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The Relation between Fasting Blood Glucose and Triglyceride with GFR in Type 2 DM Patients

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Abstract

Purpose: Identify the relation between FBG and triglyceride with GFR in T2DM patients.
Methodology: This observational quantitative research used a cross-sectional design. Data were obtained from the medical records of 50 Prolanis T2DM patients in 2023 at the Puskesmas Karangnongko, Klaten Regency, using consecutive sampling technique. The bivariate analysis used was the Spearman test.
Results: Spearman test results show that there is no significant relation between FBG with GFR in type 2 diabetes mellitus patients (p-value=0.695; r-value=0.057). Apart from that, there is also no relation between triglycerides with GFR in type 2 diabetes mellitus patients (p-value=0.654; r-value=-0.065).
Applications/Originality/Value: This research provides information regarding considerations for FBG and triglycerides as important components for detecting a decrease in GFR which can be an indicator of diabetic nephropathy.

Introduction

Type 2 diabetes mellitus (T2DM), also known as non-insulin-dependent diabetes mellitus (NIDDM), is a type of diabetes caused by the body's inability to respond properly to insulin, resulting in elevated blood glucose levels. According to WHO, over 95% of diabetes cases are T2DM (WHO, 2023). International Diabetes Federation (IDF) reported in 2021 that the global prevalence of diabetes mellitus (DM) reached approximately 537 million and is projected to increase to 643 million by 2023 and 783 million by 2045 (IDF, 2021). WHO estimates the number of DM patients in Indonesia will rise from 8.4 million in 2000 to about 21.3 million by 2030 (PERKENI, 2021b). According to the Survei Kesehatan Indonesia (SKI), Central Java Province ranks third for the highest number of DM cases, following West Java and East Java, with 118,184 cases (Kemenkes RI, 2023). Klaten Regency ranks second in Central Java, with 37,610 cases in 2022 (Dinkes Jawa Tengah, 2022; Dinkes Kabupaten Klaten, 2022).

DM diagnosis can be confirmed using fasting blood glucose (FBG), random blood glucose (RBG), and HbA1c levels (PERKENI, 2021b). According to the American Diabetes Association (ADA), HbA1c has advantages over other tests but is limited by availability and higher costs (ADA, 2021). Fasting blood glucose testing is suitable for healthcare facilities without HbA1c equipment (Supono & Yasa, 2021). Prolonged hyperglycemia can lead to microvascular and macrovascular complications, including diabetic nephropathy (Chawla, Chawla, & Jaggi, 2016; Mansour et al., 2023). This condition is marked by decreased glomerular filtration rate (GFR) due to nephron damage (Rivandi & Yonata, 2015). Previous research by Aniskurlillah, Hernawan, Nursanto, & Mahmuda (2021) found a significant relation between FBG and GFR in T2DM patients, with the p-value is 0.000. However, the research by Riyani, Nerisandi, Wiryanti, Rahmah, & Kurnaeni (2024) reported no significant association between creatinine, GFR, and FBG, with the p-value is 0.819.

Type 2 diabetes mellitus patients may also experience lipid metabolism disorders caused by insulin resistance, one of which is elevated triglyceride levels (PERKENI, 2021a). High triglyceride can cause atherosclerosis, leading to poor blood circulation to the organs, one of them is the kidney. Reduced blood flow to the kidneys can result in hypoxia, increased oxidative stress, and inflammation. If persistent, this can cause kidney tissue lesions and GFR impairment GFR (Senge, Moeis, & Sugeng, 2017). Previous research by Wang et al. (2020), which examined the relation between lipid profile and GFR, found that there was a relation between high triglyceride and a decrease in

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GFR, with the p-value is 0.01. Research results on the relation between FBG and GFR remain inconsistent, and research on triglyceride and GFR in T2DM patients is still limited. This research aims to investigate the relation between FBG, triglyceride, and GFR in T2DM patients. The findings are expected to provide insights as a reference for monitoring blood sugar and triglyceride levels in detecting diabetic nephropathy, while still assessing GFR.

Furthermore, several studies have investigated the relation between FBG and triglycerides with the glomerular filtration rate (GFR). However, to the best of our knowledge, no research has examined this relation in T2DM patients from the *Program Pengelolaan Penyakit Kronis* (Prolanis) program, especially in Klaten Regency using GFR measurements based on the CKD-EPI formula. Therefore, this research will investigate the relation between FBG and triglycerides with GFR in T2DM using the specified sample, location, and method.

Method

This research utilized a quantitative observational analytic design with a cross-sectional approach. The research was conducted at Puskesmas Karangnongko, Klaten Regency. The data used in this research were secondary data from patient medical records. The inclusion criteria in this research were Prolanis patients in 2023 with T2DM and aged 36 years – 70 years. Exclusion criteria included patients with incomplete medical records, a history of heart failure, Congenital Anomalies of the Kidney and Urinary Tract (CAKUT), and pregnancy. Sampling was performed using a consecutive sampling technique, resulting in a total of 50 participants. The GFR formula used was GFR CKD-EPI formula. Some variables of this research such as FBG, triglyceride, and GFR measured on a ratio scale.

Data analysis employed univariate and bivariate methods. The Shapiro-Wilk test was used to assess data normality. This was because the samples used were 50 samples so the normality test was used. Univariate analysis was conducted to describe patient characteristics, while bivariate analysis, specifically Spearman's test, was applied to evaluate the relation between FBG and triglyceride with GFR. If the Spearman test shows a p value <0.05, then it can be said that there is a significant relation between the variables studied in this research. In this research, if the p-value from the bivariate analysis was <0.25, further multivariate analysis was conducted, but if the p value is >0.25 then the multivariate test is not continued.

Results and Discussion

This research used medical records from 50 Prolanis patients in 2023 at the Puskesmas Karangnongko. All research results were subjected to characteristic analysis using univariate tests and hypothesis testing, namely bivariate tests using the Spearman test

Research Samples Distribution

The variables tested in the univariate analysis included gender, age, hypertension history, FBG, triglyceride, and GFR. The distribution of categorical variables such as gender, age, and hypertension history were described using frequency and percentage. Meanwhile, the distribution of numerical variables, including FBG, triglyceride, and GFR, was presented in terms of median, minimum, and maximum values. The results of the univariate analysis, which detail the distribution characteristics of all patients in this research, are shown in the following table.

Table 1. Distribution of Characteristics.

Characteristic	Frequency (%)	Median (Min-Max)
Gender		-
Male	12 (24)	
Female	38 (76)	
Total	50 (100)	
Age (years)		-
36-45	5 (10)	
46-55	13 (26)	
56-65	24 (48)	
>65	8 (16)	
Total	50 (100)	
Hypertension History		-
Hypertension	41 (82)	

No Hypertension	9 (18)	
Total	50 (100)	
Fasting Blood Glucose (mg/dL)[a]	-	146,50 (79-358)
Triglyceride (mg/dL)[a]	-	160,50 (66-505)
Glomerular Filtration Rate (mL/min/1,73 m^2)[a]	-	88 (27-132)

Note: mg: milligram, dL: deciliter, min: minute, 1,73 m^2: standardized body surface area, [a]: abnormal distribution

Based on Table 1, the distribution of characteristics shows that the total sample size was 50 (100%). The gender-based distribution indicates that the majority of T2DM patients were female, with 38 patients (76%). This finding is consistent with the research conducted by Susanti, Rizqi, Dewi, & Barokah (2024), which also found a higher prevalence of diabetes among female than male. This could be due to female generally having a higher body mass index than male, as well as the presence of premenstrual syndrome, which can lead to fat accumulation and increase the risk of developing T2DM (Rosita, Kusumaningtiar, Irfandi, & Ayu, 2022). In female, the risk of T2DM may increase due to decreased estrogen levels during menopause. Lower estrogen levels can increase fat storage and release of free fatty acids (Susanti Susanti, Rizqi, Dewi, & Barokah, 2024). The higher accumulation of fat cells interferes insulin receptor activity, especially in glucose uptake by cells, causing insulin resistance and higher blood glucose levels (Vadila, Izhar, & Nasution, 2024). In addition, female often consume fatty foods and foods high in glucose, which can further increase the risk of developing T2DM (Usman, Rahman, Rosdiana, & Sulaiman, 2020).

The distribution of patient characteristics based on age shows that the majority of T2DM patients are in age range 56-65 years, totaling 24 patients (48%). This finding is consistent with the research conducted by Komariah & Rahayu (2020). Type 2 Diabetes Mellitus occurs common in the elderly people due to physiological processes such as the progressive atrophy of pancreatic β-cells. In older age, mitochondrial activity in muscle cells also decreases, which can cause an increase in muscle fat. Additionally, as age increases, the risk of decreased insulin sensitivity and increased glucose intolerance also increases (Komariah & Rahayu, 2020).

The distribution of patient characteristics based on hypertension history shows that the majority of patients suffer from hypertension, totaling 41 out of 50 patients (82%) suffer from this disease. This finding aligns with the research conducted by Asmarani, Tahir, & Adryani (2017), which also found that the majority of T2DM patients also had hypertension (72.1%). The research showed that patients with hypertension had a 4.166-fold increased risk of developing T2DM. Additionally, research by Sari, Chasani, Pemayun, Hadisaputro, & Nugroho (2017) stated that individuals with T2DM for ≥5 years have a 33.9 times higher risk of developing hypertension. This can be attributed to elevated blood glucose levels, which can increase oxidative stress, activate protein kinase C, and receptor advanced glycated end products (RAGE), leading to inflammation, endothelial damage, and vasoconstriction, ultimately raising blood pressure (Sari, Chasani, Pemayun, Hadisaputro, & Nugroho, 2017).

Regarding FBG characteristics, the median value was 146.50 mg/dL, with a minimum of 79 mg/dL and a maximum of 358 mg/dL. Triglyceride characteristics showed a median value of 160.50 mg/dL, with a minimum of 66 mg/dL and a maximum of 505 mg/dL. Glomerular filtration rate characteristics had a median value of 88 mL/min/1.73 m^2, with a minimum of 27 mL/min/1.73 m^2 and a maximum of 132 mL/min/1.73 m^2.

Relation Between Research Variables

In this research, hypothesis testing in the form of bivariate tests was used to determine the relation between FBG and triglyceride with GFR which was carried out using a non-parametric test, that is Spearman test. That test is used because the data distribution tested with Shapiro Wilk test showed abnormal data distribution. The results of this test are presented in the following table.

Table 2. The Results of the Spearman Test.

Variable	Spearman's rho		
	N	r-value	p-value
FBG	50	0.057	0.695
Triglyceride	50	-0.065	0.654

Based on Table 2 above, the results of the Spearman test show that for FBG, the p-value is 0.695, indicating that the relation between FBG and GFR is not statistically significant. The correlation coefficient between FBG and GFR is 0.057, indicating a very weak positive correlation between the two variables. Meanwhile, for triglyceride, the p-value is 0.654, which shows that the relation between triglyceride and GFR is also not statistically significant. The correlation coefficient (r) between triglyceride and GFR is -0.065, indicating a very weak negative correlation between the two variables. Since all p-values from the Spearman test are greater than 0.25, the data analysis was not continued to the multivariate test.

Relation Between Fasting Blood Glucose with Glomerular Filtration Rate

The results of bivariate analysis with Spearman test showed that there is no significant relation between FBG and GFR, as indicated by a p-value of 0.695. The correlation coefficient (r) in this research was 0.057, meaning that as FBG levels increase, GFR also increases, though the correlation is very weak. This finding aligns with the research by Riyani, Nerisandi, Wiryanti, Rahmah, & Kurnaeni (2024), which reported no significant relation between GFR and FBG in T2DM patients, with the p-value was 0.819. Furthermore, the correlation test results in this research are consistent with the findings by Yuliandi & Hikmah (2024), which also reported no relation between FBG and GFR. This could be due to some patients having well-controlled FBG levels, as seen in our research where some patients had controlled and uncontrolled FBG levels, with a minimum value of 79 and a maximum value of 358. The research by Yuliandi & Hikmah (2024) also mentioned that a decline in GFR can occur after complications such as macroalbuminuria, typically after 10 years of living with T2DM. Therefore, the duration of diabetes important in the decline of GFR.

Regarding the duration of T2DM and its influence on the decline in GFR, this aligns with the research carried out by Kombe, Sugeng, & Sedli (2022). The characteristic test results in that research revealed an average duration of diabetes mellitus of 138.95 months. Their correlation test indicated a negative relation between the duration of diabetes and the decline in estimated GFR in T2DM patients. This means that the longer a patient suffers from T2DM, the lower their estimated GFR becomes (Kombe, Sugeng, & Sedli, 2022). The longer diabetes mellitus, the higher it is the risk of kidney failure where complications of kidney failure are often found in DM sufferers for a period of >5 years, namely 52.94% (Ningsih, A. W., Wiyono, W. I., & Jayanti, M., 2023). The length of time a patient suffers from type 2 diabetes mellitus has an influence which significantly affects the patient's urea and creatinine levels. The length of time the patient has suffered from diabetes Type 2 mellitus can affect the increase in urea and creatinine levels indicates a pre-renal problem or that damage to the kidney tissue has occurred (Liftyowati, Widowati, Camin, 2022). Another research by Ramadani, Putri, Amalia (2024). examining the relation between FBG and creatinine levels in diabetes patients over 1 to 3 years found no relation between FBG and GFR. This could be due to the sample consisting of patients with normal FBG and GFR levels. Creatinine levels are important because they can be used to calculate GFR and contribute to the calculation of GFR results (Irawan & Ludong, 2020). End-stage renal disease in diabetes mellitus patients usually occurs due to sugar levels high and uncontrolled blood pressure. To prevent or slow down the occurrence of end-stage renal disease, people are advised to adhere to taking medication to maintain blood sugar levels keep your body under control and maintain a healthy lifestyle (Ningsih, A. W., Wiyono, W. I., & Jayanti, M., 2023). In our research, the duration of diabetes could not be identified in the patients' medical records. Therefore, this limitation may be one of the reasons for the nonsignificant results in this research. Thus, the duration of diabetes is an important factor that needs to be considered.

Relation Between Triglyceride with Glomerular Filtration Rate

In this research, triglyceride did not show a significant relation with glomerular filtration rate (GFR), which is indicated by a p-value of 0.654. The relation between triglyceride and GFR was negative, with a very weak correlation strength as reflected in the correlation coefficient of r=-0.065. This coefficient showed that in this research, as triglyceride levels increase, GFR tends to decrease. This finding is consistent with the research by Palebangan (2020),which reported no significant relation between triglyceride and GFR. In that research, from of the several lipid profiles examined, only HDL levels were significantly related to GFR. Furthermore, this research aligns with the findings of the research by Pratiwi, Fatyati, Supriyanto, Nuswantoro, & Aprillia (2024), which revealed that among all lipid profiles analyzed, there are total cholesterol, triglyceride, HDL, and LDL, only HDL had a significant relation with creatinine. That is shown with the p-value was 0.001. Triglyceride, on the other hand, did not show a significant relation with creatinine. That is shown with the p-value was 0.840. The insignificance in this relation may be also influenced by dietary factors (Pratiwi, Fatyati, Supriyanto, Nuswantoro, & Aprillia, 2024). The relation between triglyceride and creatinine provides important information since creatinine is a key component in calculating GFR (Inker & Titan, 2021).

Triglyceride do not have a significant relation to GFR, this may be due to the mechanism of triglyceride does not affect GFR directly. This long-term mechanism occurs when elevated triglyceride levels contribute to metabolic syndrome, inflammation, and insulin resistance, which in turn can affect kidney function (Wang et al., 2023). The exact mechanism of kidney damage due to increased fat levels is still not completely clear, but glomerular sclerosis and atherosclerosis due to increasion of fat have an effect on kidney damage. This increase in fat may have an indirect relation with a low glomerular filtration rate (Jamshidi et al., 2020). Chronic high triglyceride levels can also lead to a decline in GFR (Pontremoli et al., 2023). In that research conducted by Pontremoli et al. (2023), also found that moderate to severe increases in triglyceride levels were associated with an increased risk of gradual decline in kidney function and ESKD over time. In our research, the duration of elevated triglyceride and the patients' dietary patterns were unknown, which may be a limitation in this research and may have influenced the non-significant results regarding the relation between triglyceride and GFR.

The limitations of this research include the use of secondary data from medical records, which restricted the ability to collect broader and more comprehensive data. Information regarding the duration of diabetes, duration of elevated

triglyceride, patients' dietary patterns, as well as the onset of hypertension and diabetes could not be adequately identified or gathered. Additionally, the sample size used in this research was limited to only 50 participants.

Conclusions

Based on the findings of this research, it was concluded that there was no significant relation between FBG with GFR in T2DM patients. This is indicated by the p-value being 0.695 and the r-value being 0.057. Likewise, regarding the relation between triglycerides with GFR, no significant relation was found between triglycerides with GFR in the T2DM patients that the researchers studied. This is shown by the p-value being 0.654 and the r-value being -0.065. Therefore, the use of FBG and triglycerides as parameters to detect a decrease in GFR as an indicator of diabetic nephropathy, but still assess GFR, is still requires further investigation.

This research has several limitations, such as only using secondary data in the form of medical records, so the information obtained is also limited. It is hoped that future research can overcome the limitations of this research by integrating two forms of data sources in the form of primary and secondary data. So that the information obtained can be more comprehensive and extensive. In addition, future research should involve a larger sample size.

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