Conference Paper

Factors Associated with Fasting Hyperglycemia

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Abstract

The aim of this study is to find out the relationship between age, gender, fat intake, obesity, physical activity, and tobacco smoke exposure with fasting hyperglycemia among adults, belonging as participants in PROLANIS programme at Puskesmas Kedungmundu, one of primary health care in Semarang City. The study was conducted on 100 adults using accidental sampling technique, consisting of 74 women and 26 men. The study design used is cross sectional. Fasting hyperglycemia is defined when blood glucose is above 130 mg/dl, physical activity measurement using the PAL, FFQ and Food Recall to measure the intake of fat, nutritional status measurement using the BMI, and interviews to determine the age, sex, and history of tobacco smoke exposure. The average fasting blood sugar was 104.2 mg / dl, the mean of fat intake was 70 grams / day, and the mean BMI of 23.9 kg / m^2. The prevalence of fasting hyperglycemia was higher in the majority of women (14,9%), p=0,551. It was also higher among respondents aged above 40 years old (16,7%), p=0.302; among them who had excess fat intake (15.2%), p=0.564; among obesity respondents (21.1%), p=0,061, among them who had sedentary physical activity (11.8%), p=0.791; and exposed to smoke (15.1%%), p=0.716. There were no associations between age, gender, fat intake, obesity, physical activity, and tobacco smoke exposure with fasting hyperglycemia.

Keywords: Fasting Hyperglycemia, Gender, Age, Fat Intake, Body Mass Index, Physical Activity, Tobacco Smoke Exposure

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1. INTRODUCTION

World Health Organization (2016) set a global target to prevent non communicable disease, especially four important diseases such as cardiovascular, cancer, chronic pulmonary and diabetes mellitus, which were contribute toward mortality and morbidity. Fasting hyperglycemia is defined when people don't eat for at least eight hours.

Recommended range from American Diabetes Association (2015) for healthy people is 70 up to 130 mg/dl. If blood glucose level is above 130 mg/dl, this condition is called as fasting hyperglycemia, which is known as common diabetes complication.

Global situation written by WHO (2016) said that the proportion of population in Southeast Asia aged 20-69 years old who suffered death due to high glucose levels is 9%. In Indonesia, basic on Ministry of Health data (2013), the proportion of impaired fasting glucose in adult aged above 15 years old is 40.4% in males, and 34.4% in females. Meanwhile in Central Java, the amount of people who suffered with metabolic syndrome is 72,268 people.

This study evaluates association between body mass index, age, gender, fat intake, physical activity, and smoke exposure with fasting glucose among adult people lived in working area of Puskesmas Kedungmundu, which known as one of primary healthcare in Semarang city.

Basic on WHO (2015), aging will impact the changes in the endocrine system, including the secretion of the hormone insulin. People with body mass index increases can lead to decrease insulin sensitivity. Exposure to cigarette smoke worsen insulin sensitivity, although second-hand smoke can be risk for metabolic syndrome [5]. Unhealthy lifestyle such as eating excess fatty food and physical inactivity also increase blood glucose levels. Proper physical activity can reduce fasting hyperglycemia in insulin resistance. Meanwhile, fat acts as a potential cause of oxidative stress that causes disruption of glucose homeostasis [15].

2. METHODS

2.1. Study population

The survey was undertaken between July 2016 and Augustus 2016 on a sample of 100 respondents, aged 18 years old and older who lived in the working area of puskesmas Kedungmundu located in city of Semarang. The sample was randomly selected from those who visit non communicable disease prevention program called PROLANIS. Informed consent was thought and obtained from the subjects and the study was approved by our Faculty's Research and Ethics Committee.

2.2. Study design

The study design was cross sectional in design. In cross sectional study, all variables are measured in the same time. Data were collected, categorized, cleaned, and analysed by using IBM SPSS Statistic 20 programme and Nutrisoft programme.

Table 1: Demographic Variables among Respondents.

Variable	Sub variable	f	%
Gender	Women	74	74
	Men	26	26
District Origin	Kedungmundu	19	19
	Mangunharjo	3	3
	Sambiroto	29	29
	Sendangmulyo	33	33
	Tandang	12	12
	Sendangguwo	4	4
Education	No formal education	9	9
	Elementary school	8	8
	Junior high school	6	6
	Senior high school	44	44
	College	33	33
Occupation	House wife	22	22
	Governmental org. worker	29	29
	Entrepreneur	23	23
	Service worker	3	3
	Others	23	23
Fasting Glucose	Fasting Hyperglycemia	13	13
	Normal Blood Glucose	87	87
Age	Age at Risk (> 40 years old)	60	4
	Age Under Risk (≤ 40 years old)	40	15
Fat Intake	Excess intake (>30% total energy)	66	66
	Normal intake (≤30% total energy)	34	34
Body Mass Index	Obesity (BMI >25 kg/m2)	38	38
	Normal (BMI ≤ 25 kg/m2)	62	62
Physical Activity	Sedentary Physical Activity	76	76
	Moderate Vigorous Physical Activity	24	24
Tobacco Smoke Exposure	Exposed by	53	53
	No exposure	47	47

2.3. Measurement

All anthropometric measurements were made in accordance with World Health Organization standards. Weight was measured by using digital personal portable scale and height was measured by using a metric tape. WHO Western Pacific Regional Office determine cut off point for obesity group when body mass index is above 25 kg/$m^{2.}$

Blood sample were collected from adult after overnight fast for 8-12 hours. Fasting glucose was measured by using *Auto-check* glucose test strips. Fasting hyperglycemia is defined as blood glucose level is above 130 mg/dl. Subject who was under drug treatment or had been suffered by diabetes mellitus was excluded from the study.

Data on socio-demographic characteristic such as age, gender, district origin, education, and occupation were collected by using a questionnaire. Dietary fat intake estimates were based on 24-hour recall interviews, then the foods were input in Nutrisurvey programme. Physical activity was assessed by asking subject to complete a questionnaire indicating their activities in one day. A list of activity was developed and detailed information about duration of each activity. Physical activity level was calculated as duration times to physical activity ratio each activity then devided by 24 hours.

2.4. Statistical Analysis

Univariate and bivariate analysis were conducted. Data was entered, compiled in the computer and analysed using Pearson's Chi Square test. P value of < 0.05 was considered as statistically significant.

3. RESULTS

3.1. Descriptive Analysis

Table 1 give the demographic and basic health characteristic of the samples. Demographic data was defined by characteristic including gender, district origin, education, and occupation. Of the 100 subject, the combined prevalence of fasting hyperglycemia and normal blood glucose in population was 13% and 87% and increased with age, fat intake, body mass index, physical activity, income status and smoke exposure. In this study population basic on the gender, woman respondents were 74%. Respondents lived in six districts in working area of Puksesmas Kedungmundu. Most of them had

higher level of education in college (33%) and senior high school (44%). Most respondents were employed and having regular income. Respondents worked as housewife, governmental organization worker, entrepreneur and service workers.

Table 2 presents the mean and standard deviation of fasting blood glucose, age, dietary fat intake, body mass index and physical activity. The mean value of fasting glucose was 104.2 mg/dl, while mean value of age was 44.5 years old. Most of respondents had excess dietary fat intake, with average value of 69.9 gram per day. Body mass index among respondents had raised average of 23.9 kg/m^2, while the mean of physical activity level was 1.96.

Table 2: Mean, Standard Deviation, Minimum and Maximum Value.

Variable	Fasting Blood Glucose (mg/dl)	Age (years)	Fat Intake (gr)	BMI (kg/m^2)	Physical Activity Level
Mean	104.2	44.5	69.9	23..9	1.56
SD	48.5	12.2	28.4	4.2	0.16
Minimum	60	19	22	15.5	1.28
Maximum	388	66	175	38.3	1.92

Table 3 presents the prevalence of fasting hyperglycemia was higher in women (14.9%) than in men (7.7%). Gender was not statistically associated with increased of fasting glucose (p=0,551). Prevalence of subjects aged 40 years and above who had fasting hyperglycemia were higher than younger subjects (16.7% vs 7.5%). Age also had no association with prevalence of fasting hyperglycemia (p value=302). Respondents who consume excess dietary fat intake had higher prevalence of fasting hyperglycemia (15.2%) than those who consume normal or lower dietary fat intake (8.8). Statistically, dietary fat intake was not associated with fasting hyperglycemia. The prevalence of fasting hyperglycemia increased by 21.1% in obesity subjects, almost three times higher than in those with normal body mass index (8.1%). Obesity had statistically un-significant association on prevalence of fasting hyperglycemia (p value=0,061). Lower prevalence of fasting hyperglycemia were more common in those who had sedentary physical activity lifestyle (11.8%) than those who had moderate vigorous physical activity (16.7%). After statistical analysis, physical activity was not associated with increased fasting glucose (p value=0.791). The prevalence of fasting hyperglycemia in respondents who had active or passive exposure to tobacco smoke was higher than those who had no exposure to tobacco smoke (15.1% vs 10.6%). In exposure to tobacco smoke with prevalence of fasting hyperglycemia, the association was not significant (p value=0.716).

Table 3: Variables Age, Fat Intake, Body Mass Index, Physical Activity, and Smoke Exposure with Fasting Glucose.

Variable	Subvariable	Fasting Glucose				p value
		Fasting Hyperglycemia		Normal Blood Glucose		
		f	%	f	%	
Age	Age at Risk (>40years)	10	16.7	50	83.3	0.302
	Age under risk (≤40 years)	3	7.5	37	92.5	
Gender	Women	11	14.9	63	85.1	0.551
	Men	2	7.7	24	92.3	
Fat Intake	Excess intake (>30% Total energy)	10	15.2	56	84.8	0.564
	Normal intake (≤30% total energy)	3	8.8	31	91.2	
BMI	Obesity (BMI >25 kg/m2)	8	21.1	30	78.9	0.061
	Normal (BMI ≤ 25 kg/m2)	5	8.1	57	91.9	
Physical	Sedentary Physical Activity	9	11.8	67	88.2	0.791
Activity	Moderate Vigorous Physical Activity	4	16.7	20	83.3	
Tobacco Smoke Exposure	Exposed by	8	15.1	45	84.9	0.716
	No Exposure	5	10.6	42	89.4	

4. DISCUSSIONS

The prevalence of fasting hyperglycemia in our study was almost similar with prevalence in Iranian adult study which value is about 13% in Semarang and 14.6% in Iran [1]. This similarity happened because both of studies selected adults as population sample. Mean of age and body mass index in our study was similar with study in China where mean of age was 44.18 years and mean of body mass index was 24.35 kg/m^2 [8]. This similarity caused by both Chinese and Indonesian adult had the same demographic characteristic such as occupation and educational status. Prevalence of people doing sedentary lifestyle in this study.

The prevalence of impaired fasting glucose in different body mass index for Kazak adult presented that highest prevalence was among subjects who had obesity (13%), compare with those who had normal BMI (8.1%). Our study also presented that highest

prevalence of fasting hyperglycemia was among obesity subject (21.1%), almost three time higher than normal one (8.1%).

Our study found that prevalence of fasting hyperglycemia was two times higher in women (14.9%) than men (7.7%). Our finding was different with early study in adult population of Bangladesh presented that prevalence of high glucose levels in men was almost two and half times (7.6%), compared with women which was around 2.8% [11]. The recent study in India showed that there's no significant difference in the prevalence of pre-diabetics among men and women (p value >0.05). Among 100 subjects which were observed in India, the prevalence of impaired fasting glucose was found to be 18.36% pre diabetes among males, and 17.64% among females. Also similar with our study, in The Nauru STEPS Survey (2011) showed that there is no association between fasting plasma glucose and sex (p=0.32).

Mean of fat intake in this study was 69.9 g/day. This is lower than the mean of fat intake in Mediterranean population which was 87 g/day among people with impaired fasting glucose, with the mean of animal fat intake was 10.9% of total energy, and plant fat intake was 18,9% of total energy [4]. In this study we didn't categorize fat intake into animal fat or plant fat. The study among healthy individuals conducted by Loughborough University (2017) showed that consuming excessive amount of energy as dietary fat for several days or weeks can impair glycemic control and reduce insulin sensitivity (p< 0.05). On the other hands, our study showed result that prevalence of fasting hyperglycemia was higher among adults who consume excess fat intake (15.2%) compared with those who don't (8.8%), although the association was statistically un-significant (p= 0.564).

Recent study about impaired fasting glucose among India population (2011) gave result that difference in prevalence of impaired fasting glucose in the age group below 46 years compared to 46 years and above group was not significant (p > 0.05). Similarly, in this study, the prevalence of impaired fasting glucose in the age group below 40 years old compared to 40 years old and above group was not significant (p=0.302). The study called The Nauru-STEPS survey (2011) with participants aged 15-16 years old gave result that there was no statistically significant differences between fasting blood glucose with age (P=0.10).

Physical activity is one of the key modifiable risk factors for hyperglycemia. Recent study among Australian adults (2007) presented that association of all activity measures with fasting plasma glucose were un-significant (p > 0.05). Prevalence of respondents who had sedentary activity level was higher (57.2%) than respondents who had light intensity activity level (23%) This result had similarity with our study findings. In

our study, prevalence of sedentary activity life among respondents was also higher than respondents who did moderate vigorous physical activity (76% vs 24%) with P value > 0.05 which means there was no association between fasting hyperglycemia and physical activity.

Our finding research had similar result with some studies. In our study the prevalence of fasting hyperglycemia was higher among respondents who exposed to ETS (Environmental Tobacco Smoke), compare with non-exposed (15.1% vs 10.6%). Study in Japanese people (2015) suggested that exposure to environmental cigarette smoke or passive smoking might primarily affect insulin sensitivity. The passive smoker inhale smaller smoke particle than active smoker, so the particle will be deeply penetrable into airways. The study in Japan presented that prevalence of impaired fasting glucose in non-smoker who live with smoking husband was higher than those non-smoker without smoking husband (29% vs 24.7%). Smoke exposure is associated with the metabolic syndrome, include the increasing of blood glucose. Recent study among adolescents from National Health and Nutrition Examination Survey (2005) showed that the prevalence of high fasting glucose among respondents who exposed to ETS (Environmental Tobacco Smokes) was higher (14.1%) than non-exposed (11.6%). Similar with our study, there was no statistical difference related to hyperglycemia in the study population from National Health and Nutrition Examination Survey (p=0.19).

5. CONCLUSIONS

There are some potential limitations in our study findings. The cross sectional nature of the data limits inference about causality, though considering that those who were already suffered from diabetes were excluded from study, the blood glucose levels of our respondents could have different accuracy because of fasting time-range. We were unable to control all respondents to have proper fasting time before blood glucose measurement. Other limitation was the food recall that some respondents were difficult to remember recent food they have consumed.

There were no association between age, gender, fat intake, body mass index, gender, physical activity, and tobacco smoke exposure with fasting hyperglycemia. The prevalence of fasting hyperglycemia was higher among adults aged above 40 years old, consumed excess dietary fat intake, had obesity status, had sedentary physical activity and exposed to tobacco smoke.

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References

[1] Alireza, E. 2014. *Trends in the Prevalence of Diabetes and Impaired Fasting Glucose in Association with Obesity in Iran*. Diabetes Research and Clinical Practice. Vol. xxx pp. 1-9.

[2] American Diabetes Association. Hyperglycemia (High Blood Glucose). http://www.diabetes.org/living-with-diabetes/treatment-and-care/blood-glucose-control/hyperglycemia.html. Accessed August, 1, 2017.

[3] Amina Khambalia, et al. 2011. *Prevalence and Risk Factors of Diabetes and Impaired Fasting Glucose in Nauru*. BMC Public Health, 11:719.

[4] Anastasia, C. 2003. *Dietary Fat Intake as Risk Factor for The Development of Diabetes.* Diabetes Care. Vol. 26 pp. 302-307.

[5] Chiolero. 2008. *Consequences of Smoking for Body Weight, Body Fat Distribution and Insulin Resistance*. American Journal of Clinical Nutrition. Vol. 87 pp. 801-9.

[6] Dewan, M. 2007. *A Prospective Study of Physical Activity and Its Role in Management and Prevention of Diabetes*. Journal of Excercise Science and Physiotherapy. Vol 3 pp. 111-119.

[7] Genievieve N. Healy, et al. 2007. *Objective Measured Light-Intensity Physical Activity Is Independently Associated With 2-h Plasma Glucose*. Diabetes Care Vol. 30 page 1384-1389.

[8] Guo, S. 2015. *Prevalence of Diabetes Mellitus and Impaired Fasting Glucose, Associated with Risk Factors in Rural Kazakh Adults in Xinjiang, China*. International Journal of Environmental Research and Public Health. Vol. 12 pp. 554-565.

[9] Hermawan, W. 2012. *Hubungan Index Massa Tubuh dengan Kadar Gula Darah Sewaktu pada Pegawai Pria di Dinas Pertanian dan Peternakan Provinsi Sulawesi Utara.* Jurnal Fakultas Kesehatan Masyarakat Universitas Sam Ratulangi Manado.

[10] Ministry of Health in Indonesia. 2013. *Riset Kesehatan Dasar*. Jakarta: Badan Penelitian dan Pengembangan Kesehatan Depkes RI.

[11] Mustofa, Z. 2016. *Blood Glucose and Cholesterol Levels in Adult Population of Bangladesh: Result*. Indian Heart Journal. Vol. 68 pp. 52-56.

[12] Oba, S. 2015. *Active and Passive Exposure to Tobacco Smoke in Relation to Insulin Sensitivity and Pancreatic B-Cell Function in Japanese Subjects*. Journal of Diabetes and Metabolism. Vol. 41 pp. 160-167.

[13] Shweta Sahai, et al. 2011. *Impaired Fasting Glucose: A Study of its Prevalence Documented at a Tertiary Care Centre of Central India and its Association with Anthropometric Variables*. Journal Indian Academy of Clinical Medicine Vol. 12 , No. 3, pp 188-192.

[14] Sion A. Parry, et al. 2017. *A Single Day of Excessive Dietary Fat Intake Reduces Whole-Body Insulin Sensitivity: The Metabolic Consequence of Binge Eating*. Nutrients Vol 9 pp 818.

[15] Teruna, Effendi A. 2013. *Diabetes Melitus dalam Aspek Biomolekular*. Jakarta: Balai Penerbit FKUI.

[16] The Global Diabetes Community. 2016. *Impaired Fasting Glycemia*. Available from: http://www.diabetes.co.uk/impaired-fasting-glycemia.html.

[17] Weitzman et al. 2005. *Smoke Exposure and Metabolic Syndrome in Adolescents.* Circulation Vol 112 page 862-869.

[18] Wen CP. 2009. *Are Asian at Greater Mortality Risks for Being Overweight than Caucasians. Redefining Obesity for Asians.* Public Health Nutr. Vol 12 (4) pp 497-506.

[19] WHO. 2016a. *Non Communicable Disease Action Plan*. Available from: `http://www.who.int/nmh/ncd-tools/diabetes/en/`.

[20] WHO. 2016b. *Fact Sheets Diabetes*. Available from: `http://www.who.int/mediacentre/factsheets/fs312/en/#`.

[21] WHO. 2015. *Ageing and Health*. Available from: *http://www.who.int/mediacentre/factsheets/fs404/en/.*