applied a combination of eating fruit before eating rice plus eating with a T model plate was 8.3±0.8%. When examining HbA1c levels on day 60, the results showed a significant decrease in group A (7.8±1.1%, p=0.003). A similar condition also occurred in group B although it was not statistically significant (7.8±1.2%). This is in line with research by Maneesing et al. (2023) and Bowen et al. (2016) where the consumption of carbohydrate sources of ¼ portion of the dinner plate can reduce HbA1c levels in diabetes sufferers[1,2]. Phe concept of limiting the consumption of carbohydrate sources at breakfast, lunch and dinner has the opportunity to reduce the total carbohydrate intake in a day. Changing the habit of consuming the main carbohydrate, in this case rice at each meal, to ¼ portion or ¼ plate and increasing the intake of vegetables and fruit to ½ portion or ½ plate, has a satiating effect on diabetes sufferers. The results of daily food intake interviews for both main meals and snacks showed that the majority of respondents rarely consumed snacks. They were used to eat 3 times a day with 1 or 2 times for snacks.

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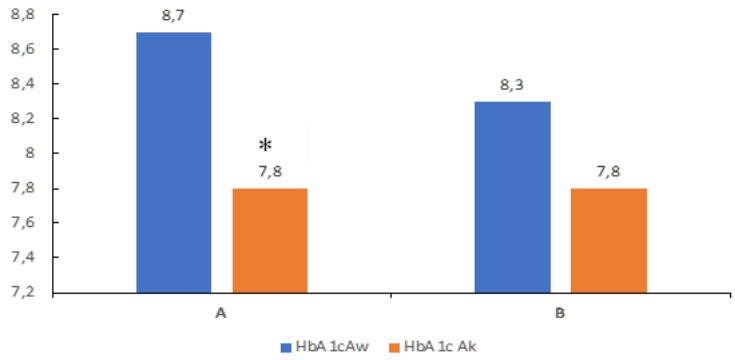

Figure 1. Average HbA1c Levels for Groups A and B After 3 Months

Disorders of carbohydrate metabolism experienced by T2DM patients should be balanced by regulating the intake of carbohydrate sources. A study in Japan with the implementation of limiting carbohydrates to 12% of total daily energy needs in diabetes sufferers can change daily carbohydrate intake (55-123 g/day) and HbA1c levels by 6-8%[45]. However, the American Dietetic Association (ADA) and Perkeni recommend limiting the intake of carbohydrate sources to no less than 130 g/day to prevent hypoglycemia[46–48]. Dietary compliance is a key factor in the success of implementing a diabetes diet or a modified form of eating model for T2DM patients in achieving glycemic targets. Several studies state that the dietary compliance of T2DM patients ranges from low to very low. This is related to the high level of exposure to information or control as well as support from family and health practitioners regarding their condition[49,50]. The practice of using a T-style plate which focuses on limiting the intake of carbohydrate sources at main meals (morning, lunch, evening) and followed by increasing fiber intake in the form of vegetables and fruit, also had an effect on reducing participants' blood sugar levels. Increasing daily intake of vegetables and fiber can improve glycemic control in diabetes mellitus sufferers[43,44]. The fiber content in natural ingredients such as vegetables and fruit have the potential to control blood sugar levels. Fiber cannot be digested by the stomach and can only be fermented by bacteria in the large intestine. Fiber can increase the viscosity of chyme[21]. *Chyme* the formation of food that has been digested in the stomach and entered the intestines. Increased viscosity can have an effect on delaying gastric emptying so that glucose absorption in the small intestine slows down[51]. In addition, fiber fermented by intestinal bacteria will produce active compounds in the form of short chain fatty acids (SCFA) which can activate G-protein coupled receptors, known as free fatty acid receptors (FFAR) 2 and 3, which are located in the intestine and in tissues. metabolically active, such as in the liver, adipocyte, myocytes, and pancreas[52].

In this study, we also analyzed changes in percent abdominal fat (visceral fat) and abdominal circumference in both groups. In Table 3, there was a trend in reducing abdominal fat and abdominal circumference over 3 months in group A, although it was not significant ($p>0.05$). However, this condition was inversely proportional to group B, where there was an increase in abdominal fat and abdominal circumference after implementing this eating model. The decreasing trend (%) of abdominal fat and abdominal circumference is in line with research by Perna et al. (2019) and Gower and Goz (2015) in T2DM patients who followed a low-carbohydrate diet for±6Sunday[47.48]. Restriction of carbohydrates causes a decrease in insulin secretion which plays a role in the transfer or storage of fat originating from 62 carbohydrate metabolism to the abdominal area[53.54]. A study in American adults who were given a high energy diet intervention through increasing meal frequency caused an increase in intrahepatic triglyceride (INTG) levels and (%) abdominal fat[55]. Carbohydrates are composed of chains of carbon, hydrogen and oxygen. In the process of energy metabolism, carbohydrates will be converted into glucose or oxidized into pyruvate[56]. In diabetes mellitus diet settings, it is stated that the recommended proportion of carbohydrates allowed for T2DM patients is between 45-65% of total energy requirements. This wide range of carbohydrate proportions should be balanced with an understanding of choosing types of carbohydrates in accordance with recommendations where the majority of carbohydrate sources chosen should be complex carbohydrates which are rich in fiber but low on the glycemic index.

Table 3. Changes in Percent Abdominal Fat and Abdominal Circumference Based on Groups A and B for 3 Months

Group	Parameter			
	Initial belly fat (%)	Final belly fat (%)	Initial abdominal circumference (cm)	Final abdominal circumference (cm)
A	10.1±3,4b	9.9±4.3b	97.7±9.9a	97.3±8.6a
B	12.4±5.2a	12.8±5.9a	99.2±10.9a	99.8±10.8a

Each value represents the mean±SD; *p<0.05, [a]Paired t test, [b]Wilcoxon

In the final part of this study, we carried out an analysis of the delta changes in abdominal circumference which are presented in Figure 2. During 3 months, it was found that there was no change in abdominal

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circumference in group A. However, this was different from group B, where there was an increase in abdominal circumference of 0.6 cm. The difference in delta abdominal circumference was significantly different between groups A and B (p=0.023).HThis is comparable to food intake monitoring data where it was found that participants in the group tended to consume fruit with a moderate to high glycemic index such as bananas, watermelon and papaya. The results of the interview showed that they consumed fruit that was easily available at a relatively affordable price. Fruit is a food that contains simple sugars in the form of sucrose, fructose, and possibly glucose. Simple sugar content and processed forms of fruit such as juice, dried fruit and candied fruit are associated with increased lipogenesis, triglyceride formation, increased fat mass and increased energy intake[57]. Studies on experimental animals (rats) show that giving fruit juice has no effect on increasing body weight when compared to giving added sugar[58]. Likewise, the results of a meta-analysis of experimental research with a Randomized Control Trial (RCT) design show that consuming fresh and whole fruit most likely does not contribute to excess energy intake and adipose tissue[59]. Further studies regarding the response of fruit groups with low, medium and high glycemic index to blood sugar responses in T2DM patients. This research did not measure or monitor physical activity in depth, so in future research, it is necessary to consider measuring physical activity and providing close assistance to each food intake consumed through diet food packages during the intervention period.

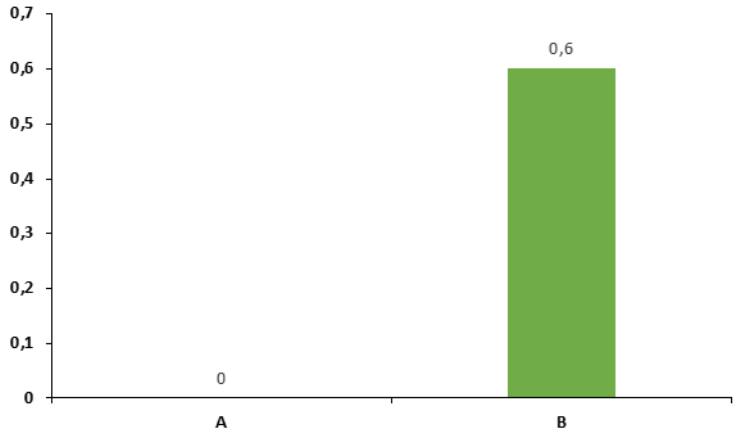

Figure 2. Delta Abdominal Circumference Groups A and B After 3 Months

CONCLUSIONS

There were differences in HbA1c levels after implementing the rice portion restriction model alone or adding fruit consumption before meals. This eating model has the potential to reduce HbA1c levels in T2DM patients. However, implementing the model of consuming fruit before eating with a T-style plate has the potential to increase the abdominal circumference of T2DM patients.

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