IEESE International Journal of Science and Technology (IJSTE), Vol. 5 No. 3, September 2016, 1-11
ISSN : 2252-5297

Food Energy Density In Relation To The Occurrence Of Type 2 Diabetes Mellitus On People In Malang City

I Nengah Tanu Komalyna[1], Etik Sulistyowati[2], Yohanes Kristianto[3]

[1.2.3] Health Polytechnic, Ministry of Health, Malang

Abstract. Diabetes Mellitus (DM) is a degenerative disease that currently has a worldwide range of epidemic. *World Health Organization* (WHO) estimates that the number of adults aged 20 years or older who suffer from diabetes mellitus will increase from 135 million in 1995 to 300 million in 2025. Increased prevalence of diabetes mellitus is associated with increased prevalence of obesity which is closely associated with increased consumption of energy-dense foods. Foods with high energy density enables the body to obtain extra energy, so energy intake into the body exceeds the needs unwittingly and increasing its effect in the form of fat deposits that predispose to obesity. Therefore, this study aimed to analyze the food energy density and its relation to the risk of type 2 Diabetes Mellitus occurence on people in Malang City. This analytic observational study with case control design is done in the public healths center in Malang City. Subjects of the study were patients with type 2 diabetes mellitus as cases and non-diabetic as controls. Data collection was conducted by interviews using questionnaire, measurements, and calculations. The data were analyzed descriptively and by using *OODS Ratio* statistical test with significance level by 95%. Research findings on 38 subjects of the case group and 43 subjects of the control group showed that their favorite food is almost the same, ie Malang community's favorite menus such as *soto* (clear chicken soup), *rawon* (beef stew made with keluak), meatballs, chicken satay, *gule* (lamb curry), *rujak cingur* (vegetables salad with slices of beef snout), *gado-gado* (salad eaten with peanut sauce), that have energy density between 1.37 to 3.47 calories/gram and beverages with energy density of 0.4 to 2.2 calories/gram. There are significant differences between the intake of energy and carbohydrates in case and control group (p=0,008;p=0.006). There are no significant difference between the energy density of the food intake of the case group and the control group, although the case group had higher mean of energy densities. The results also showed that subjects with high-energy-density food are 1.48 times at risk of diabetes than those who did not. Therefore, further research is needed on the energy density of a variety of Malang City typical foods and education about proper diabetes mellitus diet is also needed as a prevention effort of increasing number of diabetics.

Keywords : *foods, energy, density, diabetes mellitus*

1. Introduction

Diabetes Mellitus (DM) is a degenerative disease that currently has a worldwide range of epidemic. *World Health Organization* (WHO) estimates that the number of adults aged 20 years or older who suffer from diabetes mellitus will increase from 135 million in 1995 to 300 million in 2025. In Indonesia, the prevalence of diabetes mellitus also showed an increase along with the increase in per capita income and the lifestyle changes, especially in big cities[1]. Based on the results of the study of *Diabcare* Indonesia in 2001, the majority (98%) of DM patients are classified as type 2 diabetes mellitus or not depending on insulin[2]. Diabetes mellitus, if not controlled properly, could result in various complications and chronic diseases in several organs in the form of neuropathy, nephropathy, ulcer or gangrene [3].

Increased prevalence of diabetes mellitus is associated with increased prevalence of obesity which is closely associated with increased consumption of energy-dense foods. Energy-dense foods are foods that have high energy density. These foods usually have high simple carbohydrate content added with sugar and fat, so they tend to be tasty, inexpensive and widely favored. Based on RISKESDAS Indonesia in 2007, the prevalence of most consumed risk food is seasoning (75.7%), sweet (63.1%) and fat (13.5%). Research findings on early adolescents showed that the average energy density of food of the adolescents group with obesity hypertension is higher than those without obesity hypertension (p=0,001)[4].

Low energy density foods consumption can lower total energy intake, while the excessive high energy density foods consumption contribute to the increase in total energy intake and also contribute positive energy balance [5]. Research in the United States on the subjects with low energy density food intake has lower total

energy intake (275-425 kcal/day) compared to subjects with high energy density food intake even though they consume more food (300-400 g/day more) [6].

Liking habit for eating high energy density foods or the ignorance selection of food based on the energy density is the risk factor of type 2 diabetes mellitus. Foods with high energy density enables the body to obtain extra energy, so the energy intake into the body exceeds the needs unwittingly and its effect is in the form of increased fat deposits in the body. This habit will facilitate the occurrence of obesity which is closely associated with the occurrence of type 2 diabetes mellitus.

Therefore, researchers wanted to conduct measurements of the food energy density and food intake in relation to the diabetes occurrences. Considering Riskesdas, 2007, the number of diabetic patient in Malang City is higher than the average number in East Java.

Based on the background of the study that have been described, the research problem is formulated as follows: the increasing prevalence of diabetes mellitus needs to get serious attention. Among the risk factors that need to be controlled is weight that exceeds the normal weight. Food intake has an essential role in an effort to control body weight. Until now, there is no energy density data of a variety of foods, especially foods that commonly consumed by people with type 2 diabetes. Meanwhile, people assume that fast food or junk food has a lower risk contribution to weight gain than conventional foods. This presumption needs to be proven with researching data collection. The purpose of this research is to analyze the food energy density and its relation to the risk of type 2 diabetes mellitus occurence in Malang.

2. Research Method

2.1. Type and Research Design

This research is analytic observational with case-control design. According to the research objective, this study aimed to determine the relation between the food energy density and the occurrence of type 2 diabetes mellitus in Malang [7].

2.2. Place and Time

This research was conducted in Kendalkerep health center, Mulyorejo health center, and Griya Bromo Malang Health Clinic, in October to December 2014.

2.3. Population and Subject

Subjects were patients who came to the health center; case subjects were patients diagnosed with type 2 diabetes mellitus during the research and control subjects were patients without diagnosis of type 2 diabetes mellitus. The research subject is accessible population with inclusion and exclusion criteria as follows:

a. Inclusion criteria:

1) Literate and can communicate well
2) 41 – 75 years old
3) Male and female
4) Agreed to participate in the research by signing *informed Consent*

b. Exclusion criteria:

1) Experiencing complications of diseases that require hospitalization
2) Have disease that makes it difficult to communicate
3) Pregnant or breastfeeding

The sample size necessary for this research is estimated based on the sample size formula[8], as follows:

$$n = \frac{2\,\sigma^2\,(Z_{\alpha/2} + Z_{\beta})^2}{(\mu_1 - \mu_2)^2}$$

Where:

n : a sample size of each group
σ : the standard deviation of the outcome 0,3 [4]
Zα : 1,96 with α=0,05
Zβ : 1,28 with desired power 90%
$\mu_1-\mu_2$:the difference in *mean outcome* of intervention and comparison group 0,22 [4]

Obtained value n = 38 for each group, estimated 10% chance escaped researcher notice, the estimated sample size of each group as many as 42 people. Sampling was done purposively in two Health Center in Malang that have the highest prevalence of type 2 diabetes mellitus.

2.4. Data Collection Technique

The data of identity and characteristics of the subject were obtained through interviews by using a structured questionnaire. Eating habits data was obtained by interview using FFQ and a 24-hour recall form. Weight and height anthropometric nutritional data status is done by measurement using weight scales to the nearest 0.1 kg and microtoise to the nearest 0.1 cm; and body mass index is calculated by using weight(kg)/height(m)^2 formula. Energy density data were obtained by calculating the total energy content of the food divided by the weight of food with units of kcal/gram.

2.5. Data Analysis Technique

The data that has been collected were tabulated and analyzed descriptively. The relation between energy density and the occurrence of type 2 diabetes mellitus is discovered by the OODS Ratio statistical test. Statistical significance performed at the level of accuracy of 95%.

3. Research Findings

This research was conducted in Kendalkerep health center, Mulyorejo health center and Griya Bromo Malang Health Clinic, in which people with diabetes mellitus and other diseases have medical examinations in Malang. Health centers and Griya Bromo Malang Health Clinic have diabetes corner, as a center for the provision of education to people with diabetes who visit health centers or clinics. The number of subjects who met the inclusion criteria for this research was 38 subjects with diabetes mellitus as the case group and 43 non-diabetic subjects as the control group.

3.1. Subject Characteristics

Subject characteristics include age, gender and body mass index that are presented in Table 1.

Table 1. Characteristics of Research Subjects

Characteristics	Group		P-Value
	Case	Control	
N	38	43	
Age (years) *mean*±1SD	57,70±8.49	49,37±12,06	0,050
Gender			
- Male	8(21,05%)	16(37,21%)	
- Female	30(78,95%)	27(62,79%)	
Nutritional status based on the Body Mass Index (kg/m^2)	25.32± 4.21	23,40± 4,2	0.554

Case group subjects were around 47-73 years old with a mean age of 57.70 ± 8:49 years, while the control group subjects were around 28-75 years old with a mean of 49.37 ± 12.06 years. The results showed significant age difference between the subject of case group and the control group (p=0,05), in which the mean age of case group subjects was higher than the control group. The subjects of the case group in this research, have been suffering from diabetes ranged from 3 months to 26 years. The fasting blood glucose levels ranged from 101 g/dL - 355 g/dL. Sixteen case group subjects (42,11%) have well-controlled blood glucose level. Where most claimed to have experienced a decrease in blood glucose levels, although not well-controlled.

The nutritional status of the subjects in this research, based on the Body Mass Index, is largely classified as *overweight*, with a mean body mass index of subject of the case group higher than the control group, although it was not statistically significant (p = 0.554).

3.2. Subject Eating Habit

In general, eating meals 3 times and snacks 1-2 times a day are the subjects' habit, both the case and control groups.

3.2.1. Favorite Food

The subjects in this research, both the case and the control group, had almost the same preference for the type of food, the food that was generally loved by the people of Malang City. The types of food include *rawon* (beef stew made with keluak), *soto* (soup), *gule* (lamb curry), chicken satay, *tahu lontong* (food consisting of rice steamed in a banana leaf served with soybean curd and peanut sauce), meatballs, *gado-gado* (salad eaten with peanut sauce), *rujak cingur* (vegetables salad with slices of beef snout), *kupang lontong* (food consisting of rice steamed in a banana leaf served with shellfish), *siomay* (dumplings), and *pecel* (salad made of blanched vegetables served with peanut sauce). Although the type of their favorite food is almost the same, the subjects of case group cut down on eating their favorite foods compared to control group. Likewise for the preferred beverage, they have almost the same type, ie coffee, tea, milk, soft drinks and fruit juices.

The type of animal and vegetable dishes in the menu which often consumed include tofu, tempe (fermented soybean cake), chicken, beef, eggs, fish, and goat's meat. Likewise for the types of vegetables consumed by research subjects both case group and control group are almost the same: leaf vegetables such as spinach, water spinach, mustard greens, Chinese cabbage and root vegetables such as carrots. Fruits like papaya, banana, watermelon, apple, and melon as well as seasonal fruits like mango is the type of fruit which is often consumed by the subjects.

Several types of carbohydrate food source that are rarely consumed is tuber crops such as bread, noodles, cassava, sweet potato, potato, and taro. Most states the reason that the rice and corn rice are easier in processing and do not cause bloating. Bread and noodles deliberately reduced from daily menu because the subjects are unaccustomed to them and because of old age, so they were afraid to consume them. Moreover, animal side dish such as duck and dairy products like cheese are very rarely consumed. In general, the food preparation is done by frying with little oil, sautéing and cooking with thin coconut milk.

The results of *Food Frequency Questionnaire* (FFQ) also showed that subjects of case group rarely consume sugary foods, including cutting down the use of sugar as well as brown sugar, whereas the control group consumed more freely. This is due to most of the subjects of case group, since being diagnosed with diabetes, were directly limiting sugary foods for fear of complications of diabetes.

3.2.2. Favorite Food Energy Density

The calculation result of the energy density of subjects' favorite foods and beverages in this research are presented in Table 2.

Table 2. Energy Density of Subjects' Favorite Foods and Beverages

Type of Food	Energy Density (Kcal/gram)	Type of Beverages	Energy Density (Kcal/gram)
Rawon	1,70	Coffee	2,2
Soto	1,83	Tea	0,5
Pecel	1,50	Milk	0,7
Gule	1,48	Soft Drinks	0,4
Lontong chicken satay	2,22	Fruit Juice	1,0
Meatball	3,47		
Gudeg	1,37		
Tahu lontong	1,85		
Rujak cingur	1,74		
Tahu campur	1,79		
Siomay	2,61		
Lontong kupang	1,96		

Gado-gado	2,15

The results showed that the energy density of favorite food of both subject of case group and the control group ranged from 1.37 to 3.47 cal / gram, and on beverages ranged from 0.4 to 2.2 cal / gram. If it is classified, the energy density of subjects' foods and beverages in this research is relatively low to moderate.

The selection of favorite food between the subject of case group and the control group do not differ on the type of food, it only differs from the number of subjects that love the food. The distributions of the subject based on favorite food by group are presented in Table 3.

Table 3. The Type and Amount of Research Subjects' Favorite Food by Group

Type of Favorite Food	Frequency	
	Case Group	Control Group
Rawon	25	12
Soto	21	32
Pecel	6	13
Gule	7	11
Lontong chicken satay	9	7
Meatballs	14	14
Gudeg	3	5
Tahu lontong	4	6
Rujak cingur	5	8
Tahu campur	2	6
Siomay	5	3
Lontong kupang	5	7
Gado-gado	8	5

Most of the control group subjects put soto (energy density = 1.83 cal / gram) as the favorite food in first place, second and third place, respectively meatballs (energy density = 3.70 cal / gram) and pecel (energy density = 1.50 cal / gram), whereas most of case group subjects prefers rawon (energy density = 1.70 cal / gram), soto (energy density = 1.83 cal / gram), and meatballs (energy density = 3.70 cal / gram).

3.2.3. Subject's Energy and Vitamin Intake

Results showed that energy intake of case group subjects ranged from 993.3 calories - calories 1815.7, while the control group subjects ranged from 511.8 calories - calories 2857.1. The mean of subject's energy intake, carbohydrate, protein, fat and fiber based on groups are presented in Table 4.

Table 4 shows that the energy intake of case group subjects was significantly lower than the control group, so the percentage of the adequacy of energy fulfillment of case group subject become significantly lower than the control group (p = 0.008). Similarly, the intake of carbohydrates, the case group subjects consuming carbohydrate in significantly lower amount than the control group (p=0,006).

Table 4. The Mean of Subject's Energy Intake, Carbohydrate, Protein, Fat and Fiber Based on Group

Energy and Vitamin	Group		P-Value
	Case	Control	
Energy			
- Intake (Kcal)	1032,83±387,88	1299,80±486,40	0,008
- Adequacy (%)	53,73± 22,17	61,05±22,01	
Carbohydrate			

- Intake (gram)	133,04±51,38	169,64±63,99	0,006
- % of energy	52,40±7,37	53,80±13,36	
Protein			
- Intake (gram)	36,13±19,34	46,20±21,44	0,300
- % of energy	13,80±2,11	13,90±2,93	
Fat			
- Intake (gram)	41,09±21,16	50,30±29,80	0,112
- % of energy	34,90±9,23	33,2±12,87	
Fiber			
- Intake (gram)	7,50±4,65	7,79±3,86	0,840*[*)]
- % of energy	30,00±18,6	31,16±15,44	

Protein intake of the case and the control group subject is not significantly different (p=0,300). As well as protein, there is also no significant difference on fat intake between case and control group subjects. However, fat intake tend to be high in both groups, where the mean of fat intake in case group subject is higher than the control group. The fat intake mean of case group subjects amounted to 34.90% ± 9.23%, and the control amounted to 33.2% ± 12.87%.

3.2.4.Food Energy Density and Diabetes Mellitus Occurrence

The results showed mean of food energy density of case group subjects amounted to 1.63 ± 0.36 kcal/g and the control group amounted to 1.61 ± 0.32 kcal/g. The subjects of case group tend to have higher food energy density compared to the control group. The distribution of subjects by the food energy density by groups are presented in Table 5.

Table 5. Distribution of Subjects Based on the Food Energy Density By Group

Food Energy Density	Group		Total
	Case	Control	
High	5 (13,20%)	4 (9,30%)	9 (11,12%)
Normal	33 (86,80%)	39 (90,70%)	72 (88,88%)
Total	38 (100,00%)	43(100,00%)	81 (100,00%)
ODDS Ratio		1,48	

Table 5 shows that the subjects of case group have higher food energy density (13.20%) compared to the control group (9.30%), although, statistically, the relation between the food energy density and the occurrence of diabetes in this study was not significant (p=0,645).

4. Discussion

The results of independent t-test showed a significant age difference between the subjects in the case group and the control group (p = 0.05), where the age of subjects in the case group was higher than the control group. This is in line with the results of the research by Zahtamal (2009) [9] about the risk factors for diabetes mellitus patients where it was found out that the age of the subjects were ranged from 45-70 years, as well as the research results by Agus Suryono, et al (2014) [10] which showed that patients with DM were aged more than 45 years old. It can happen since the ability of body tissues to absorb blood glucose declines along with the aging process.

In the case group, more subjects were female (78.95%) compared to the subjects in control group (62.79%). The same thing was also obtained from the research by Zahtamal (2009) [9] and Agus Suryono, et al (2014) [10], in which > 57% of DM patients with were female. This is because the habits of women who prefer to consume foods containing chocolate, sugar and ready to eat snacks, so that it can raise blood glucose levels.

The subjects in case group are mostly housewives (57.90%), which was more than the control group (46.51%). DM more commonly happen in female, especially housewives, because they require little energy for doing their activities and they have less physical activities that can lead to accumulation of fat in the body which can lead to insulin resistance and an increase in blood sugar levels of patients with type 2 diabetes. The lack of physical exercise or sport is also one of the factors which can cause type 2 diabetes mellitus [11]. According to a study conducted in China, if someone has less physical exercise or sport, then the glycogen reserves or fat will remain stored in the body. This will trigger a wide range of degenerative diseases and one them is type 2 diabetes mellitus.

The subjects of this case group have been suffering from diabetes for 3 months to 26 years. The fasting blood glucose levels ranged between 101 gr/dL - 355 gr/dL. Sixteen (42.11%) subjects in the experiment group had their blood glucose levels under control, where most of them had experienced a decrease in blood glucose levels, although had not been well controlled. Type 2 diabetes is the result of a combination between body tissues which develop resistance to insulin action of and the inability of the pancreas to produce enough extra insulin to handle the condition [12]. Type 2 diabetes is a pathophysiology disorder of insulin resistance, when insulin secretion occurs to compensate for the resistance of peripheral tissues even though it fails in the end of the mechanism. Major abnormalities in laboratory results are in the form of high blood sugar levels [13].

Based on the Body Mass Index, the nutritional status of the subjects in this study is mostly classified as overweight, where the average of body mass index of the subjects in the case group was higher than the control group although it was not statistically significant ($p = 0.554$). Purnawati research (1998) [14] showed a significant relationship between BMI with the onset of type 2 diabetes. High BMI has twice greater risk of developing type 2 diabetes compared to those with low BMI. The results of Miftahul Adnan, et.al research (2014) [15] also showed that patients with type 2 diabetes were mostly classified as moderate obese with a body mass index ranging from 25 to 29.9 kg / m2. High free fatty deposits can cause increased up-take of cells to free fatty acids and stimulate fat oxidation, which in turn will inhibit the use of glucose in muscle [16].

According to D'adamo (2008) [17], the levels of leptin in the body will increase on people who are overweight. Leptin is a hormone associated with obesity gene. Leptin acts on the hypothalamus to regulate body fat levels, the ability to burn fat into energy and satiety. Leptin levels will increase along with the increase of body weight. Leptin works on the peripheral and central nervous system. The role of leptin on resistance is because leptin inhibits the phosphorylation of insulin receptor substrate-1 (IRS) which consequently inhibit glucose uptake, thus causing an increase in blood glucose levels.

The results of Food Frequency Questionnaire (FFQ) showed that subjects at the case group rarely eat sweets and also reduce the use of palm sugar or brown sugar, whereas the subjects in control group consumed them more freely. This is due to the fact that after diagnosed with diabetes the subjects on the case group started to limit their consumption of sweet foods because they fear of diabetes complications.

Sweet foods or drinks contain elements of simple carbohydrates that produce high energy. Fructose does not give satiety effect after eating. Someone who consumes sugary foods/drinks will not be satisfied and will eat continuously. Excessive consumption will increase the intake of energy which would then be stored in the body as fat reserves. Consumption of fried foods (deep frying) has effect on the increasing consumption of energy and lipid. Fried foods have savory flavor, are usually crunchy, tasty and rich in fat. This causes a person to want to eat constantly, thus increasing high energy intake and low satiety. Low levels of satisfaction can affect the ability of insulin and leptin response, the hormone that stimulates hunger and satiety.

If it is classified, then the energy density of foods and drinks on the subjects in this study was low to moderate. This is because their favorite foods are snacks with complete nutrients with a well balanced composition of carbohydrate, protein and fat. These foods also contain enough fiber and water that can lower the value of the energy density on food. Most of the subjects in control group put *soto* (energy density = 1.83 cal/gram) as the favorite foods in first order, while in the second and third, respectively, they put *meatballs* (energy density =

3.70 cal/gram) and *pecel* (energy density = 1.50 cal/gram) as their favorite snacks. Most of the subjects in experiment group prefer *rawon* (energy density = 1.70 cal/gram), *soto* (energy density = 1.83 cal/gram), and *meatballs* (energy density = 3.70 cal/gram). The interviews showed that the subjects in the case group, after being diagnosed with diabetes and got counseling or education about diet for people with diabetes, began to change their eating habits by reducing or limiting sweets and fried food. Even if there was a desire for sweet drinks or sweet foods, they would use artificial sweeteners.

As for the low energy density of favorite foods on the subjects of the control group, it was because the subjects began to also reduce eating energy-dense foods, sweet foods and fried food. Although they do not suffer from diabetes, they were aware of the risk. They also felt that as they get older, their appetites are decreasing and they realized that food is associated with the incidence of various diseases especially for the elderly. The knowledge about food for the elderly and its implication to the incidence of degenerative diseases was acquired by the subjects from the nutrition counseling undertaken by students who conducted their field practice in the working area of public health centers or from dieticians in public health centers and Griya Bromo clinic which also have counseling and nutrition education program in its service.

Good and proper education will develop awareness of the patients to want to change and practice the diet recommended, so that their blood glucose levels can always be controlled within a normal range to prevent complications. DM patients who do not receive education have a 4 times higher risk of complications than those who received education.

The fact is that according to the characteristics of the adults and elderly, who began to experience problems with their appetite, associated with their income decrease, and their dependence on other family members that affect their eating habits, especially in the elderly. This is also corroborated by the results of research on obese and non-obese adolescents [4] [18] which showed that teenagers prefer food with a high energy density such as fried chicken, fried foods, and sweet bread, which according to the characteristics of the food selection in adolescents that no longer based on nutrient content, but it is more influenced by the socialization among their peers. Generally, teens tend to consume foods with high energy density that is usually high in simple carbohydrate content with added sugar and fat.

Type 2 diabetes disease is a degenerative disease that is strongly associated with diet. Diet is an overview of the types, the amount and composition of food eaten every day by someone. Urban life style with a diet high in fat, salt, and excessive sugar result in various diseases which includes diabetes mellitus [11].

Therefore, this study collected the data of energy and macro nutrients intake, where the intake of energy and nutrients of the subjects were obtained by calculating the average amount of energy and nutrients input from the food and drink consumed during the day obtained by using food recall compared to energy sufficiency. The adequacy of the macro-nutrients must include protein, fat and carbohydrates which were calculated based on the percentage of fulfillment of the total energy consumption.

Energy intake of the subjects in the case group was significantly lower than the control group, so the percentage of energy fulfillment adequacy of the subjects in the case group was significantly lower than the control group ($p = 0.008$). It is similar with the carbohydrate intake, the subjects in the case group have significantly lower consumption of carbohydrates compared to the control group ($p = 0.006$). From the interviews it was discovered that the subjects from the case group, since being diagnosed with diabetes began to limit the intake of daily meals mainly from carbohydrates intake such as rice, noodles, bread, cassava, and others, including sweet foods containing only energy derived from carbohydrates. This is the cause of low compliance of subjects of energy sufficiency in case group compared to the control group.

The restriction on the amount of energy and carbohydrates was done by the subjects in case group to decrease blood glucose levels. There is a tendency that subjects with low energy intake will have blood glucose levels in control. Olga Paruntu (2012) [18] state that people with type 2 diabetes with energy intake exceeding the needs

will have 31 times greater risk for experiencing uncontrolled blood glucose levels compared to people with the intake of energy as needed. However, if this happens constantly, it can have an impact on the occurrence of complications of hypoglycemia or diabetic ketoacidosis. Therefore, it is still necessary to have counseling or education to people with diabetes in order to do proper diet.

There were no significant differences in protein intake between subjects in case group and the subjects in control group ($p = 0.300$). Protein intake was compared to the total energy in accordance with the recommended diet to meet the body's needs. Protein is a source of amino acids that the body needs for growth process, cells and tissues repair and energy sources along with carbohydrates and fats. Protein can be obtained from animal and vegetables which act as the main sources of protein for the majority of Indonesian people, including the subjects in this study. Most of the fulfillment of protein was derived from vegetable sources, namely tofu, tempeh, and beans because they are easy to get and relatively cheap. There is no significant relationship between the level of protein intake with controlling blood glucose [18], but there is a tendency in people with type 2 diabetes who exceed the consumption of protein may have uncontrolled blood glucose levels. This is caused by the excessive intake of protein will result in excessive amino acid degradation and will become glucose precursor and CoA acetyl that will be used as energy sources [19].

As with protein, fat intake of the subjects in case group and control group also did not show any significant differences in this study. However, fat intake tends to be high in both groups, with the average of fat intake in subjects belong to the case group was higher than the control group. The average fat intake of the subjects in the case group was ranging from 34.90% ± 9.23%, and on the control group was ranging from 33.2% ± 12.87%. For optimal health, the recommended fat intake is about 20% -30% of total energy. Some research indicates that there are a significant association between fat intake and blood glucose levels control. This can be explained because in the process of fat metabolisms which mostly are triglycerides, it must be broken down into glycerol and fatty acids before it is absorbed through the emulsification process. The result of fat digestion in the form of lipids was absorbed by the mucous membrane of the small intestine by method of passive diffusion. Excess fat intake will lead to excessive supply of fat in the liver so that through the process of lipogenesis and with the help of very low density lipoprotein (VLDL), the fat can be stored in adipose tissues whereas the glycerol can be converted into glucose through glikogenesis process [20].

Fiber is an important component of the food for the health of the body. The effect of fiber in the gastrointestinal tract, among others, is slowing gastric emptying time, increasing transit time by slowing the movement of the small intestine and decreases the absorption of nutrients, including glucose and cholesterol, which is good for people with diabetes and hypercholesterolemia. However, the results of this study showed a low intake of fiber either in the case group or in the control group. Average fiber intake in the case group reach to only 7.50 ± 4.65 grams per day and the control group 7.79 ± 3.86 grams per day. When compared with the recommended daily fiber intake of 25 grams, this figure is relatively small. This is because in general the subjects consume a full meal with vegetables on the lunch menu only, while in the morning and evening they generally only consume staple food and side dishes. Low intake of energy and carbohydrates also become one of the factors affecting the low intake of fiber on the subjects.

The energy density of food is the amount of energy in a specific weight of food which is calculated by dividing the total daily energy intake (in calories) with a total weight of food consumed (in grams). The results showed the average energy density of foods of the subjects in the experiment group was 1.63 ± 0.36 calories/gram and in the control group was 1.61 ± 0.32 calories/gram. The subjects in the case group tended to have higher food energy density compared to the control group. Data energy density foods are classified based on the *cutoffs tertile* according to a gender-based research conducted by Jason, et.al. Food intake for women is considered to have normal energy density when the food consumed in a day has energy density ranging from 1.45 to 1.98 calories/gram and men 1.53 to 2.08 calories / gram.

Subjects from the case group had more high energy density foods (13.20%) compared to the subjects in control group (9.30%), although the relationship between the energy density of foods and the incidence of diabetes in

this study was not statistically significant (p = 0.645). However, there was a tendency that although the average energy intake in the case group was lower than the control group, the fat intake in the case group was higher than the control group. In addition, the fiber intake in the case group was lower than the control group and the majority of the subjects in the case group preferred food with higher energy density if compared to the control group although the types of food was similar.

The results of the research also showed that subjects with a high energy density food have 1.48 (95% CI = 0.366 to 5.955) times higher risk of developing diabetes compared with subjects with normal dietary energy density. In line with the results of this research, Jing Wang, et.al (2008) [21] states that, although not significant, the correlation between the energy density of the food with the incidence of diabetes mellitus that has been followed up for three years showed that subjects who had high energy density of food have 1.74 (95% CI = 0.890 to 3.337) times higher risk of suffering from diabetes compared to the normal ones.

5. Conclusions and Recommendations

Based on the results of this study, the case group that had foods with higher energy density (13.20%) compared to the control group (9.30%) showed that subjects with a high energy density foods have 1.47 (95 %, CI = 0.511 to 3.229) times higher risk to develop diabetes compared to those who consume foods with normal energy density, although not significantly proven. It is recommended that public health centers should give more diet education for diabetic sufferers to prevent complications of hypoglycemia and diabetic ketoacidosis because it the sufferers tend to be afraid to eat foods as because of their lack of knowledge and misleading information about diabetes diet. Some research on energy density foods that often consumed by people in Malang City in particular need to be conducted to obtain information in order to prevent the incidence of degenerative diseases associated with diet.

References

[1] Suyono, S. (2002). Tendencies of the Increasing Number of Diabetes Mellitus Patients (in S. Soegondo, P. Soewondo & I. Subekti (Eds.), *Guidelines for Integrated Management of Diabetes Mellitus*, Jakarta: Pusat Diabetes dan Lipid RSUP Nasional Dr. Cipto Mangunkusumo-FK UI.

[2] Soegondo, S., Soewondo, P., Semiardji, G., & Soebadri, S. (2003). The status of Diabetes control in Indonesia: A national audit of patients with type 2 diabetes mellitus in the year 2001. *Majalah Kedokteran* 53.

[3] Soeatmadji, D.W.(1996). Diabetes Mellitus and Infections. in: Textbook of *Internal Medicine*, edisi 3. Jakarta:FKUI

[4] Rizka Dyah Ayu Avihani & M. Sulchan. (2013). *Food Energy Density and Heredity as Risk Factors of Obesity Hypertension on Early Adolescents*. Program Studi Ilmu Gizi FK UNDIP Semarang

[5] Jacob C Seidell & Tommy LS Visscher. (2005). Community Health Aspects for over Nutrients. In: *Community Health Nutrition*. Jakarta: Penerbit Buku Kedokteran EGC.

[6] Jason H Ledikwe, et.al. (2006). Dietary Energy Density is Assosiated with Energy Intake and Weight Status in USA Adults. *Am J Clin Nutr*.83, 1362-8.

[7] Sastroasmoro, Sudigdo dan Ismail, Sofyan. (2011). *Basics of Clinical Research Methodology 4th edition*. Jakarta: Sagung Seto

[8] Lemeshow,S., Hosmer,D.W., Klar,J., & Lwanga, S.K. (1990). *Adequacy of Sample Size in Health Studies*. Pramono,D. & Kusnanto, H. (1997) (translated), Jogjakarta: Gadjah Mada University Press.

[9] Zahtamal. (2009). *Risk Factors for Diabetes Mellitus Patients.* http://berita kedokteran masyarakat.org/index.php/BKM/article/view/117/42. (accessed on 06 Jun 2013)

[10] Agus Sudaryanto, Noor Alis Setiyadi , Diah Ayu Frankilawati. (2014). The Correlation among Eating Pattern, Genetic, and Exercise toward Diabetes Melitlus Type II Incidents in Puskesmas Nusukan, Banjarsari working area. The 5th SNST Proceeding. Fakultas Teknik Universitas Wahid Hasyim Semarang 19-24

[11] Suyono, Slamet dkk. 2005. *Tendency of the Increasing Number of Diabetes Mellitus Sufferers.* Jakarta : FKUI

[12] Bryer, Michael. (2012). *100 Interviews about Diabetes*. Jakarta: PT Indeks
[13] Berkowitz, Aaron. (2013). *Lecture Notes: Clinical Pathophysiology with Samples of Clinical Cases.* Tangerang Selatan: Binarupa
[14] Purnawati, Lies. 1998. *Correlation between IMT and Diabetes mellitus with dependency on Insulin of Outpatients in RSUPN Cipto mangunkusumo in 1998. A* Thesis: Universitas Indonesia.
[15] Miftahul Adnan, Tatik Mulyati, Joko Teguh Isworo . Correlation between Body Mass Index and Diabetes Mellitus (DM) Type 2 Blood Glucose Levels of Outpatients in RS Tugurejo Semarang. *Jurnal Gizi Universitas Muhammadiyah Semarang 2 (1)*
[16] Mc.wright, Bogdan. 2008. *Guidelines for Diabetes Sufferers*. Jakarta: Prestasi Pustaka Publisher
[17] D'adamo, Peter, J. 2008. *Diabetes Healthy Diet Suitable According to Blood Types.* Yogyakarta: Delapratasa
[18] Olga Paruntu (2012). Nutrients Intake with Diabetes Control for Diabetic Sufferers.*GIZIDO*, Volume 4 No.1, Mei 2012.
[19] Linder, Maria C. 1992. Nutritional Biochemistry and Metabolism, Terjemahan Parakkasi, A. *Biokimia Nutrisi dan Metabolisme*. Jakarta: UI Press
[20] Almatsier, Sunita. 2003. *Basic Principles of Nutrition*. Jakarta: Gramedia Pustaka Utama
[21] Jing Wang, Robert Luben, Kay Tee Khaw, Sheila Bingham, Nicholas J. Wareham & Nita G. Foouhi. 2008. Dietary Energy Density Predicts the Risk of Incident Type 2 Diabetes. *Diabetes Care 31: 2120-2125.*