

# A New Diabetic Management Using Standardized Diet and Post Meal Plyometric Exercise

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**Abstract**—Prevalence of diabetes mellitus in the world has increased significantly in the last decades. Post meal physical exercise studies could improves blood glucose levels in diabetic patients. Plyometric exercise is a simple body movement that usually uses in body weight management. Therefore the aim of this study was to investigate the effect of combination of diet and post meal plyometric exercise on blood glucose levels of diabetic patients. A total of 19 diabetic patients were participated in this randomized control trial study. The control (C) group (10 patients) only received a standardized diet was determine using the IEA recommendation and the treatment (T) group (9 patients) received the same diet and post meal jumping jack for 2 min. Fasting and postprandial blood glucose levels were measured in the 1<sup>st</sup> and 7<sup>th</sup> days of intervention. Mean BMI in C and T groups was > 25 kg/m<sup>2</sup>. Reduced mean blood glucose levels in 0 min of the C group (146.90±68.34 mg/dL) in 7<sup>th</sup> day intervention were significant lower than 1st day (198.70±91.64 mg/dL). While mean blood glucose levels of the T group in 0, 30 and 60 min at 7<sup>th</sup> day intervention (143±53.95; 203.78±79.64; 237±72.76 mg/dL) were significantly lower than 1<sup>st</sup> day intervention (179.78±74.17; 254.67±102.73; 287.89±109.44 mg/dL) respectively. Standardized diet and post meal plyometric exercise can decrease postprandial blood glucose levels in diabetic patients. Further investigation are required to find appropriate type and duration of post meal exercise, based on individual patients with diabetes.

**Keywords**— *plyometric exercise; standardized diet; diabetes mellitus; blood glucose levels*

## I. INTRODUCTION

Diabetes Mellitus (DM) is one of non-communicable diseases that rapidly increases in the last decade and becomes a serious threat on global health population. The International Diabetes Federation (IDF) has reported that 5.6% adults (20-79 years old) in the world has diabetes mellitus and it is estimated to rise 1.3 times in 2045. Type-2 diabetes mellitus is very common found in community in either developing or developed countries [1]. The prevalence of DM in Indonesia is the sixth top rank around the world which is approximately 3%

Indonesian people living with diabetes. In addition, many diabetic patients have poor glycaemic control which leads to increase complications and to decrease their quality of life. Therefore it will increase global mortality rate and national health costs [2].

Some international diabetes organizations have recommended that non-pharmacology therapy through diet modification and physical exercise are the good way to achieve a normal glycaemic control [2]–[4]. Indonesian Endocrinology Association (IEA) has also developed 3 basic principles of recommended dietary management for diabetic patients (regularly eating time, consumed properly food amount and type) [5]. However, the majority of diabetic patients just reduces their meal frequency and food intake with high glycaemic index [6].

Furthermore, diabetic patients should do a physical exercise at least three times/week with 30-45 min duration and moderate intensity to enhance reduction of their blood glucose levels [3]. Recent studies have reported that exercise after meal can improve blood glucose levels of diabetic patients through insulin sensitivity and muscular glucose uptake [7]–[11]. Plyometric exercise or jumping training which consists of jumping, bounding and hooping is primarily used by athletes to improve their muscle strength and speed performance [12], [13]. The jumping jack is easily done by everyone, in everywhere and every time. Lately, this exercise has become popular for weight loss program [14]. Therefore the aim of this study was to investigate the effect of combination of standardized diet and post meal plyometric exercise on blood glucose levels in diabetic patients

## II. METHODS

### A. Experimental design and Participants

This study used a randomized control trial with pre-post-test control group design. The research protocol was approved by the Ethics Committee of Dr. Moewardi General Hospital with

Number 502/ VI/HREC/ 2017. Members of Diabetic Association in two Primary Health Cares in Tasikmadu and Kartasura Districts were participated in this study. Eligible participants had to match with subject criterias: aged 40-65 years old, never got diet therapy, did not smoke, had >130 mg/dL fasting blood glucose and >180 mg/dL postprandial blood glucose levels, had low physical exercise (30-45 minutes/day and <3 times/week), and took regularly oral hypoglycaemic drugs (metformin, sulfonylurea derivatives, or combination of both drugs).

Our experiment was done for 2 weeks, which was commenced with nutrition counselling session in the first week and the following week all participants got standardized diet and did the jumping jack. Firstly, 19 selected participants wrote their informed consent and had to attend the nutrition counselling session. Their body weight (BW) was then measured using a SMIC digital personal scale (China) and their body height used a GEA Medical SH-2A (China). Blood glucose levels were measured using Semi-Automatic Chemistry Analyser BM-sp7000S (China) and blood pressure used GEA Mercury Sphygmomanometer (China).

Before intervention, the participants were randomly divided into two groups: 10 participants in control (C) and 9 participants in treatment group (T). The C group received a standardized diet only and T group received a standardized diet and performed 5 min post meal jumping jack for 2 min. Both treatments was done at the Primary Health Cares in the first and seventh days of intervention. All participants had to do both treatments at their home for other days of intervention.

### B. Standardized Diet

Participants consumed a standardized diet that consisted of carbohydrate (mixture of brown and white rice), protein (tofu, egg or meat), 100 g mixed vegetables, and 1 piece of banana. Total energy and nutrient values of the standardized diet were calculated using the IEA equation (Table 1) and adjusted to energy requirement of each participants. Their daily food intake were regularly recorded in the diet note book, asked by enumerator in the first and seventh days of intervention and monitored by phone from the second to sixth days .

TABLE I  
ENERGY AND MACRONUTRIENT CONTENTS IN THE STANDARDIZED DIET

| Group | Intervention (Day) | Nutrition Fact (Mean±SD) |       |       |        |       |
|-------|--------------------|--------------------------|-------|-------|--------|-------|
|       |                    | E (kcal)                 | P (g) | L (g) | CH (g) | F (g) |
| C     | 1 <sup>st</sup>    | 529.34                   | 18.43 | 18.42 | 76.90  | 7.30  |
|       |                    | ±                        | ±     | ±     | ±      | ±     |
|       | 7 <sup>th</sup>    | 63.54                    | 3.51  | 2.16  | 8.90   | 0.55  |
|       |                    | ±                        | ±     | ±     | ±      | ±     |
| T     | 1 <sup>st</sup>    | 570.76                   | 18.99 | 22.53 | 76.74  | 7.80  |
|       |                    | ±                        | ±     | ±     | ±      | ±     |
|       | 7 <sup>th</sup>    | 68.50                    | 4.15  | 2.52  | 8.83   | 0.55  |
|       |                    | ±                        | ±     | ±     | ±      | ±     |
| T     | 1 <sup>st</sup>    | 510.14                   | 17.29 | 17.74 | 75.69  | 7.12  |
|       |                    | ±                        | ±     | ±     | ±      | ±     |
|       | 7 <sup>th</sup>    | 73.18                    | 3.45  | 1.97  | 11.30  | 0.64  |
|       |                    | ±                        | ±     | ±     | ±      | ±     |
| T     | 7 <sup>th</sup>    | 550.23                   | 17.69 | 21.78 | 74.56  | 7.62  |
|       |                    | ±                        | ±     | ±     | ±      | ±     |
| T     | 7 <sup>th</sup>    | 77.15                    | 3.94  | 2.24  | 11.23  | 0.64  |
|       |                    | ±                        | ±     | ±     | ±      | ±     |

E, energy; P, protein; L, fat; CH, carbohydrate; F, fiber; g, gram

### C. Blood Glucose Test and Statistical Analysis

Before nutrition counselling session, fasting and 2h-postprandial blood glucose levels of all participants were measured. The next blood glucose levels were measured in 0, 30 and 60 minutes after meal in the first and seventh days of intervention using the same device in earlier measurement. All collected data were presented as Mean±SD whereas statistical analysis were performed using independent and paired t-tests in IBM SPSS for Windows Version 20 with p value <0.05.

## III. RESULTS

Table II indicated the characteristics of all participants in this study. Control group had higher average of BW, BMI, fasting and 2h-post prandial glucose levels, and protein intake than that of T group although it did not differ significantly. While lower average of age, blood pressure, energy, fat and fiber intake was observed in C group, compared with T group but it did not reach significant differences. All participants in both groups had overweight with low physical exercise.

TABLE II  
BASIC CHARACTERISTICS OF DIABETIC PATIENTS IN CONTROL AND TREATMENT GROUPS

| Variable                           | Control<br>(n=10) | Treatment<br>(n=9) | <i>p</i><br>value |
|------------------------------------|-------------------|--------------------|-------------------|
|                                    | Mean±SD           |                    |                   |
| Age, years                         | 53.50±7.28        | 54.11±6.07         | 0.42              |
| BW, kg                             | 62.99±9.17        | 58.03±8.27         | 0.23              |
| BMI, kg/m <sup>2</sup>             | 26.79±2.73        | 25.88±3.77         | 0.28              |
| Duration of DM                     | 4.65±3.48         | 4.05±3.71          | 0.23              |
| Physical exercise<br>(min/week)    | 60±12             | 77±16              | 0.11              |
| Fasting glucose,<br>mg/dL          | 212.5±103.88      | 205.88±99.54       | 0.47              |
| 2h-post prandial<br>glucose, mg/dL | 316.9±154.6       | 305.07±150.46      | 0.45              |
| Systolic blood<br>pressure, mmHg   | 128±18.74         | 131.11±9.28        | 0.65              |
| Diastolic blood<br>pressure, mmHg  | 85±8.5            | 88.89±9.28         | 0.36              |
| Recall;                            |                   |                    |                   |
| Energy (kcal)                      | 916.6±375.09      | 981.411±342.59     | 0.69              |
| Protein (g)                        | 34.11±19.96       | 30.28±12.83        | 0.62              |
| Lipid (g)                          | 31.96±19.67       | 39.8±14.99         | 0.34              |
| Carbohydrate<br>(g)                | 129.31±43.37      | 129.1±54.12        | 0.99              |
| Fiber (g)                          | 6.72±1.96         | 6.99±3.91          | 0.86              |

BMI, body mass index

In comparison with blood glucose levels before intervention, lower mean blood glucose levels was found in C and T groups (Figure 1). In the 1<sup>st</sup> day intervention, the average of blood glucose levels in 0 min was similar between C (255.6±109.53 mg/dL) and T groups (254.67±102.73 mg/dL). Whereas mean blood glucose levels in 30 and 60 min of C group (198.7±91.64, and 298.60±109.53 mg/dL) were higher than T group (179.78±74.17; and 287.89±109.44 mg/dL) but it was not significantly different (p= 0.99 and p=0.83).

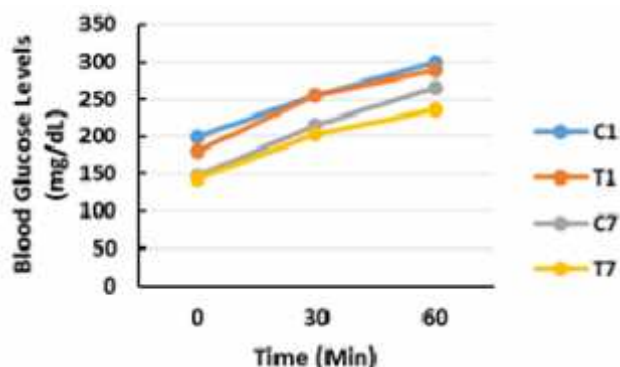


Figure 1. The mean blood glucose levels in 1<sup>st</sup> and 7<sup>th</sup> days after nutrition counselling and post meal exercise (C1 and T1 were group in the 1<sup>st</sup> day intervention while C2 and T2 were group in the 7<sup>th</sup> day intervention)

In the 7<sup>th</sup> day intervention, the average of blood glucose levels (0, 30 and 60 min) in both groups was lower than that of the 1<sup>st</sup> day intervention. All mean blood glucose levels in T group at the 7<sup>th</sup> day intervention were significantly lower than that of the same group in the 1<sup>st</sup> day intervention ( $p=0.03$ ;  $p=0.02$  and  $p=0.03$ ) respectively. Higher significant reduction of mean blood glucose levels in 0 min was observed in the C group ( $146.90 \pm 68.34$  mg/dL) with  $p=0.04$ . Mean blood glucose levels in C group after treatment did not significantly differ from mean blood glucose levels in T group.

Figure 2 showed that blood glucose levels in T group were higher than blood glucose levels in C group in different times except in 0 min blood glucose levels. C group had lower 0 min blood glucose levels compared with T group ( $-51.80$  vs  $-36.78$  mg/dL) with  $p=0.58$ . In contrast with 0 min blood glucose levels, T group had higher blood glucose levels in 30 and 60 min than in C group ( $p=0.72$  and  $0.62$  respectively).

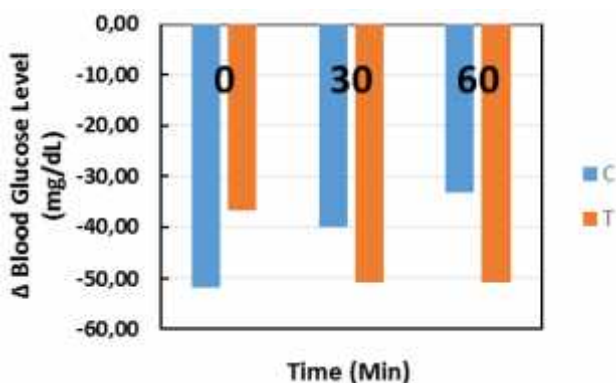


Figure 2. The mean blood glucose levels after intervention between C and T groups.

TABLE III  
THE AVERAGE OF ENERGY AND MACRONUTRIENT INTAKES IN C AND T GROUPS AFTER INTERVENTION

|         | Daily Needs of<br>Enery and<br>Macronutrients | Intake (Days)         |                         | p value |
|---------|---|-----------------------|-------------------------|---------|
|         |   | 1                     | 7                       |         |
| C Group |   |                       |                         |         |
| E (Cal) | 1435.6±300.9                                  | 1301±307.6<br>(90.6%) | 1241.5±224.3<br>(86.5%) | 0.61    |
| P (g)   | 71.8±15.1                                     | 43.4±10.4<br>(60.4%)  | 41.3±9.1<br>(57.5%)     | 0.63    |
| L (g)   | 39.8±8.36                                     | 49.7±18.1<br>(124.6%) | 39.7±11.6<br>(99.7)     | 0.20    |
| C (g)   | 197.4±41.4                                    | 178.5±38.1<br>(90.4)  | 185.8±33.1<br>(94.1)    | 0.62    |
| F (g)   | 20±0  | 13.6±3.9<br>(68%)     | 14.1±4.4<br>(70.5%)     | 0.74    |
| T Group |   |                       |                         |         |
| E (Cal) | 1354.1±265.3                                  | 988.6±372.4<br>(73%)  | 1129±394.3<br>(83.2%)   | 0.31    |
| P (g)   | 67.7±13.3                                     | 28±9.3<br>(41.4%)     | 36.5±14.7<br>(53.9%)    | 0.07    |
| L (g)   | 37.6±7.4                                      | 30.3±15.2<br>(80.6%)  | 39.6±18.9<br>(105.3%)   | 0.23    |
| C (g)   | 186.2±36.5                                    | 155.7±68.2<br>(83.6%) | 163±48.6<br>(87.5)      | 0.74    |
| F (g)   | 20±0  | 11.4±5.7<br>(57%)     | 13.9±5.6<br>(69.5%)     | 0.33    |

E: Energy; P: Protein; L: Lipid; C: Carbohydrate; F: Fiber

Energy and macronutrients intake in both group increased after nutrition counselling and post meal exercise except protein and lipid intake in C group (Table III). Total energy generated from all macronutrient intake in both groups did not reach 100%, compared with calculated daily needs of all participants. In both groups, carbohydrate and fiber intake increased 2.5-12.5% after 7<sup>th</sup> day intervention, compared with the 1<sup>st</sup> day intervention although it was not significant difference. Reduced energy, protein and lipid intake was insignificantly observed in C group after the 1<sup>st</sup> and 7<sup>th</sup> days intervention which varied from 2.9 to 24.9%. On the other hand, 10-24.7% increased energy, protein and lipid intake was found in T group after the 1<sup>st</sup> and 7<sup>th</sup> days intervention but it was not statistically different.

#### IV. DISCUSSION

In the present study we have evaluated energy and macronutrient intake in diabetic patients with overweight. In general, they have DM for several years ago, low physical exercise, uncontrolled blood glucose levels, low daily intake, and no metabolic syndrome. After nutrition counselling and post meal exercise, all diabetic patients have increased daily food intake especially fiber and reduced blood glucose levels. However increased energy and macronutrient intake in both groups were below than the recommended diabetic daily needs. Furthermore, more reduction of blood glucose levels and more increase of macronutrient intake are apparently seen in diabetic patients who got standardized diet and post meal physical exercise. These findings suggest that non pharmacological therapy is able to control blood glucose levels without administration of oral diabetic drugs.

Some diabetic patients have inappropriate perception for their diet. They restrict rice and sweetened foods and decrease meal frequency. Unfortunately, they still consume other carbohydrate sources like cassava, sweet potatoes, noodles, and bread during their snack time. That's why their blood glucose levels are above than the normal blood glucose levels before and after meal times (Table II). In this present study, we made a standardized diet (Table I) according to IEA (2015). Our data showed that nutrition counselling could reduce blood glucose levels in all diabetic patients. We controlled and monitor their diet through short message services or telephone. They could prepare their own meals according to diet recommendation issued by the IEA. Results of our study are in agreement with other studies conducted in Taiwan and Italy. Better glycemic control can be achieved by attending nutrition education and implementing self-care behaviour [15]. The other study reported that more dietary adherence is found in Italian diabetic patients who individually chose popular/ commercial diet programs, compared with Italian diabetic patients who got diet program from healthcare providers [16].

Although daily intake in all diabetic patients increased after intervention, increased fibers intake plays an important role in glucose homeostasis. Dietary fiber consumption will be fermented by human microflora in the large intestine which produce short chain fatty acids (SCFAs) like acetate, propionate and butyrate [17], [18]. From cellular and molecular aspects, SCFA provides 10% alternative energy fuel and increases free fatty acid (FFA) oxidation, glucose uptake in human muscles and adiposes, glucagon like peptide 1 (GLP-1) hormone in the colon, and insulin secretion in the beta cell pancreas [19], [20]. Therefore increased fiber consumption may result in reduction of blood glucose levels and weight loss in diabetic patients with overweight.

Our study showed that jumping jack after meal can reduce post prandial blood glucose levels in diabetics patients. Our results support a recent study that post meal exercise for 15 min in diabetic patients lower more blood glucose levels, compared with diabetic patients who did one time daily exercise [21]. Contrasting with our study, combination of aerobic exercise (cycling) and resistance training for 60 minutes in 3x/week could also improve glycemic control, lipid profile, blood pressure and Insulin receptor substrate 1 (IRS-1) expression in Brazilian diabetic patients [22]. Similar outcome was also observed in a healthcare study conducted in Korean diabetic patients with low and moderate intensities of aerobic exercise (walking for 30 minutes in five times/week). Those exercises could improve glycaemic control and prevent DM complication [23]. However our study did not include diabetic patients group with one-time daily exercise. Therefore we can not conclude that post meal jumping jack reduce more blood glucose levels than one-time daily exercise.

Nutrition counselling in our study has a positive effect in terms of reduction of fasting blood glucose levels but low effect in 1-h postprandial blood glucose levels in diabetic patients (>200 mg/dL). Jumping jack-added diet program after meal time is able to reduce around 30 mg/dL post prandial blood glucose levels in diabetic patients. This exercise may

stimulate glucose uptake by upregulation of GLUT-4 transporter and enhancement of mitochondrial function and biogenesis [24], [25]. Our result is in accordance with Pahra's study but their result indicated that post meal fast walking for 15 min could decrease 80 mg/dL blood glucose levels after 60 days [21]. Lower decreased blood glucose levels in our study are more likely related to different type and duration of physical exercise. Further studies are therefore required for improvement of physical exercise type and duration to achieve controlled blood glucose levels and to increase weight loss in diabetic patients with overweight.

## V. CONCLUSIONS

A combination of nutrition counselling and post meal jumping jack can reduce more blood glucose levels in diabetic patients, compared with diabetic patients with nutrition counselling only. Diabetic patients should follow recommended standard diet and post meal exercise to improve their glycaemic control.

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