



RELATIONSHIP BETWEEN FASTING BLOOD GLUCOSE LEVELS AND LDL CHOLESTEROL LEVELS IN PATIENTS WITH TYPE-2 DIABETES MELLITUS IN DIPONEGORO NATIONAL HOSPITAL

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ABSTRACT

Background: Diabetes Mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels above the normal range. International Diabetes Federation (IDF) reported that in 2019, around 463 million people in the age group of 20-79 years old globally, or 9.3% of the global population in the same age group, have diabetes mellitus. Type-2 diabetes mellitus can cause lipid metabolism disorder, which is the increase of lipolysis in adipose tissues that resulted in the increase of fat in blood, including triglyceride and cholesterol. Currently, there are differences between researches that prompted this study's interest in proving that Type-2 Diabetes Mellitus may cause disruption in lipid metabolism. This study analyzed the relationship between fasting blood glucose and LDL cholesterol levels in type-2 diabetes mellitus patients. **Aim:** To prove the correlation between fasting blood glucose levels with LDL cholesterol levels in patients with type-2 diabetes mellitus. **Methods:** This research is an observational analytical study with a cross-sectional design on 40 subjects. The secondary data for this research was obtained from diabetic patients at Diponegoro National Hospital. The correlation analysis was done using the Spearman Rank test. **Results:** Spearman Rank analysis showed no significant association between fasting blood glucose levels with LDL cholesterol levels in patients with type-2 diabetes mellitus ($p = 0,119$ and $r = 0,250$). **Conclusion:** There was no significant correlation between fasting blood glucose levels with LDL cholesterol levels in patients with Type-2 Diabetes Mellitus.

Keywords: *Diabetes mellitus, fasting blood glucose, LDL cholesterol*

INTRODUCTION

Diabetes Mellitus (DM) is a disease of chronic metabolic disruption with a sign of blood glucose level increase above normal limits.¹ Type-2 Diabetes Mellitus could be caused by a decrease of insulin secretion by beta cells of the pancreas and/or failure in insulin response by insulin target cells, which is also often called as insulin resistance.²

International Diabetes Federation (IDF) reported that in 2019, around 463 million people in the age group of 20-79 years old globally, or 9.3% of the global population in the same age group, have diabetes mellitus. Indonesia itself is ranked 7 out of 10 countries with the most number of Diabetes Mellitus, with the number of approximately 10.7 million people.¹

2018 Basic Health Research (Riskesdas) showed that Diabetes Mellitus prevalence in Central Java to be around 2.1%, an increase when compared to the 2013 reports, which found the prevalence of the disease to be around 1.6%. Cities and regencies in Central Java reported that Diabetes Mellitus patients are the second highest non-communicable disease, right behind hypertension, with a percentage

of 13.4% out of 3,074,607 non-communicable disease in 2019.^{1,3}

Type-2 Diabetes Mellitus may be caused by lipid metabolism disorders, which is the increase of lipolysis in adipose tissues that resulted in the increase of fat in blood, including triglyceride and cholesterol. Hypercholesterolemia may induce Low Density Lipoprotein (LDL) cholesterol increase and High Density Lipoprotein (HDL) cholesterol decrease. Those three lipid fractions are also known as the lipid triads and have an important role in the pathogenesis of atherosclerosis. This condition is also known as dyslipidemia. This disruption in lipoprotein metabolism will cause dyslipidemia and in turn creates oxidative stress.^{4,5}

LDL cholesterol is a lipoprotein with the function of transporting fat fraction from the heart to peripheral cells, especially cholesterol.⁴ Most of the cholesterol in blood is in the form of LDL cholesterol. It is deemed as optimal if the amount of LDL cholesterol is less than 100 mg/dL. A rise in LDL cholesterol blood levels can increase the risks of cardiac disease in the patients.^{6,7} LDL cholesterol is the main type of atherogenic lipoprotein. Newest



molecular medicine research reported that atherogenic dyslipidemia is the most harmful type of dyslipidemia. One of the cause of endothelial dysfunction on the early stages of atherosclerosis plaque formation is atherogenic dyslipidemia by the form of LDL cholesterol deposits on the walls of artery blood vessels.^{8,9} Cholesterol Treatment Trialists' (CTT) Collaboration (2010) stated that there is a strong relationship between LDL cholesterol levels and cardiovascular diseases incidence, where generally an LDL cholesterol decrease of 1 mmol/L will reduce the risks of main vascular disease incidence around 22%.¹⁰

Good blood glucose management in Diabetes Mellitus patient is one of the important factors in lowering the risks of complications. Diabetes Mellitus patients need holistic treatment that covers education, physical activities, medical nutrition therapy, medications, and blood glucose monitoring in order to manage blood glucose levels.¹¹

Insulin resistance that is suffered by Type-2 Diabetes Mellitus patients may affect metabolism process of the body, such as changes in production process and disposal of plasma lipoprotein. The decrease of insulin effects that occur in adipose tissues causes a decrease in lipogenesis process and an increase in lipolysis process. This will induce glucotoxicity and lipotoxicity to happen, which in turn will cause an increase in LDL cholesterol.⁴

Currently, there are differences between researches that prompted this study's interest in proving that Type-2 Diabetes Mellitus may cause disruption in lipid metabolism. This research uses fasting blood glucose levels to measure blood glucose in Type-2 Diabetes Mellitus patients. This research is aimed at proving the relationship of fasting blood glucose levels with LDL cholesterol levels in Type-2 Diabetes Mellitus patients in Diponegoro National Hospital.

METHOD

This research was conducted on February-August 2021 in medical records installation of Diponegoro National Hospital. Research method used in this study was analytical observational with cross-sectional approach.

Samples used in this study were 40 Type-2 Diabetes Mellitus patients that fulfilled the inclusion criteria and not the exclusion criteria. Inclusion

criteria of this research were patients with Type-2 Diabetes Mellitus, male and female, 35-60 years old, normal blood pressure (90-120/60-80 mmHg), had undergone fasting blood glucose and LDL cholesterol level tests, and triglyceride levels of <400 mg/dL. Exclusion criteria of this study were patients with history of hypothyroid disease, chronic renal failure, congestive cardiac failure, heart disorders, and progestin consumption or anabolic steroid therapy. Consecutive sampling from medical records of Type-2 Diabetes Mellitus patients that fulfilled inclusion criteria and not the exclusion criteria was used to choose samples.

Independent variable of this research was fasting blood glucose levels, while the dependent variable was LDL cholesterol levels in Type-2 Diabetes Mellitus patients. Fasting blood glucose levels in this study were blood glucose levels in plasma that were checked after 8 hours of fasting with glucose oxidase method. Normal level of fasting blood glucose was <100 mg/dL. LDL cholesterol levels in this study was the LDL cholesterol levels found in serum that was measured using Friedewald method and had a normal level of <100 mg/dL.

Descriptive analysis and hypothetical test was conducted. Spearman Rank test was used to test the hypothesis of the relationship between fasting blood glucose levels and LDL cholesterol levels since the data were not normally distributed.

RESULTS

Characteristics Subjects

Descriptive analysis was done by understanding the frequency and data distribution of each variables. Based on the obtained data, characteristics of research subjects were as follows.

Table 1 shows the characteristics of the subjects that includes age, sex, blood pressure, fasting blood glucose levels, post-fasting blood glucose levels, and lipid profile levels such as total cholesterol, triglyceride, HDL cholesterol, and LDL cholesterol. Type-2 Diabetes Mellitus patients that had normal blood pressure were included. Majority of the Type-2 Diabetes Mellitus patients in this study had an uncontrolled fasting blood glucose levels and high levels of LDL cholesterol.



Table 1. Characteristics of Research Subjects

Variable	F	%	Mean ± SE	Median (min-max)
Age (years)			52,30 ± 6,38	53,50 (36-60)
35-40 years	2	5		
41-45 years	6	15		
46-50 years	6	15		
51-55 years	9	22,5		
56-60 years	17	42,5		
Sex				
Male	21	52,5		
Female	19	47,5		
Systole (mmHg)			115,93 ± 6,12	120 (99-120)
Diastole (mmHg)			75,53 ± 4,94	78,5 (64-80)
Fasting Blood Glucose (mg/dL)			159,35 ± 57,01	146 (86-287)
Controlled	3	7,5		
Uncontrolled	37	92,5		
Post-Fasting Blood Glucose (mg/dL)			204,08 ± 78,89	196,5 (77-371)
Total Cholesterol (mg/dL)			213,85 ± 40,34	221 (140-280)
Triglyceride (mg/dL)			190,18 ± 93,43	166 (54-395)
HDL (mg/dL)			42,28 ± 14,63	39 (9-80)
LDL (mg/dL)			133,05 ± 36,56	141,5 (61-198)
Normal	18	45		
Slightly High	10	25		
High	11	27,5		
Very High	1	2,5		

Correlation Test

Data of fasting blood glucose levels were not normally distributed ($p=0.005$) and data of LDL cholesterol levels were not normally distributed ($p=0.037$), which prompted the use of Spearman Rank test in non-parametric bivariate analysis correlative testing between fasting blood glucose levels and LDL cholesterol levels.

Table 2. Correlation Test Results

LDL Cholesterol Levels	Correlation Coefficient (r) Significance (p) Data Pairs (n)	Fasting Blood Glucose Levels
		0,250
		0,119
		40

Based on the Spearman Rank correlation test, it was obtained that $p=0.119$ and $r=0.250$. This shows that there was no significant relationship between fasting blood glucose levels and LDL cholesterol levels in Type-2 Diabetes Mellitus patients.

DISCUSSION

Characteristics Subjects

Research conducted found that 21 subjects (52.5%) are males, a higher number when compare to females with 19 subjects (47.5%). Age distribution of the subjects are between 30-60 years old.

Mean blood pressure of the subjects is around 116/75, which is still categorized as normal according to Joint National Committee (JNC) VIII.¹² This is in line with the inclusion criteria set in this study, which is normal blood pressure. Triglyceride levels distribution ranges around 54-395 mg/dL with a mean number of 190.18 mg/dL. This is in line with the requirements of formula usage to count LDL cholesterol levels indirectly, which is no triglyceride levels of above 400 mg/dL.

LDL cholesterol levels of the subjects ranges around 61-198 mg/dL with a mean number of 133.05 mg/dL. Majority of the patients with Type-2 Diabetes Mellitus in this study has a high level of LDL cholesterol. This is consistent with the research conducted by Finisia Noviyanti, et al (2015) which reported that 59.9% of Type-2 Diabetes Mellitus patients has a high level of LDL cholesterol.⁴

Distribution of fasting blood glucose levels in the subjects ranges around 86-287 mg/dL with a mean number of 159.35 mg/dL. Majority of Type-2 Diabetes Mellitus patients in this study has an uncontrolled fasting blood glucose.



Relationship between Fasting Blood Glucose Levels and LDL Cholesterol Levels in Type-2 Diabetes Mellitus

Significance of fasting blood glucose levels with LDL cholesterol levels is found to be $p=0.119$. Correlation coefficient is found to be $r=0.250$. This shows that there is no significant relationship between fasting blood glucose levels and LDL cholesterol levels in Type-2 Diabetes Mellitus patients. This research matches a previous study by Malau (2014) which stated that there is no significant relationship between fasting blood glucose levels and LDL cholesterol levels in Type-2 Diabetes Mellitus patients due to $p<0.05$ ($p=0.963$).¹³

This result is also in line with a study conducted by Rahayu, et al (2020) that found no significant relationship between fasting blood glucose and LDL cholesterol ($p=0.483$). Rahayu stated in her research that the increase of LDL cholesterol in Type-2 Diabetes Mellitus is not caused by a rise in synthesis but due to glycosylation process.¹⁴ LDL cholesterol in Type-2 Diabetes Mellitus will undergo much higher glycosylation and oxidation processes which will render LDL cholesterol receptors incapable of identifying glycosylated LDL cholesterol. This makes fasting blood glucose not contributing much nor significantly, even though it does increase LDL cholesterol levels.^{14,15}

The result obtained is different than a study conducted by Arifin (2019) which reported that blood glucose do have a significant relationship with the increase of blood lipid levels. This difference could be caused due to the research conducted by Arifin using subjects without factoring in their history of Type-2 Diabetes Mellitus. The study conducted in this journal uses subjects with Type-2 Diabetes Mellitus. Moreover, it could also be caused by this study that uses minimum sampel.¹⁶

Other factor that may influence the result is obesity factor. This research do not evaluate the obesity levels of the subject due to inadequate weight and height data to be calculated into BMI. Ercho (2013) stated that there is a significant difference between LDL cholesterol levels on obesity subjects with non-obesity subjects.¹⁷

Smoking habits may also influence the result of this study. Sanhia, et al (2015) claimed that smoking habits may increase the risk of a rise in LDL cholesterol levels. This is caused by cigarettes that

contain various dangerous substances, such as nicotine that affects the heart, increase blood clotting, and eventually increase LDL cholesterol and decrease HDL cholesterol levels.¹⁸

Agustiyani, et al (2017) stated that risk factors such as nutrition intake and physical activities may increase LDL cholesterol levels. High-fat nutrition intake can increase LDL cholesterol levels. Besides that, constant physical activities will increase the activity of lipoprotein lipase enzymes and decrease the activity of hepatic lipase enzymes. Triglyceride and VLDL will then be hydrolyzed by lipoprotein lipase, which will increase VLDL and IDL conversion. Hepatic lipase will convert some of IDL into LDL cholesterol. The rest of IDL will be taken by liver and peripheral tissues through the mediation of LDL cholesterol receptors. This mechanism is what makes routine physical activities capable of decreasing cholesterol and LDL cholesterol while increasing the HDL cholesterol levels.¹⁹

This study do not include evaluation towards those risk factors, which in turn may cause the relationship between fasting blood glucose levels and LDL cholesterol levels in Type-2 Diabetes Mellitus patients to be deemed as statistically insignificant.

Even so, if seen from a clinical perspective, it can be understood from this study that majority of the subjects has high LDL cholesterol levels. This is in line with the study conducted by Glorya Stevani, et al (2014) which reported that patients with poor glycemic control have significantly higher total cholesterol and LDL cholesterol levels than patients with good glycemic control.²⁰

CONCLUSION

There is no significant relationship between fasting blood glucose levels and LDL cholesterol levels in patients with Type-2 Diabetes Mellitus.

Ethical Approval

This study has obtained ethical clearance from Health Research Ethics Committee of Faculty of Medicine of Diponegoro University with a certificate number of No. 193/EC/KEPK/FK-UNDIP/VI/2021.

Identity of the subjects will be kept secret and will not be publicized for any means.



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Conflicts of Interest

There is no conflict of interest related to the materials, methods, and findings in this study.

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