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THE RELATIONSHIP BETWEEN LIPID PROFILE AND HBA1C LEVELS IN TYPE 2 DIABETES MELITUS PATIENTS

Miako Pasinggi, Irfansyah Baharuddin Pakki*, Yadi
Universitas Mulawarman, Jl. Kuaro, Gn. Kelua, Samarinda Ulu, Samarinda, Kalimantan Timur 75119, Indonesia
*irfanchango@gmail.com

ABSTRACT
Diabetes Mellitus is a chronic disease with high morbidity and mortality rates, requiring comprehensive and integrated management. Dyslipidemia is an important risk factor contributing to the occurrence of both microvascular and macrovascular complications in individuals with Diabetes Mellitus. Optimal control of HbA1c levels and lipid profiles is considered essential in reducing the risk of complications and improving patient outcomes. Therefore, monitoring and managing these parameters is a critical component of diabetes care to prevent further complications. This study aims to analyze relationship between lipid profile with HbA1c levels in Type 2 Diabetes Mellitus (T2DM) patients at Puskesmas in Samarinda. A cross-sectional study was conducted involving 1,482 patients with T2DM, selected through a total sampling technique. Data were obtained from secondary sources, specifically medical records. Bivariat analysis using the Chi-Square test was performed to evaluate the relationship between lipid profile and HbA1c levels. The analysis identified significant relationship between TG (p = <0,001 ; OR = 3,350; 95% CI:2,701-4,157), TC (p = <0,001; OR = 1,862; 95% CI: 1,486-2,334), HDL-C (p = 0,003; OR = 1,567; 95% CI: 1,169-2,100), and LDL-C (p = 0,013; OR = 1,310; 95% CI: 1,063-1,614). This study found a significant association between all components of the lipid profile and HbA1c levels among patients with type 2 diabetes mellitus (T2DM) in Samarinda. Levels of triglycerides (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were all significantly related to poor glycemic control. .

Keywords: diabetes mellitus; glycemic control; lipid profile; non-communicable diseases; samarinda

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INTRODUCTION

Non-Communicable Diseases (NCDs), also known as chronic diseases, are currently the leading cause of death worldwide and represent one of the greatest health challenges of the 21st century (WHO, 2018). Diabetes mellitus (DM) is one of the chronic diseases classified under Non-Communicable Diseases (NCDs) (Jenderal Pencegahan dan Pengendalian Penyakit Direktorat Pencegahan dan Pengendalian Penyakit Tidak Menular, 2019). Unlike infectious diseases, DM has a long disease course, causes multisystem complications, and requires long-term management. Globally, the prevalence of T2DM continues to rise, driven by factors such as sedentary lifestyles, unhealthy diets, aging populations, and urbanization (Kementerian Kesehatan Republik Indonesia, 2020; PERKENI, 2021). In Indonesia, particularly in urban areas like Samarinda, the burden of T2DM is becoming increasingly significant and contributes to both morbidity and mortality. Data from RISKESDAS 2018 for East Kalimantan Province, the prevalence of diabetes mellitus in Samarinda City is the highest in East Kalimantan at 4.11% (Kementerian Kesehatan Republik Indonesia, 2018).

One of the most common and serious metabolic abnormalities associated with T2DM is dyslipidemia (Addis et al., 2024). Diabetic dyslipidemia typically presents with elevated triglycerides (TG), increased low-density lipoprotein cholesterol (LDL-C), and reduced high-density lipoprotein cholesterol (HDL-C), which together significantly elevate the risk of

cardiovascular disease (CVD) (Azagew et al., 2024; C. Thambiah & Lai, 2021; PERKENI, 2019). Cardiovascular complications remain the leading cause of death among individuals with diabetes (Rosandi, 2021).Glycated hemoglobin (HbA1c) is widely used as a reliable biomarker for long-term glycemic control and is also a predictor of diabetes-related complications (Hasanah & Ikawati, Apt., 2021; Lau & Aw, 2020; Wang et al., 2021). Recent studies have explored the potential correlation between HbA1c levels and lipid profiles, suggesting that poor glycemic control may be associated with abnormal lipid metabolism. This relationship may provide insights for using HbA1c not only as a marker of glycemic status but also as an indirect indicator of dyslipidemia (Alboueishi et al., 2021; Feingold, 2023).

Given the increasing prevalence of T2DM in Samarinda and the high risk of cardiovascular complications due to dyslipidemia, it is essential to investigate the relationship between lipid profile components and HbA1c levels. Understanding this relationship may contribute to better management strategies aimed at reducing complications and improving the quality of life for T2DM patients.Based on the above explanation, this study aims to analyze the relationship between lipid profile and HbA1c levels in patients with Type 2 Diabetes Mellitus at Puskesmas in Samarinda City.

METHOD

This study used an analytic design with a cross-sectional approach utilizing secondary data obtained from medical records of type 2 diabetes mellitus (T2DM) patients. The sample was selected using total sampling technique, including all T2DM patients at Puskesmas in Samarinda who underwent HbA1c and lipid profile tests in 2024, totaling 1,482 samples. This study was conducted in February 2025. The data were collected and analyzed using univariate and bivariate analysis. Univariate analysis was used to describe the characteristics of each research variable based on gender, age, systolic blood pressure, BMI, HbA1c level, HDL cholesterol, LDL cholesterol, total cholesterol, and triglycerides. Bivariate data were analyzed using the Chi-square test to examine the relationship between lipid profile values and HbA1c levels in T2DM patients. This study received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Mulawarman, Samarinda, under approval number 64/KEPK-FK/I/2025.

RESULT

Tabel 1.
Frequency Distribution of Research Variables at T2DM Patients

Characteristic		f	%
HbA1c	≥ 7 %	837	56,5
	< 7 %	645	43,5
Gender	Man	451	30,4
	Women	1031	69,6
Age	≥ 45 years	1350	91,1
	< 45 years	132	8,9
Systolic Blood Pressure	≥ 140 mmHg	609	41,1
	< 140 mmHg	873	58,9
BMI	≥ 25 kg/m^2	899	60,7
	< 25 kg/m^2	583	39,4
HDL-C	< 40 mg/dL	232	15.7

Characteristic		f	%
	≥ 40 mg/dL	1250	84,3
LDL-C	≥ 130 mg/dL	875	59,0
	< 130 mg/dL	607	41,0
TC	≥ 200 mg/dL	1046	70,6
	< 200 mg/dL	436	29,4
TG	≥ 150 mg/dL	732	49,4
	< 150 mg/dL	750	50,6

A total of 1,482 type 2 diabetes mellitus (T2DM) patients were included in this study. Based on glycemic status, 56.5% of the respondents had HbA1c levels ≥ 7%, indicating poor glycemic control. The majority of participants were female (69.6%). Most of the study population (91.1%) were aged 45 years or older. Based on systolic blood pressure, the majority of respondents had levels < 140 mmHg (58.9%). Regarding body mass index (BMI), 60.7% had a BMI ≥ 25 kg/m², indicating overweight or obesity. In terms of lipid profiles, 84.3% of patients had HDL-C ≥ 40 mg/dL. Elevated LDL-C levels (≥ 130 mg/dL) were found in 59.0% of participants. Additionally, 70.6% had total cholesterol (TC) levels ≥ 200 mg/dL. A total of 50.6% of the respondents had normal triglyceride (TG) levels (50,6%).

Tabel 2
Analysis Results

Variable	Glycemic Control				Total		P *value*	OR (95%CI)
	HbA1c ≥ 7 %		HbA1c < 7					
	f	(%)	f	(%)	f	(%)		
HDL							0,003	1.567 (1,169-2,100)
< 40 mg/dL	152	65,5	80	34,5	232	100		
≥ 40 mg/dL	685	54,8	565	45,2	1250	100		
LDL								
≥ 130 mg/dL	518	59,2	357	40,8	875	100	0,013	1.310 (1,063-1,614)
< 130 mg/dL	319	52,6	288	47,4	607	100		
TC								
≥ 200 mg/dL	638	61	408	39	1046	100	<0,001	1,862 (1,486-2,334)
< 200 mg/dL	199	45,6	237	54,4	1482	100		
TG								
≥ 150 mg/dL	520	71	212	29	732	100	0.032	3,350 (2,701-4,157)
< 150 mg/sL	317	42,3	433	57,7	750			

The bivariate analysis showed a statistically significant association between glycemic control and all lipid profile components. All components of the lipid profile, HDL-C, LDL-C, total cholesterol (TC), and triglycerides (TG), were significantly related to HbA1c levels. Among these, elevated triglyceride levels (≥ 150 mg/dL) showed the strongest association, with patients in this group being more than three times as likely to have poor glycemic control (HbA1c ≥ 7%). Low HDL-C, high LDL-C, and elevated total cholesterol levels were also associated with increased odds of inadequate glycemic control. These results highlight the importance of monitoring and managing lipid profiles as part of comprehensive glycemic control strategies in T2DM patients.

DISCUSSION

Type 2 diabetes mellitus (T2DM) is a long-term metabolic condition characterized by elevated blood glucose levels and resistance to insulin (Galicia-Garcia et al., 2020). One

common complication among individuals with T2DM is dyslipidemia (Daneshvar et al., 2024). The findings of this study reveal a significant association between glycemic control, as measured by HbA1c levels, and various components of the lipid profile in patients with type 2 diabetes mellitus (T2DM) in Samarinda. A total of 1,482 patients were analyzed, and the majority (56.5%) had poor glycemic control (HbA1c ≥ 7%), underscoring the ongoing challenge in managing diabetes effectively at the primary care level.

Among the lipid parameters, triglycerides (TG) demonstrated the strongest association with poor glycemic control. Patients with elevated TG levels (≥ 150 mg/dL) were more than three times as likely to have HbA1c ≥ 7% (OR = 3.350; 95% CI: 2.701–4.157; p < 0.001). This finding is consistent with previous studies suggesting that hypertriglyceridemia is commonly observed in insulin-resistant states and reflects poor metabolic control in T2DM patients (Artha et al., 2019; El Alami et al., 2022; Kumari et al., 2022). A study by Nivedhini and Jamuna Rani revealed a significant relationship between triglyceride levels and HbA1c levels. Elevated triglyceride levels lead to an increase in circulating free fatty acids, which subsequently disrupt the signaling pathway between insulin receptors and glucose transporters. This condition triggers subclinical inflammation that results in insulin receptor dysfunction and damage to pancreatic beta cells. This mechanism explains why managing hyperglycemia in patients with high triglyceride levels is more complex compared to those with normal triglyceride levels (Nivedhini & A.Jamuna Rani, 2023).

Total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) were also significantly associated with higher HbA1c levels. TC ≥ 200 mg/dL increased the likelihood of poor glycemic control by nearly two-fold (OR = 1.862; 95% CI: 1.486–2.334; p < 0.001), while LDL-C ≥ 130 mg/dL was associated with a modest but significant increase in poor glycemic control (OR = 1.310; 95% CI: 1.063–1.614; p = 0.013). Elevated levels of TC and LDL-C have been widely recognized as contributing factors to cardiovascular risk, which is already elevated in diabetic individuals. These results are in line with several studies that have demonstrated a significant relationship between HbA1c levels and LDL-C (Artha et al., 2019) However, unlike the results of our study, several previous studies have shown no statistically significant association between LDL-C levels and HbA1c (Begum et al., 2019).Interestingly, high-density lipoprotein cholesterol (HDL-C) levels (< 40 mg/dL) were also significantly associated with higher HbA1c levels (OR = 1.567; 95% CI: 1.169–2.100; p = 0.003). Different from our findings, previous studies have shown that there is no significant association between HDL-C levels and HbA1c levels (Alzahrani et al., 2019). HDL-C is known for its protective cardiovascular effects, and its reduction is commonly observed in diabetic dyslipidemia. The inverse relationship between HDL-C and glycemic control observed in this study suggests that impaired lipid metabolism is tightly linked with hyperglycemia.

Notably, Stratton in Sun et al showed reducing HbA1c levels by just 1% can lead to a 37% reduction in the risk of developing microvascular complications (Sun et al., 2022). Nevertheless, various studies have highlighted that increasing physical activity and adopting healthier lifestyle changes can significantly improve both blood sugar control and lipid profile abnormalities (Johansen et al., 2017; O'Donoghue et al., 2021). These results highlight the importance of a comprehensive metabolic management approach in T2DM patients. Monitoring lipid profiles alongside HbA1c may provide valuable insights for identifying patients at higher risk of complications and guiding therapeutic decisions.

CONCLUSION

HbA1c was found to have a significant associated with commonly measured serum lipid

levels. This suggests that HbA1c might serve a dual purpose, not only as an indicator of glycemic control but also as a potential biomarker for identifying dyslipidemia in individuals with type 2 diabetes. Utilizing HbA1c in this way could allow for earlier detection of lipid abnormalities through an affordable and widely used test. Identifying high-risk T2DM patients in this manner may support earlier intervention with lipid-lowering therapies. This study's cross-sectional design limits the ability to establish causality, and future longitudinal studies are recommended to better understand the temporal relationships between glycemic control and dyslipidemia. Nonetheless, the large sample size and consistent associations across all lipid components strengthen the validity of the observed findings.

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