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Effect of Modified Diet and Exercise on Insulin Level in Diabetes Mellitus Type-2 Patients

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Abstract: Diabetes Mellitus type-2 is a chronic degenerative disease with an increasing prevalence and incidence rate. Obesity and insulin resistance have been confirmed as the main causes. This study aims to understand the effect of modified diet and exercise to insulin level in diabetes mellitus type-2 patients. This was a comparative experimental study to modify body weight in diabetes mellitus type-2 patients with obesity in a diabetic clinic of Dr. M Djamil Hospital, from January until December 2010. Subjects in the treatment group received the consultation regarding exercise and modified diet for six months whereas subjects in the control group did not get any intervention. Then, in the end of the study, the BMI, fasting glucose and insulin level were measured in both groups. We found a significant difference in protein intake in both groups. We also found a significant difference in insulin level before and after the treatment (12.24±9.21 µU/ml and 8.58±4.40 µU/ml; p = 0.035, respectively). There is no significant difference in reduction of blood glucose level in both groups. We suggest to further research to see the role of glycemic index to blood glucose level in diabetes mellitus type-2 patients and distribution of information in community about the role of modified diet and exercise to reduce obesity in diabetes patients.

Key words: Diabetes mellitus type-2, obesity, glucose level, insulin level, BMI

INTRODUCTION

Diabetes mellitus (DM) is an endemic disease, not only in developed countries but also in developing countries. World Health Organization (WHO) and International Diabetic Federation (IDF) estimated that the number of diabetes patients worldwide will rise up to 333 million in 2025 or 6.3% of adult populations (Barry and Muller-Wieland, 2008).

Diabetes prevalence for all age-groups worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030. The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. The prevalence of diabetes is higher in men than women, but there are more women with diabetes than men. The urban population in developing countries is projected to double between 2000 and 2030 (Wild *et al*., 2004). In Indonesia, the prevalence of diabetes keeps rising from years to years. In 1982, the prevalence was rising in some areas in Indonesia: Jakarta from 1.7 to 5.7%, Ujung Pandang from 1.5 to 5.4%, even 6.1%. From some epidemiological reports, the diabetes prevalence was 1.5-2.3% among people aged over fifteen years old. In Surabaya, the epidemiological study in primary health centre, covered 13 460 people, the prevalence of diabetes in urban area was 1.43% compared to 1.47% in rural (Tjokroprawiro, 1983).

The increasing number of diabetes prevalence in some areas in Indonesia was caused by ethnical and lifestyle of people (Sutanegara and Budhiarta, 2000). Diabetes type-2 is caused by failure and decrease of the insulin to be secreted so that hyperglycemia occurred. The insulin resistance was a condition when there is inadequate response to physiological effect of insulin in some body parts i.e., muscles, adipose tissues and liver (Furukawa and Fujita, 2004; Schenk *et al*., 2008). The cause of insulin resistance differs by genetic and acquired factors. The acquired factor, such as environment factor, could cause DM type-2. Obesity, lifestyle and drugs i.e., steroids, diuretics and anti-hypertension was categorized as environment factor (Frogel and Velho, 2001).

Obesity was the major cause of DM type-2. Abdominally obese was suspected to be the trigger to insulin resistance and predispose to have DM type-2 (Schelenker and Long, 2007). Free fatty acids are released quickly so that there is an increase in free fatty acids from liver in the circulation. This condition lead to reduction of liver function to tie up and extract insulin from the circulation. This state also lead to hyperglicemia and increasing of gluconeogenesis. The increasing level of free fatty acids would inhibit the glucose uptake by muscle cells, though the insulin level keeps rising. The glucose level will remain high. This

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mechanism explain the physiological basis of insulin resistance which occurred in DM type-2.

The objectives of this study are to determine the effect of modified diet intervention on insulin and blood glucose and insulin levels and to determine the effect of exercise intervention to BMI in obesity patients.

MATERIALS AND METHODS

This was an experiment study aimed to modify body weight of DM type-2 patients with obesity in diabetic clinic Dr. M. Djamil Hospital from January to December 2010. The total subjects of this study was 110. Subjects were matched with inclusion and exclusion criteria. A half of the subjects grouped as in treatment arm (DM type-2, BMI IMT ≥27.0 kg/m^2) and the rest as in control arm (DM type-2, BMI<25.0 kg/m^2). The subjects in the intervention group received modified diet and exercise consultation in the first month, then, the diet and exercise were done for the following six months. Subjects in the treatment group were visited fortnightly to control their diet and exercise. The subjects in the control group were not received any of the intervention. In the end of the intervention, the BMI, blood fasting glucose and insulin level were measured in both groups.

We do interview to all subjects using questionnaire to collect both characteristics and exercise history. Nutrition intake data was collected using serial 24 h food recall during the intervention. Blood fasting glucose and insulin level were collected from blood sampling analyzed with ELISA method. Body Mass Index was calculated from height and body weight measurement using microtoise with 0.1 cm accuracy and SECA digital scale with 0.1 kg, respectively.

To analyze the difference before and after the intervention, dependent t-test (paired-samples t-test) and independent t-test were performed with $\alpha = 0.05$.

RESULTS

The study was done to mostly women in both treatment and control group with similar average of age. Most subjects had higher education.

Table 2 shows that subjects in treatment group had significantly lower in consumption of total energy, carbohydrate and protein intake during the intervention and the did exercise more frequent and longer compared to the control group.

There was no difference in blood glucose level and BMI index before and after intervention, although insulin level decreased after the intervention.

DISCUSSION

Characteristic of subjects: The majority of the subjects in both intervention and control group was female. This may be due to the number of female life expectancy in Indonesia is higher than men's (Central Bureau of Statistic of Indonesia, 2005). From age distribution, subjects who had type-2 diabetes mellitus in both treatments and the control group was at the age of 50-60 years with mean age 56.25±7.08 years and 58.33±6.90 years, respectively. It means that in old age, people are more susceptible to degenerative disease. This may be caused by the lowering of immune system in old age. The mean age of subjects were slightly lower that the life expectancy in Indonesia, i.e. 66 years (Central Bureau of Statistic of Indonesia, 2005).

Based on data shown in Table 1, two third of subjects both in intervention and treatment group were in high education level (completed high school) and a half of the subjects work as government employee with stable income and allow people to easily meet their demand for foods and spare times to practice exercise.

Nutrition intake and exercise: Modified diet and exercise consultation to the intervention group have resulted in the average intake of total energy, carbohydrate and protein intake. The average of protein intake among subjects in both intervention and control groups were 53.14±22.64 and 62.14±18.66 g/day, respectively. Proportion of carbohydrate from total energy in treatment group was 63.25% whereas in control group was 64.60%. Walking and aerobic were classified as exercises using aerobic energy system. This system is able to use fat reserve so that it would lose weight in obesity patients. This study showed that exercise was

Table 1: Distribution of subjects' characteristics based on age, sex, education level and jobs

Variables	Treatment (n = 55)	Control (n = 55)
Age (years)	55.93±7.43	57.94±6.93
Sex		
Male (%)	32.7	30.9
Female (%)	67.3	69.1
Education level		
Low (%)	29.1	27.3
High (%)	70.9	72.7
Occupation status		
Government employee (%)	41.9	49.1
Self employed (%)	7.2	7.2
Housewife (%)	38.2	36.4
others (%)	14.5	7.3

Table 2: Average of nutrient intake and level of exercise

Variables	Treatment (Mean±SD)	Control (Mean±SD)
EI (kcal)*	1774.38±703.41	1956.70±519.07
CI (g)*	290.09±115.49	315.45±92.40
PI (g)*	53.14±22.64	62.14±18.66
FI (g)	45.94±26.61	49.48±21.58
EF (times/week)	5.07±2.49	3.86±2.65
DOE (min/week)*	55.00±16.23	4 2.69±20.17

*Significant if p<0.05. CI: Carbohydrate intake, EI: Energy intake, PI: Protein intake, FI: Fat intake, EF: Exercise frequency, DOE: Duration of exercise

done more often in treatment group, with walking and aerobic as the most frequent type.

Difference of glucose level, insulin level and BMI before and after the intervention: The result of statistical analysis showed that there was no significant difference of blood fasting glucose level in the intervention group. Yet, there is a decline in glucose level before and after the intervention, from 184.91±76.87 to 181.19±74.44 mg/dl. This finding describes that with the intervention, there was an impact to decrease BMI (Table 3). The decreasing of BMI contributed to the decline of blood fasting glucose level of the patients.

The average of insulin level among subjects in the intervention group before the study was 12.24±9.21 µU/ml, thus decline to 8.58±4.40 µU/ml at the end of the study. There was a significant difference of the mean insulin level before and after the intervention. This is because insulin is used in body metabolism and contributed to the significant difference among subjects before and after the intervention. A study conducted by Goodpaster *et al.* (2000) found that hyperinsulinemia and insulin resistance were more profound in obesity subjects. This study showed that there was a decline in insulin level (Table 4) before and after the intervention.

Based on this data, it showed that the average BMI in intervention group (DM type-2 with obesity) was closely near the minimum threshold for obesity, which is ≥27.0 kg/m^2. This study also found that there was no significant difference between the average of BMI before and after the intervention. But, there was still the decline in BMI in the intervention group before and after the intervention: 30.13±3.49 to 28.72±3.50 kg/m^2. In control group, there were no differences between glucose level, insulin level and BMI at the beginning to the end of this study (Table 3, 4).

If we look closer from the difference of declining glucose level, insulin level and BMI, there were significant difference of the declining insulin level in both groups (Table 5), but there were no significance in glucose level and BMI (Table 5). The differences of the declining of glucose level, insulin level and BMI between both groups in Table 5, there was no declining of glucose level. The only prominent result was seen in the declining of insulin level between both groups as it was statistically significant. Also, the declining of BMI was quiet better in intervention group, as hamper test close statistically to significant result. From the data above, the modified diet accompanied by exercise gave best result in declining the insulin level and BMI rather than glucose level.

Conclusions: There are several concluding remarks from this study. Female patients were higher in this study. The majority of subjects were in high education level, work as government employee and the mean age

Table 3: Differences of glucose level, insulin level and BMI before and after the intervention in the intervention group

Variables	Mean±SD	p-value*
Glucose level (mg/dl)		
before	184.91±76.87	0.804
after	181.19±74.44	
Insulin level (µU/ml)		
Before	12.24±9.21	0035*
After	8.58±4.40	
BMI (kg/m^2)		
Before	30.13±3.49	0.104
After	28.72±3.50	

*Significant difference with p<0.05

Table 4: Differences of glucose level, insulin level and BMI before and after the study in control group

Variables	Mean±SD	p-value*
Glucose level (mg/dl)		
Before	169.42±7480	0.588
After	163.44±7700	
Insulin level (µU/ml)		
Before	7.03±4.79	0.271
After	8.45±5.52	
BMI (kg/m^2)		
Before	23.98±2.36	0.284
After	24.36±2.34	

*Significant difference with p<0.05

Table 5: Difference in glucose level, insulin level and BMI between groups

Variables	Mean±SD	p-value*
Glucose level (mg/dl)		
Treatment group	3.72±83.93	0.902
Control group	5.97±65.58	
Insulin level (µU/ml)		
Treatment group	3.66±9.39	0.017*
Control group	-1.42±7.38	
BMI (kg/m^2)		
Treatment group	1.41±3.89	0.057
Control group	-0.37±1.52	

*Significant difference with p<0.05

was around 50-60 years. We found a significant difference in total energy, carbohydrate and protein intake between the intervention compared to the control groups. The insulin level was also significantly difference between both groups. There were no significant differences of blood fasting glucose level and BMI before and after the intervention. Then, this study found that there was a significant difference in the declining of insulin level between the two groups.

Conflict of interest: There is no conflict of interest in this research.

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