Food Consumption Pattern and Sociodemographic and Blood Glucose Level Correlates on Type 2 Diabetes Mellitus Patients

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Abstract

The objective of this study was to analyze food consumption pattern and sosiodemographic and blood glucose level correlates on type 2 Diabetes Mellitus (DM) patients in Kotamobagu, North Sulawesi. The study used clinical epidemiological design with survey method. The primary data was obtained through interview using questionnaire, direct observation and measurement. Secondary data was collected from documents in related institutions. The result showed that most of the subjects with type 2 DM and means blood glucose levels were female (214,5 mg/dL), aged 43-50 years (221.9 mg/dL), senior high school graduates (179.0 mg/dL), Mongondow ethnic (229.6 mg/dL), housewives (235.4 mg/dL) whose income 3,600,000 - ≤7,200,000 rupiahs per year (250.1 mg/dL). Food consumption pattern of the patients was mostly staple food+side dish+vegetables. Most of the subjects had consumption of unbranded palm oil, snacks and tea/coffee. The sugar added to the tea/coffee was commonly refined sugar. Mean nutrient intake of energy, protein, fat and carbohydrate was 1202 kcal, 34.5 g, 38.8 g and 195.5 g, respectively. Energy and protein adequacy level was categorized as severe deficit. Regression analysis models showed that food consumption pattern, family history of DM, DM medication use and Body Mass Index (BMI) were significantly correlated with blood glucose level among type 2 DM patients p-value <0.05.

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1. Introduction

National Workshop on Food and Nutrition X reported that recently Indonesia trends to have non communicable disease as the national problem, namely type 2 Diabetes Mellitus (DM). The countries with the highest number of diabetes people projected in 2030 are India (79.4 million people), China (42.3 million people), America (30.3 million people), Indonesia (21.3 million people), Pakistan (13.9 million people), Brazil (11.3 million people), Bangladesh (11.1 million people), Japan (8.9 million people), Phillipines (7.8 million people), and Mesir (6.7 million people) [1]. Agency for Health Research and Development Ministry of Health Republic of Indonesia reported that the prevalence of DM in Indonesia diagnosed by doctor was 1.5% for female and 0.4% for male, while based on symptom was 2.1% with prevalence tends to be higher in female than male [2].

Agency for Health Research and Development Ministry of Health Republic of Indonesia reported that the tendency of DM based on interview in 2013 was 2.1% (Indonesia), higher than in 2007 (1.1%). In two provinces named West Papua and West Nusa Tenggara, the tendency was declining, while other 31 provinces were increasing, such as in Maluku (from 0.5% to 2.1%), South Sulawesi (from 0.8% to 3.4%), and East Nusa Tenggara (from 1.2% to 3.3%). On the other hand, the mean proportion of poor consumption behavior of vegetables and or fruits was 93.5%, not changing from the condition in 2007. The population aged ≥10 years mostly consumed monosodium glutamate (7.3%), followed by sweetened food and beverages (53.1%), and fatty food (40.7%) [2].

The main pilars to control DM are food planning, physical exercise, medicine or pharmacological theraphy, and education. In food planning, beside energy, microminerals, such as selenium, zinc, chromium, and calcium, also influence blood glucose level. Good food choice will give nutrients according to the need of normal body function. On the contrary, improper food choice causing inadequate quantity and quality of the nutrients will cause essential nutrient deficiency [3]. About one third (34%) of glucose as the result of digestion will be brought to liver, 33% will be distributed to muscle and adipose tissue, while 33% will be distributed to red blood cell and central nervous system [4].

The objective of the study was to analyze food consumption pattern and sosiodemographic and blood glucose level correlated on type 2 DM patients in Kotamobagu, North Sulawesi.

2. Methods

2.1. Study Design

The study was clinical epidemiological study with survey method. This study described the correlated of independent and independent variables through determined hypothesis test. The study protocol was approved by Ethical Committee of Sam Ratulangi University Manado Number KEP 071301 dated July 15, 2013.

2.2. Population and Sample

The population was all type 2 DM patients documented in Health Office of Kotamobagu, covering five Community Health Center (CHC), which were Bilalang, Upai, Gogagoman, Kotabangon and Motoboi Kecil, and two hospitals, namely Datoe Binangkang (government hospital) and Monompia (private hospital). The minimum sample size was determined using proportionate stratified random sampling.

The samples were 108 type 2 DM patients from CHC and hospital from population of 532 people. The blood glucose level was measured from all subjects who signed the informed consent, except infant and child <15 years old. The assessment was not conducted to patient with severe diseases/coma, bleeding history, and regular use of blood thinner drug. Blood glucose measurement was conducted to patients aged >21 tahun, except pregnant women (ethical reason).

2.3. Model

In order to test the hypothesis of food consumption pattern and sociodemographic and blood glucose level correlated of type 2 DM patient, we used linier regression model Ostle and Mensing [5]. as follow:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$$

Notes :

Y_i : measured blood glucose level

$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$: regression coefficient

X_1 : age of the patient

X_2 : DM history of the father

X_3 : DM history of the mother

X_4 : food consumption pattern

X_5 : use of DM medicine

X_6 : body mass index (BMI)

ε : galate

2.4. Study Site and Time

The study sites were five CHCs, namely Gogagoman, Kotobangon, Motoboi Kecil, Bilalang, and Upai, and Datoe Binangkang Hospital and Monompia Hospital in Kotamobagu, North Sulawesi. The study was conducted in four months from May to August 2013.

2.5. Data Collection

The data collected was primary data obtained from interview with subject, observation and direct measurement, while secondary data was obtained from documents in related institutions.

The primary data were:

(1)   Subject characteristics (age, sex, social-economic characteristics, DM history, BMI) which were collected through interview using quesstionnaire and measurement. The anthropometric measurements (body weight and height) were conducted using standardized and validated tools.

(2)   Food consumption pattern. The data was obtained through 1 x 24 hour recall in three consecutive days. The data processing included:

a.   Nutrient intake calculation. The calculation was conducted by converting household portion to weight of the food (gram) and to nutrients using Food Composition Tables (FCT) of Indonesia. The calculation was based on formula by Hardinsyah and Briawan [6].

b.   Nutrient adequacy level. Energy and protein adequacy level was categorized as severe deficit when the adequacy level less than 70% [2].

(3)   Identification and availability of low GI local food

The GI value of local food was determined using mixed food IG determination procedure (Rimbawan and Effendi 2011). The chosen GI determination was used to determine GI of the local food consumed by the subjects with blood glucose level (fasting, 2 hour post prandial) measurement.

In order to analyze GI value of local food consumed by type 2 DM patient, we used International table of glycemic index: 2002 [7] . Further, the local food was classified based on GI value with this criteria:

-       Low GI   < 55
-       Medium GI   55 - 69
-       High GI   > 70

The GI value was presented in percentage.

(Source: Diabetes and Lipid Center Cipto Mangunkusumo Hospital/Faculty Medicine of University of Indonesia and Nutrition Instalation of Cipto Mangunkusumo Hospital, 2003).

2.6. Data Processing and Analysis

Data processing covered editing, coding, entry, and data analysis. Data collected was presented in tables and analyzed with descriptive and inferential statistics.

The data was analyzed quantitatively and qualitatively. Subject characteristics, food consumption pattern were interpreted in qualitative descriptive. Quantitative data were obtained from 1 x 24 hour recall and blood glucose level measurement which interpreted analytically. All data from the survey were cleaned, tabulated, and statistically analyzed using Microsoft Excel and Statistical Package for the Social Science (SPSS) version 17.

3.   Results

3.1 Subject Characteristics

(1) Sex and age of the subject

From table 1 and Based on sex, 71.3% (77 people) of the subjects were female. The patients with age range of 43-50 years were 28 people (25.9%).

Table 1. Distribution of subject by sex, age and glucose blood level on type 2 DM patients

Variables	n	%	Mean blood glucose levels (mg/dL)
Sex			
Male	31	28.7	262.6
Female	77	71.3	214.5
Total	108	100.0	228.3
Age			
≤ 26 years	3	2.8	168.3
27-34 years	7	6.5	207.6
35-42 years	14	13.0	251.3
43-50 years	28	25.9	221.9
51-58 years	20	18.5	251.9
59-66 years	24	22.2	234.4
67-74 years	9	8.3	199.6
≥ 75 years	3	2.8	170.3
Total	108	100.0	228.3

Mean glucose blood levels on type 2 DM patiens, higher by sex of male (214,5 mg/dL) and age 43- 50 years (221,9 mg/dL).

(2)   Social economic characteristics

a.   Education level, ethnic, and marital status

Education level of subject was 14 people (13.0%) of no schooling, 11 people (10.2%) of elementary school graduate, 29 people (26.9%) of junior high school graduate, 41 people (38%) of senior high school graduate and 13 people (12.0%) of university graduate. In Kotamobagu, most of the subjects were senior high school graduates. Education level was the indicator of the knowledge of the subject, particularly in controlling the disease.

Ethnic of the subject was Mongondow with 96 people (88.9%), Java with 6 people (6.8%), Minahasa with 3 people (2.0%), Gorontalo with 2 people (1.9%), and Bali with 1 person (0.9%). The marital status of the subject was 2 people (1.9%) of unmarried, 90 people (83.3%) of married, 4 people (3.7%) of divorced, 8 people (7.4%) of widow, and 4 people (3.7%) of other marital status.

b.   Occupation and income of the subject

The occupation of the subject was schooling with 4 people (3.7%), housewife with 50 people (46.3%), government employee with 18 people (16.7%), private employee with 2 people (1.9%), seller with 12 people (11.1%), farmer with 15 people (13.9%), labor with 1 person (0.9%), and other occupation with 6 people (5.6%). Based on the distribution, the highest proportion of the occupation was housewife (46%), while the smallest proportion was labor (1%). This showed that housewives have bigger potential to suffer from Type 2 DM. the income of the subject was ranged from 3,600,000 to 7,200,000 rupiahs per year.

(3)   Body Mass Index (BMI)

The mean body height and weight of the patients were 156.3 cm and 55.2 kg, respectively. Based on the distribution of BMI, 89 people (82.4%) were categorized as obese (BMI $\geq$27.0), 3 people (2.8%) as underweight (BMI<18.5), 12 people (11.1%) as normal (BMI$\geq$18.5-<24.9), and 4 people (3.7%) as overweight (BMI$\geq$25.0-<27.0). The blood glucose level was ranged between 126 mg/dL and 450 mg/dL with mean of 227.5 mg/dL. The patients who received insulin or other drug as medication by doctor or health personnel to reduce blood glucose were 39 people (36.1%), while the rest (53.9%) were not.

This study showed that almost all of the patients were obese (BMI$\geq$27.0). This may cause the occurrence of other disease and reduced insulin sensitivity. Based on regression test, addition of 1 kg/m^2 of BMI was associated with 1,472 mg/dL reduce in blood glucose level.

3.2. Food Consumption Pattern on type 2 DM patients

Food consumption pattern of the subject was varied. This study found food groups which giving risk to the patients, such as offal, fatty food, food cooked with coconut milk, salty food, preserved food, sweetened food and beverages, and beverages with caffeine. Wulanti [8] found that among obese patient with type 2 DM, the energy intake was 2129 kcal, protein 37 g, fat 62 g, and carbohydrate 358 g. The mean adequacy level of energy was 52.5% with categories of inadequate (30%), adequate (25%), and excess (45%).

(1)   Type of local food consumed

Based on the interview, the type of food in Kotamobagu was divided into five food groups. The staple food which often consumed was cereals, such as rice, sticky rice, tubers (cassava, sweet potatoes, and taro), and wheat flour. The side dish was animal food (fresh fish, canned fish/*fufu* fish, egg) and vegetables (*gedi* leaf, *goroho* banana, watercress, cassava leaf, and papaya leaf or flower. The subject also consumed fruits (*matoa*, papaya, banana), snacks (steamed cassava, steamed cassava with coconut milk, steamed sweet potatoes with or without coconut milk, and snack from flour, such as *panada*, *lalampa*, steamed or fried *goroho* banana.

Food consumption pattern of the subject was staple food+animal food with 26 people (24.07%), staple food+animal food+vegetables with 34 people (31.48%), staple food+animal food+fruits with 13 people (12.30%), staple food+animal food+vegetables+fruits with 28 people (25.92%), and staple food+animal food+vegetables+fruits+snacks with 12 people (11.11%). The study also found that the number of day with fruit consumption was ranged between 6 and 7 days with 2 (1.9%) and 28 people (25.9%), respectively. The portion of fruit consumption was between 1 and 4 portions a day with 81 people (75.0%) and 4 people (3.7%), respectively. The number of day with vegetable consumption was 7 days (the highest) with 77 people (71.3%) and 5 days (the lowest) with 3 people (2.8%). The biggest and smallest portion of vegetable consumption were more than 1 portion with 3 people (2.8%) and 1 portion a day with 42 people (38.9%), respectively.

Consumption of oil/fat, snack and tea/coffee.

Type of oil/fat commonly used by the patient was unbranded palm oil with 42 people (38.9%), branded coconut oil with 29 people (26.9%), unbranded coconut oil with 27 people (25.0%) and branded palm oil with 10 people (9.3%). Consumption of snack of the subject was 49 people (45.4%) as "often", 23 people (21.3%) as "always", 19 people (17.6%) as "sometimes", and 17 people (15.7%) as "not at all". There were 87 people (80.6%) answering "yes" in consuming coffee, tea, soft drink, energy drink, while 21 people (19.4%) answered "no". Adding sugar to tea or coffee was answered "always" by 62 people (57.4%), "often" by 11 people (10.2%), "sometimes" by 5 people (4.6%) and "not at all" by 30 people (27.8%). The type of sugar added was refined sugar with 71 people (65.7%), artificial sweetener with 24 people (22.2%), other type of sugar with 11 people (10.2%) and "do not know" by 2 people (1.9%). Most of the patients had inadequate consumption of oil and fat.

(2)   Nutrient intake

Energy and nutrients are very important for physical growth and development as well as to conduct daily activities to according Kartasapoetra and Marsetyo. Further, nutrient intake also has wider impact on human life. Taniguchi and Wang state beside on health, nutrient intake has influence on productivity, academic performance and income.

Based on the result, consumption of the nutrients mentioned in table 2 were less than national mean of 2150 kcal energy and 57 g protein per capita per day. The result showed that the energy adequacy level was categorized as severe deficit with 87 people (80.6%), mild deficit with 19 people (17.6%), adequate with 1 person (0.9%), and excess with 1 person (0.9%). Protein adequacy level of the patients was categorized as severe deficit with 74

people (68.5%), mild deficit with 22 people (20.4%), good with 4 people (3.7%), and excess with 8 people (7.4%). This showed the importance of food consumption which meets balance diet and modification of local food.

Table 2. Mean nutrient intake by type 2 DM patients

Nutrient intake	Mean
Energy (kcal)	1202
Protein (g)	34.5
Fat (g)	13.8
Carbohydrate (g)	195.5

3.3.   *Identification and Availability of Local Food in Kotamobagu*

Identification of type, quantity, and GI of local food was conducted to get description on daily consumption of local food. This study conducted the identification from various food sourse, namely staple food, side dish and snack in Kotamobagu.

(1)   Identification of local food (staple food)

Only several food had medium GI, such as corn with IG of 59. Local food (staple food) in Kotamobagu is suitable for the community and still preserved until now. It can be proven that most of the families are still consuming the food. The type and name of local food (staple food) were as follow:

  - *Inolut* (rice, corn)

  - *Sinabedak* (rice, sweet potatoes)

  - *Dinangoi* (sago flour, palm sugar, grated coconut)

  - *Pinadaal* (maize, gedi leaf, cassava)

  - *Toigu pinatung* (young corn)

  - *Kolak Toigu Molunow* (young corn, palm sugar)

  - *Kokolek* (young corn, sago, palm sugar, coconut milk)

  - *Buneabud* (palm sugar, coconut milk, sagoo flour, young corn)

  - *Inambal* (sago flour, offal)

- *Sinutuan* (gedi leaf, rice, young corn, spinach, watercress, cassava, yellow pumpkin)

- *Bage' bete binangoan* (taro' coconut milk)

- *Bage' kayu binangoan* (cassava' coconut milk)

(2)   Identification of local food (side dish)

The local food (side dish) in Kotamobagu contained low GI ranged from 11 to 53, except local food with corn as the ingredient (*kolak toigu molunow*, *kokolek*) with medium GI (59). The side dishes were as follow:

- *Manuk sinorang* (chicken, spices, coconut oil)

- *Ilosingan* (chicken, potato)

- *Bingka binongot* (small fish (*nike*))

- *Manuk binangoan* (chicken, potato, coconut milk)

- *Yondog ginolagag* (*gedi* leaf, *goroho* banana)

- *Yondog binangoan* (*gedi* leaf, coconut milk, *goroho* banana, bamboo sprout)

- *Kuyat bungai kapaya'* (papaya flower, young papaya leaf, watercress)

- *Longki* (young taro leaf)

- *Pangi binongot* (pangi seed, fresh fish)

- *Toya' i woku* (fresh fish/tuna, potato)

Among side dish, only *Toya i woku* used potato with high GI (89). There was also several local food whose GI still unknown, such as pangi seed, bamboo sprout, young taro leaf, and several spices.

(3)   Identification of local food (snack)

The local food (snack) was identified as having low GI (11-53), except koyabu with sticky rice flour as the ingredient (IG = 87). The details were presented as follow:

- *Kukis amu* (amu fruit, palm sugar, oil)

- *Cucur* (rice flour, palm sugar)

- *Biapong* (wheat flour, grated coconut)

- *Panada* (fish, wheat flour, refined sugar, coconut oil)

- *Bagea* (sago flour, coconut milk, peanut, walnut)

- *Koyabu* (sticky rice flour, cassava, palm sugar)

- *Binarundak* (sticky rice, coconut milk, spices)

- Fried *Batata'* (sweet potatoes, wheat flour, coconut oil)

- Fried *goroho* banana (goroho banana, coconut oil)

It is identified also several type of fresh fruit and beverages often consumed, such as pinapple (*nanasi*), matoa, mango (*kombiloy*), rambutan (*bolangat*), banana (*lutu'*); soybean drink, palm water (*saguer*) and young coconut (*simbuyung*).

Table 3. Effect of food consumption pattern and blood glucose level correlated on type 2 DM patients with ANOVA test

	Variables	Mean	SD	*P*-value
Type of food consumption	staple food+animal food	580.00 a	23.09	0.000**
	staple food+animal food+vegetables	433.67 b	18.12	
	staple food+animal food+fruits	344.75 c	34.87	
	staple food+animal food+vegetables+fruits	255.07 d	31.79	
	staple food+animal food+vegetables+fruits+snacks	160.19 e	26.36	
Consumption frequensi fruits/weeks	1 day	234.38 a	117.72	0.157
	2 day	221.45 a	78.09	
	3 day	197.39 a	98.81	
	4 day	187.29 a	50.37	
	5 day	201.00 a	0.00	
	>5 day	269.96 a	135.41	
Consumption frequensi vegetables/weeks	1 day	188.71 a	42.09	0.288
	2 day	236.00 a	55.17	
	3 day	288.11 a	180.04	
	4 day	166.14 a	48.58	
	5 day	254.00 a	169.74	
	>5 day	229.09 a	104.04	
Consumption oils and	Palm oil packaging	212.30 b	110.27	0.021*

fats/weeks		
Palm oil output	281.78 a	130.25
Coconut oil packaging	223.24 ab	86.72
Coconut oil home	201.29 b	95.86

Note:

*) Significant difference at 5% level

**) Significant difference at 1% level

Numeral with different letters indicate significant differences.

In order to test the hypothesis of food consumption pattern relationship with blood glucose level among type 2 DM patients, we used linier regression model.

Hypothesis:

H_0 : $\beta_1 = \beta_2 = ... = \beta_{18} = 0$

H_1 : minimum one β_i is not zero

The hypothesis criteria was rejecting H_0 if p<0.05. Since this study found that p value= 0.000**, H_0 was rejected meaning that food consumption pattern was associated with blood glucose level using p<0.05.

Hypothesis:

H_0: $\beta_j = 0$: There is food consumption pattern and blood glucose level correlated among type 2 DM patients

H_1: $\beta_j \neq 0$: There is no food consumption pattern and blood glucose level correlated among type 2 DM patients

The criteria was rejecting H_0 if p value<0.1. Since the food core consisted of the fruits and vegetables consumption, type of oil/fat often used, eating out of home, snack consumption, use of monosodium glutamate, beverages consumption had p value<0.1, this indicated that food core was associated with blood glucose level with p<0.1.

ANOVA shown that type of food consumption and glucose blood level significant difference at 1% level (0.000**). Food consumption oils and fats/weeks , significant difference at 5% level with p value (0.021*).

Table 4 showed that based on Pearson Correlation, food consumption, particularly energy source food consumption, had significant association (p<0.05) with blood glucose level among type 2 DM patients. This mean that more regular the local food consumption, blood glucose level may be controlled or reduced. Protein source food consumption was also significantly associated (p<0.1) with blood glucose level among type 2 DM patients.

Table 4. Result of Pearson Correlation on food consumption (energy, protein) and blood glucose level correlated among on type 2 DM patients

Nutrient		Blood glucose level (mg/dL)
Energy	Pearson Correlation	0,190
	Significance	0,049*
	N	108
Protein	Pearson Correlation	0,170
	Significance	0,078**
	N	108

Notes

*) significant

**) very significant

Tabel 5. Linier regression analysis effect factors that the blood glucose levels on type 2 DM patients

Variables		Coeffisien	P-value
Constanta		454.502	0.000
Age		-0.948	0.269
Diabetes history	Father	-59.300	0.071[*]
(Mother = 0)	Both parents	7.031	0.853
	Uncle	-24.287	0.729
	Aunt	-43.795	0.454
	Child	-82.891	0.117
	Our brothers	117.711	0.003[**]
	Do not know	16.800	0.526
Nutrient consumption level	severe deficit	-196.351	0.000[**]
(Good = 0)	mild deficit	-216.157	0.000[**]
	Excess	-235.411	0.001[**]
use of DM medicine (Tidak = 0)		31.273	0.149
BMI		-1.472	0.549
		F-aritmetic	3.163
		P-value (F test)	0.000
		R-square	39%

Note :

**) significant (1%)

*) significant (10%)

4.   Discussion

In Kotamobagu , there was more female (214,5 mg/dL), suffered from type 2 DM than male (262.6 mg/dL). This showed that female is more possible to suffer type 2 DM. The highest proportion of subjects was aged 43-50 years (221.9 mg/dL),. Most of the DM patients were aged 26 to 70 years. As the result of regression test, every increase in 1 year in age would reduce blood glucose level by 0.94 mg/dL.

Based on education level, most of the patients were senior high school graduates. Education level can be used to assess the knowledge, especially knowledge on the disease suffered by the subject. Ethnic of the subjects was mostly Mongondow. The marital status of the type 2 DM patients was mostly married. Previous study found some of married couples suffered from type 2 DM. Therefore, the household health expenditure was higher. Devi stated that traditional street food was related with family environment, particularly with maternal education level and frequency of eating out of home. Ohno stated that income was higher as the economic grew, while sustainable economic exchange caused lifestyle homogeneity and reduced habit of eating traditional food. There were 10 types of food in the study, but the number was increasing as receiving Chinese food. The introduction of Chinese food, which was plant basis, on the diet of traditional Mongolian animal improved the food consumption and nutrient intake and reduced risk of chronic disease.

This study proved that housewives had bigger potential to suffer from type 2 DM. The income of the subjects was ranged from 3.600.000-≤7.200.000 per year. The patients who received insulin or other drugs as medication from doctor or health personnel to reduce blood glucose level was 39 people (36.1%), while the other 69 people (3.9%) were not. BMI in Type 2 DM patients in Kotambagu obese (BMI ≥ 27.0).

BMI was calculated by dividing body weight in kilogram (kg) with square of body height in meter (M²) and not related to sex. BMI is significantly related to total body fat. Recently, BMI is used globally as tool to identify body weight excess and obesity where the prevalence of excessive weight (obesity) increases to according Hill. BMI is considered as the indicator of adipose tissue in the body. Even though BMI does not measure body fat directly, BMI is correlated with body weight measurement using *underwater weighing* dan *dual energy x-ray absorbtiometry* (Grummer-Strawn). BMI is used for adult with age 18 years and above. BMI cannot be used for infant, child, adolescent, pregnant woman and sport athlete. Besides, BMI also cannot be implemented in special case (disease), such as edema, ascites and hepatomegaly [23]. Body weight increase and obesity was the main factor of type 2 DM contributing 60-90%. Goldstein stated that among people with excessive body weight, insulin sensitivity was declining. The body weight reduction below 10% showed increased insulin asensitivity and glucose tolerance and reduced cholesterol serum as well as hypertension. This study described that most of the type 2 DM patients were obese (BMI≥27.0) which further might cause occurrence of other disease and reduced insulin sensitivity. Based on regression test, the increase in BMI by 1 kg/m^2 might reduce blood glucose level by 1.472 mg/dL.

Prevalence of underweight, overweight, and obesity among adult were 8.7%, 13.5% and 15.4%, respectively. The lowest prevalence of underweight among adult in North Sulawesi was 5.6%, while in 2013, the prevalence was the highest (34.7%). There was tendency that the prevalence of obesity among adult (>18 tahun) was

increasing in each province in year 2007, 2010 and 2013. Prevalence of obesity among male adult in 2013 was 19.7%, higher than in 2007 (13.9%) and in 2010 (7.8%). While, the prevalence of obesity among female adult (>18 tahun) in 2013 was 32.9%, increased by 18.1% from year 2007 (13.9%) and by 17.5% from year 2010 (15.5%). There was no big change in proportion of normal nutritional status from year 2007 to 2013 (<40%). There rest was variation of stunting-obese and normal-obese which tends to be increased. That proportion of national population ≥10 years who consumed sweetened food/beverage in a day was 53.1%. Proportion of population with consumption of fatty food, cholesterol and fried food ≥1 times per day was 40.7%.

Kittler dan Soucher in study food is defined as element with nutrients to maintain human growth. Food is element other than drug which contains nutrients which is useful when it enters the body. The functions of food are to prevent disease, maintain body health, and cure disease. From the statement by Hipocrates in Lucock "Let food be thy medicine and medicine be thy food", it can be understood that food have characteristics to counter various diseases so that it can maintain health and improve immunity [3].

Food consumption pattern are quantity and quality of food consumed in particular area. Food consumption pattern as a set of food including type and average quantity of food commonly consumed by population in particular time. From the result of 1 x 24 hour recall which was conducted in three consecutive days, food consumption pattern of the subjects were varied and classified in six categories. We obtained food groups containing risk for type 2 DM patient, such as offal, fatty food, food processed with coconut milk, salty food, preserved food, sweetened food/beverages and caffeinate beverages. Patient with type 2 DM and obese, the energy intake was 2129 kcal, protein 37 g, fat 62 g, and carbohydrate 358 g. The mean adequacy level of energy was 52.5% with categories of inadequate (30%), adequate (25%), and excess (45%) [8]. Based on interview, some of the patients had daily consumption of staple food, side dish and vegetable. The patients were expected to improve the consumption based on balance diet and add snack. The staple food which often consumed was cereals, such as rice, sticky rice, tubers (cassava, sweet potatoes, and taro), and wheat flour. The side dish was animal food (fresh fish, canned fish/*fufu* fish, egg) and vegetables (*gedi* leaf, goroho banana, watercress, cassava leaf, and papaya leaf or flower. The subject also consumed fruits (*matoa*, papaya, banana), snacks (steamed cassava, steamed cassava with coconut milk, steamed sweet potatoes with or without coconut milk, and snack from flour, such as *panada*, *lalampa*, steamed or fried *goroho* banana.

There are four food groups in Indonesia with different functions. The first food group is staple food as carbodydrate or energy source, such as rice, corm, sweet potatoes, sago, with function of satiety and considered good for health. The second group is side dish as protein and fat source, such as meat, fish, egg, tempeh, tofu which form the good taste of the food. Regarding amino acid combination, biological value of animal protein is higher than plant protein. Food consumption pattern is influenced by how the person gives the meaning of the food. Usually, the acceptance and refusal of particular type of food is difficult to change because it is private [4].

This study showed that the consumption of vegetables and fruits tends to be poor since it had not meeting the balance diet (varied and nutritious). There was significant difference in vegetables consumption between intervention and control group (p<0.001). There was also decrease in fasting blood glucose (p=0.034) and 2 hour post prandial glucose level (p=0.006) among intervention group, compared to control group [9]. Poor fiber

consumption, older age, and hypertension increased risk of DM among overweight subjects [10]. Further, Prijadi found that soluble fiber consumption is the protective factor of type 2 DM.

Fruit contain a wide range of specific bioactive substances which can act through multiple pathways in the human body e.g. as antioxidants, reduce inflammation and improve endothelial function . High fruit intake has been shown to reduce the risk of e.g. cardiovascular disease and some cancer types. We conclude that an advice to restrict fruit intake as part of standard MNT in overweight adults with newly diagnosed Type 2 DM does not improve glycemic control, body weight or waist circumference. Considering the many possible beneficial effects of fruit, we recommend that fruit intake should not be restricted in Type 2 DM subjects (Gonzalez-Gallego J, Garcia-Mediavilla MV, Sanchez-Campos S, Tunon MJ).

This study showed that generally, food consumption pattern for oil/fat, snack and tea/coffee among the subjects were high. This may worsen the disease. Reported that consumption of roasted/baked food, sweetened food/beverages and monosodium glutamate was declining in 2013 compared to 2007, while consumption of salty food was increasing [2].

Type 2 DM patients with severe deficit consumption rate, the deficit and more lightweight than the rate of nutrient consumption both significantly different at the 1% level. On average blood glucose level in type 2 DM patients with severe deficit nutrient consumption is lower than the 196.3 mg/dL consumption patterns well. On average blood glucose levels of diabetic patients with mild deficits nutrient consumption is lower than the 216.2 mg/dL consumption patterns well. The average blood glucose level in diabetic patient with nutrient consumption rate is obtained is lower than the rate of 235.4 mg/dL good nutrient consumption.

The average Recommended Dietary Allowance (RDA) for energy and protein of type 2 DM patients was 2176.4 kcal and 50 g, respectively. The RDA for energy was slightly higher than national RDA, but lower than national RDA for protein. This indicates the importance of food consumption to prevent and control type 2 DM. National RDA for energy and protein was 2150 kcal/capita/day and 57 g/capita/day based on nitrogen balance study (clinical data) and 76 g/day based on macro energy distribution to anticipate protein energy malnutrition and stunting. While, in availability level, there was addition of 10% reflecting losses and food damage from producer to consumer resulting in 2400 kcal/capita/day for energy and 63 g/capita/day for protein based on nitrogen balance and 84 g/day based on macro energy distribution [11].

Energy and nutrients are very important for physical growth and development as well as to conduct daily activities [15]. Further, nutrient intake also has wider impact on human life. Taniguchi and Wang, beside on health, nutrient intake has influence on productivity, academic performance and income. The result of this study showed that nutrient consumption of the patients was still poor, except for carbohydrate. This is not good for type 2 DM patients, especially in preventing and controlling blood glucose. If the body lack of nutrient, particularly energy and protein, it will cause hunger in the beginning and further, reduction in body weight which cause reduction in work productivity. Continuous nutrient deficiency will cause mild and severe malnutrition. If there is no improvement in energy and protein consumption, the body will be easily attacked by infectious disease which may cause death. The energy contribution was 9-14% from protein, 24-36% from fat,

and 54-63% from carbohydrate. This result was less than the adequacy, which is 5-15% energy from protein, 25-55% energy from fat, and 40-60% energy from carbohydrate depending on age or growth phase. The energy and protein adequacy corrected by actual body weight (for every age group) is calculated based on formula by National Workshop on Food and Nutrition [6,11].

Nutrient intake level is obtained by dividing nutrient consumption with RDA. The categories of energy and protein adequacy level based are severe deficit (<70%), mild deficit (70-90%), adequate (90-110%), and excess (>110%). Based on the calculation, the energy and protein adequacy level was 56% and 69.1%, respectively. This meant that the adequacy level for energy and protein was categorized as severe deficit. Energy and protein are the two affecting factors for health. Energy is used by the body as fuel to do activity. Protein is functioned as nutrient to create and repair body tissue as well as energy source [2].

Energy consumption level in rural, urban, and urban+rural, in 2005 and 2007 met RDA based on National Workshop on Food and Nutrition VIII, which was 2000 kcal/cap/day. Energy consumption level in rural in 2005 and 2007 was 105.8% and 105.1%, respectively, while in urban was 100.0% and 100.8%. In urban+rural (national), the energy consumption level in 2005 and 2007 was 103.1% and 102.5%, respectively [18].

This study found that energy and protein adequacy level was severe deficit. This may be caused by avoidance of type 2 DM patients on energy, protein and carbohydrate source food. They are do not have will to eat in a large portion because they are afraid of increased blood glucose level. This means that most of the subjects misunderstand about nutrient source from food and therefore need assistance from nutritionist during the experiment. Most of the patients (81.8%), male or female, had very poor consumption of zinc food source. Most of the patients (69.9%) were also had high (≥126 mg/dL) fasting blood glucose level. There was 57% of the patients had 2 hour post prandial blood glucose level in high category (>180 mg/dL) [19].

Based on identification of local food (staple food), only several food had medium GI, such as corn with GI of 59. The local food (side dish) in Kotamobagu contained low GI ranged from 11 to 53, except local food with corn as the ingredient (*kolak toigu molunow*, *kokolek*) with medium GI (59). Among side dish, only *Toya i woku* used potato with high GI (89). The local food (snack) was identified as having low GI (11-53), except koyabu with sticky rice flour as the ingredient (IG = 87). There was also several local food whose GI still unknown, such as *pangi* seed, bamboo sprout, young taro leaf, and several spices. It is identified also several type of fresh fruit and beverages often consumed, such as pinapple (*nanasi*), *matoa*, mango (*kombiloy*), rambutan (*bolangat*), banana (*lutu'*); soybean drink, palm water (*saguer*) and young coconut (*simbuyung*).

GI value is affected by the content of protein, fat, fiber and other non nutritive substance, and processing method [20]. Addition of fat into food containing carbohydrate will reduce response of 2 hour post prandial blood glucose level (Collier). Yoo state that GI value is negatively correlated with phytate content in the food. Other study found that fermented food or with addition of organic amino acid reduced GI value of the food [21]. Low GI diet in DM patients improved the controlling of blood glucose. Ragnhild state food consumption of food with low GI increased sensitivity of insulin production in pancreas. Factors affecting GI of a food were starch

digestibility, starch-protein interaction, type and quantity of fatty acid, dietary fiber content, processing method, anti-nutrient food, and physical appearance of the food [7].

Expected impact of the study to strength the public health program strategies, especially in the prevention and management of risk factors for type 2 DM patients, creating a change in people's behavior, and encourage local knowledge of local food in Type 2 DM patients, so it can manage menu / food daily as a family food security strategy, protective and promotive pattern of each individual and family health general and more specifically in type 2 DM patients. Our study has several constraints/ limitations among others: (1) the time of the study on behavior (food consumption patterns) there are some subjects that have not well responded to questions and open; (2) must be given a clear understanding of the current measurement of blood glucose levels; (3) no other response variables measured as (IFCC, NGSP) HbA1c levels and lipid profile (cholesterol total, triglycerides) on Type 2 Diabetes Mellitus patients; (4) differences in perceptions about the gauge for food consumption based on the theory/practice measuring devices based on local wisdom; (5) being secondary data, a lack of reliable information related to some variables such as duration of DM and other details limited the scope of our analysis.

5.   Conclusions

In Kotamobagu, that most of the subjects with type 2 DM and means blood glucose levels were female (214,5 mg/dL), aged 43-50 years (221.9 mg/dL), senior high school graduates (179.0 mg/dL), Mongondow ethnic (229.6 mg/dL), housewives (235.4 mg/dL) whose income 3,600,000 - ≤7,200,000 rupiahs per year (250.1 mg/dL).

Food consumption pattern (type of food consumption, quantity of food consumed, consumption of vegetables and fruits, oil/fat, snack, and tea/coffee added with sugar) were associated with blood glucose level among type 2 DM patients ($p < 0.05$).

Pearson Correlation showed that there was significant association ($p < 0.05$) between energy and protein consumption with blood glucose levels among type 2 DM patients. It means that more consumption of local food tends to reduce blood glucose level.

Regression analysis models showed that food consumption pattern, family history of DM, DM medication use and BMI were significantly correlated with blood glucose level among type 2 DM patients *p*-value <0.05.

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