



Nicky Rayi Fernanda, Meita Hendrianingtyas, Edward Kurnia Setiawan L.

ASSOCIATION BETWEEN HbA1C AND TRIGLYCERIDE LEVELS IN DIABETES MELLITUS PATIENTS WITH OBESITY

Nicky Rayi Fernanda¹, Meita Hendrianingtyas^{2*}, Edward Kurnia Setiawan L.²

¹Undergraduate Programme, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia

²Department of Clinical Pathology, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia

Keywords:

*Type 2 diabetes mellitus,
Diabetes mellitus with obesity,
HbA1c,
Triglycerides.*

Received: 07 August 2025

Revised: 18 September 2025

Accepted: 19 September 2025

Available online: 01 May 2026

Corresponding Author:

E-mail: meitanote2015@gmail.com

ABSTRACT

Background: The prevalence of type 2 diabetes mellitus (T2DM) continues to increase, while the obese group has a risk of T2DM seven times greater than the non-obese group. Obesity can also increase triglyceride levels with a significant impact on HbA1c. The relationship between increased HbA1c values and triglyceride levels in T2DM with obese patients needs further discussion. While previous studies have shown correlation between HbA1c and triglycerides, evidence remains scarce in obese with type 2 DM patients in Indonesia. **Aim:** To analyze the association between HbA1c and triglyceride levels in diabetes mellitus patients with obesity. **Methods:** This study was an observational analytical with a cross-sectional design conducted on 38 subjects from February – October 2022. The data obtained for this research was secondary data from the medical records of T2DM with obese patients at the Diponegoro National Hospital. The independent variable in this research was HbA1c and the dependent variable was triglyceride levels. The correlation analysis was done using Spearman Rank test. **Results:** The Spearman Rank's correlation test results between HbA1c and triglyceride levels in T2DM with obese patients were $p < 0.001$ and coefficient correlation = 0.57. **Conclusion:** There was a significant positive relationship with a strong correlation between HbA1c and triglyceride levels in T2DM with obese patients. This finding supports the importance of HbA1c and triglyceride monitoring in clinical practice, especially in obese T2DM patients, to manage and reduce long-term cardiovascular risk.

Copyright ©2026 by Authors. Published by Faculty of Medicine, Universitas Diponegoro Semarang Indonesia. This is an open access article under the CC-BY-NC-SA (<https://creativecommons.org/licenses/by-nc-sa/4.0/>).

INTRODUCTION

Diabetes mellitus (DM) is a chronic disease characterized by high blood glucose levels (hyperglycemia) and impaired carbohydrate, lipid, and protein metabolism due to abnormalities in insulin secretion and/or action. Compared to other types of DM, the prevalence and incidence of type 2 DM continues to increase, accounting for 90-95% of DM cases.¹

According to WHO, obesity accounts for 44% of diabetes cases, and the prevalence of obesity-related diabetes is projected to double, reaching 300 million cases by 2025. Being overweight triples the risk of diabetes, while obesity raises it sevenfold. Projections estimate that by 2030, 9.5% of adults will have diabetes, with one-third of this increase directly

linked to obesity.² Based on data from the Ministry of Health's 2018 Basic Health Research Report (RISKESDAS), the incidence of DM in 2018 was around 10.9%, followed by an increase in the prevalence of obesity from 14.8% in 2013 to 21.8% in 2018.¹

Excess body weight markedly elevates lifetime T2D risk—from 7% to 70% in men and from 12% to 74% in women as BMI rises.^{3,4} The prevalence of dyslipidemia is also greater in obese patients (74.9%), with a 57.6% risk of elevated TG levels.⁵ Elevated triglycerides (TG) in T2DM are primarily due to impaired insulin secretion or function, leading to enhanced hepatic VLDL production and delayed clearance of TG-rich lipoproteins, driven by higher substrate availability for TG synthesis.⁶



Nicky Rayi Fernanda, Meita Hendrianingtyas, Edward Kumia Setiawan L.

These complications can be prevented and reduced by good glycemic control, which includes monitoring glycated hemoglobin A1c (HbA1c).⁴ HbA1c examination can determine the average glycemia indication over the previous few months and take into account preprandial and post prandial blood glucose levels.⁴

Findings from study revealed that HbA1c levels above 9% were associated with a 2.69-fold increased risk of hypertriglyceridemia (OR=1.71–4.23, $p<0.001$).⁴ The risk of microvascular complications may increase by 18% for every 1% increase in HbA1c.⁸

While previous studies have shown correlation between HbA1c and triglycerides, evidence remains scarce in obese with type 2 DM patients in Indonesia. Therefore, the author would like to conduct research on the relationship between HbA1c levels and TG levels in DM patients, especially in individuals with obesity.

METHODS

This research is an analytical observational research with a cross-sectional design conducted in February - October 2022 at the Medical Record Installation of Diponegoro National Hospital Semarang. This study was conducted to determine the relationship between HbA1c values and triglyceride levels in patients with diabetes mellitus with obesity.

The samples used in this study were 38 patients with type 2 DM who underwent outpatient treatment at Diponegoro National Hospital and met the inclusion and exclusion criteria. Sample size was determined based on feasibility; no formal power calculation was conducted. The inclusion criteria in this study were men and women aged 18-65 years and had medical records of HbA1c and triglyceride laboratory examination results, while the exclusion criteria in this study were DM patients with dyslipidemia treatment, patients with severe liver disease, nephropathy, and pancreatitis. Sampling was done by purposive sampling from the medical records of type 2 DM patients with obesity who met the inclusion and exclusion criteria.

The independent variable of this study is the level of HbA1c and the dependent variable of this study is the level of triglycerides. We did not control for dietary intake, medication use, or duration of diabetes,

which may influence blood glucose and lipid levels. This remains a limitation.

HbA1c levels were measured using the High Performance Liquid Chromatography (HPLC) method with normal values $<5.7\%$, while triglyceride levels were measured using the Glycerol Peroxidase Para Amino Phenazone (GPO-PAP) method with normal values <150 mg/dL.⁹

Obesity in this study was determined using body mass index (BMI) measurements with a cut-off for obesity of ≥ 25 kg/m². Determination of type 2 DM in this study was based on HbA1c levels, which were grouped into 3 categories, viz: Normal $<5.7\%$, Prediabetes 5.7-6.4%, and Diabetes $\geq 6.5\%$.⁷ According to Perkeni (2021), normal triglyceride levels are <150 mg/dL.

Data analysis in this study includes univariate analysis in the form of frequency distribution and bivariate analysis in the form of Spearman correlation test.

This study has passed ethical feasibility or ethical clearance with the issuance of an ethical feasibility letter number 93 / EC / KEPK / FK-UNDIP / IV 2021 by the Health Research Ethics Commission (KEPK) Faculty of Medicine, Diponegoro University.

RESULTS

A total of 38 patient were included in the study. The characteristics of the research subjects can be seen in Table 1 and Table 2.

Table 1. Characteristics of Gender and Body Mass Index

Variables	n	%
Gender		
Male	13	34,2
Female	25	65,8
Body Mass Index		
Overweight	4	10,5
Obese 1	22	57,9
Obese 2	12	31,6

Based on Table 1, the gender distribution of patients in this study shows that female gender dominates compared to male gender. Based on the distribution of body mass index, it was found that most of the respondents were in obesity level 1 (22 people) and obesity level 2 (12 people). There were 4 respondents with overweight body mass index.



Nicky Rayi Fernanda, Meita Hendrianingtyas, Edward Kumia Setiawan L.

Table 2. Characteristics of Research

Variable	Median (min - max)
Age (years)	54,5 (30 – 60)
HbA1c (%)	7,3 (4,9 – 13,8)
Triglycerides (mg/dL)	168 (37 – 597)

The age distribution of the subjects ranged from 30 to 60 years. Subjects' HbA1c levels ranged from 4.9-13.8%, with a mix of 5 subjects with HbA1c levels <5.7% and up to 33 subjects with HbA1c levels >5.7%. Triglyceride levels in subjects ranged from 37-597 mg/dL, with a composition of 15 subjects with triglyceride levels <150 mg/dL and as many as 23 subjects with triglyceride levels >150 mg/dL.

Table 3. Spearman Rank Correlation Test

Parameters	r	p
HbA1c	0,57	<0,001
Triglycerides		

Table 3 shows the results of hypothesis testing of the relationship between HbA1c levels and triglyceride levels in DM patients with obesity using the Spearman rank test. The results of the analysis test show the results of $p < 0.001$ with a correlation coefficient = 0.57. There is a significant positive relationship with a moderate correlation value between HbA1c levels and triglyceride levels in DM patients with obesity.

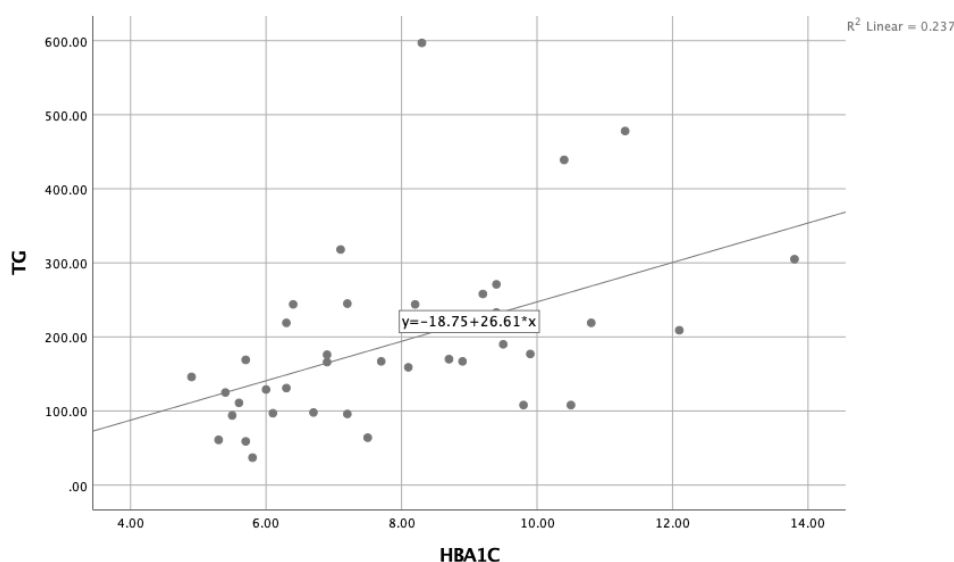


Figure 1. Scatter Plot Graph

In Figure 1, it can be seen that the points spread out and form a line with a pattern from the bottom left to the top right. Based on this pattern, it can be concluded that the two variables are significantly correlated with a positive correlation direction, meaning that an increase in HbA1c will be followed by an increase in triglyceride levels with the equation $\text{triglycerides} = -18.75 + 26.61 \times \text{HbA1c}$.

DISCUSSION

Characteristics of Research Subjects

The distribution of research subjects was predominantly female, with 22 individuals (57.9%). This data is consistent with the Ministry of Health's

2018 Basic Health Research Report (RISKESDAS), which states that type 2 DM affects more women (1.78%) than men (1.21%).¹⁰

In this study, the highest number of respondents with Body Mass Index (BMI) obesity level 1 was 22 people. Based on research by Irena et al (2020) conducted in Semarang on 77 respondents, the study tried to correlate BMI with HbA1c levels in abdominal obese women, the results showed that there was a significant relationship between BMI and HbA1c levels in abdominal obese women. The respondents were also found to be at high risk for DM (8.75%) and diagnosed with DM (3.75%).¹¹ Another study by Bizuayehu et al (2022), which looked at the



Nicky Rayi Fernanda, Meita Hendrianingtyas, Edward Kumia Setiawan L.

prevalence of obesity and influencing factors in type 2 DM patients, found that triglyceride levels were higher in respondents in the obese group than in other groups, with a median triglyceride level in the obese group of 247 mg/dL, so it can be concluded that there is an association between obesity and triglyceride levels in type 2 DM patients.¹²

The age distribution of the subjects in this study was in the range of 30-60 years. This research was consist with the research of Bizuayehu et al (2022) who found that the incidence of type 2 DM occurred mostly between the ages of 45-60 years (47.8%).¹²

The distribution of HbA1c values of the subjects in this study ranged from 4.9 to 13.8%. A study by Salim et al (2022), which correlated the level of HbA1c with MCV in patients with type 2 DM, found that the mean level of HbA1c in patients with type 2 DM was 8.3% (females) and 7.93% (males).¹³

The distribution of triglyceride levels in the subjects of this study ranged from 37 to 597 mg/dL. In a study by Ahmmed et al (2021) of 132 subjects with type 2 DM, the mean triglyceride level was 218.70 mg/dL (women) and 208.1 mg/dL (men).⁴

Association between Hba1c and Triglyceride Levels in Diabetes Mellitus Patients with Obesity

The significance of the value of HbA1c with triglyceride levels in patients with diabetes mellitus with obesity obtained a p-value <0.001 and the correlation coefficient obtained a value of 0.57. This shows that there is a significant positive relationship with a moderate correlation value between the value of HbA1c and triglyceride levels in DM patients with obesity.

These results are in accordance with research by Widhyasih et al (2018) conducted in Jakarta on 90 respondents who were type 2 DM patients, the study tried to correlate HbA1c levels with triglyceride levels in type 2 DM patients, it was found that there is a positive relationship between HbA1c levels and triglyceride levels because the p value was obtained = 0.000 with $r = 0.594$ so it is in accordance with this study.¹⁴ The results of this study are also in line with the research of Zheng et al. (2019), which said that there is a significant relationship between HbA1c values and triglyceride levels in type 2 DM patients ($p < 0.001$). Another study by Hyassat et al (2022) stated that there was an association between HbA1c levels

>8% with an increased risk of hypertriglyceridemia (OR=1.6) in type 2 DM individuals.¹⁶

Hyperglycemia arises from reduced insulin sensitivity and declining β -cell mass, with obesity amplifying this through genetic and epigenetic susceptibility, microenvironmental disruption of insulin signaling, impaired β -cell function, and dysregulated microbiome-gut-brain interactions. However, obesity in type 2 DM patients can increases hepatic glucose production and insulin levels.¹⁷ Obesity may appear as a simple excess of body weight while it is the main factor for progressive metabolic disturbances, with type 2 DM being most strongly linked.

Elevated TG common in type 2 DM patients and sustained by chronic insulin resistance (IR), which boosts FFA release from abdominal adipose tissue. These FFAs accumulate in the liver as VLDL, which subsequently exchange TG for esterified cholesterol with HDL and LDL, heightening atherogenicity and accelerating atherosclerosis—the leading cause of morbidity and mortality worldwide.¹⁸ Altered lipid metabolism also happens due to obesity, leading to an increase in circulating free fatty acids. High levels of free fatty acids can accumulate in tissues not suited for fat storage, such as the liver and muscles, causing lipotoxicity. This condition exacerbates insulin resistance by interfering with insulin signaling and glucose transport mechanisms.¹⁹

Our findings suggest that HbA1c levels $\geq 6.5\%$, significantly increase the risk of hypertriglyceridemia in type 2 DM patients with obesity. This highlights the importance of integrating HbA1c and triglyceride monitoring in routine clinical practice, as early detection and management of dyslipidemia may reduce long-term cardiovascular complications.

This study has several limitations. The relatively small sample size may restrict the generalizability of the findings, while the cross-sectional design prevents establishing a causal relationship between HbA1c and triglyceride levels. Additionally, as this was a single-center study, the results may not fully represent the broader population of type 2 DM patients with obesity in Indonesia. Another limitation of this study is the lack of adjustment for potential confounding variables such as dietary intake, medication use, physical activity, and duration of diabetes. These factors may influence both HbA1c and triglyceride levels, thereby affecting the observed association. Future studies



Nicky Rayi Fernanda, Meita Hendrianingtyas, Edward Kumia Setiawan L.

should incorporate more comprehensive data collection, multicenter longitudinal studies with larger cohorts and multivariate analysis to minimize the impact of confounders and warranted to confirm these observations.¹⁸

CONCLUSION

Based on the results of the research, it can be concluded that there is a strong positive significant relationship between HbA1c levels and triglyceride levels in DM patients with obesity. This finding supports the importance of HbA1c and triglyceride monitoring in clinical practice to enhance therapeutic strategies, improving patients' quality of life and reduce long-term cardiovascular risk, especially in obese type 2 DM patients.

REFERENCES

1. PERKENI. Pedoman Nasional Pelayanan Kedokteran Tatalaksana Diabetes Melitus Tipe 2 Dewasa. Jakarta: 2020.
2. Grant B, Sandelson M, Agyemang-Prempeh B, Zalin A. Managing obesity in people with type 2 diabetes. *Clin Med (Lond)*. 2021 Jul;21(4):e327-e231. doi: 10.7861/clinmed.2021-0370. PMID: 35192472; PMCID: PMC8313195.
3. Garg C, Daley SF. Obesity and Type 2 Diabetes. [Updated 2025 Jun 12]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK592412/>
4. Naqvi S, Naveed S, Ali Z, Ahmad SM, Asadullah Khan R, Raj H, Shariff S, Rupareliya C, Zahra F, Khan S. Correlation between Glycated Hemoglobin and Triglyceride Level in Type 2 Diabetes Mellitus. *Cureus*. 2017 Jun 13;9(6):e1347. doi: 10.7759/cureus.1347. PMID: 28713663; PMCID: PMC5509244.
5. Ahmmed MdS, Shuvo S das, Paul DK, Karim MR, Kamruzzaman Md, Mahmud N, et al. Prevalence of dyslipidemia and associated risk factors among newly diagnosed Type-2 Diabetes Mellitus (T2DM) patients in Kushtia, Bangladesh. *PLoS Global Public Health*. 2021;1(12):1-13.
6. AlZeer I, AlBassam AM, AlFeraih A, AlMutairi A, AlAskar B, Aljasser D, AlRashed F, Alotaibi N, AlGhamdi S, AlRashed Z. Correlation Between Glycated Hemoglobin (HbA1c) Levels and Lipid Profile in Patients With Type 2 Diabetes Mellitus at a Tertiary Hospital in Saudi Arabia. *Cureus*. 2025 Mar 17;17(3):e80736. doi: 10.7759/cureus.80736.
7. Schnell O, Crocker JB, Weng J. Impact of HbA1c Testing at Point of Care on Diabetes Management. *JDST SAGE Publications Inc*. 2017;11(3):611-7.
8. Yudha NSD, Arsana PM, Rosandi R. Perbandingan Profil Lipid pada Pasien Diabetes Melitus Tipe 2 dengan Kontrol Glikemik yang Terkendali dan Kontrol Glikemik yang Tidak Terkendali di RSUD Dr. Saiful Anwar Malang. *Jurnal Penyakit Dalam Indonesia*. 2021;8(4):172-7.
9. Hardisari R, Koiriyah B. Gambaran Kadar Trigliserida (Metode Gpo-Pap) Pada Sampel Serum dan Plasma EDTA [Internet]. *JTL*. 2016;5:27-31. Available from: www.teknolabjournal.com
10. Laporan Nasional Riskesdas 2018 [Internet]. 2018. Available from: http://labdata.litbang.kemkes.go.id/images/download/laporan/RKD/2018/Laporan_Nasional_RKD2018_FINAL.pdf.
11. Irena BF, Sulchan M. Levels of HbA1c in Women with Abdominal Obesity at Women's Correctional Institution Class IIA Semarang City. *JNH*. 2020;8(1):15-24.
12. Bizuayehu T, Menjetta T, Mohammed M. Obesity Among type 2 Diabetes Mellitus at Sidama Region, Southern Ethiopia. *PLoS ONE*. 2022;17(4):4-9.
13. Salim Y, Kalanjati VP, Prajitno JH, et al. Hemoglobin A1c (HbA1c) is strongly correlated with Mean Corpuscular Volume among Type 2 Diabetes Mellitus (T2DM) Patients admitted to a Tertiary Hospital in East Java, Indonesia. *Fol Med Indones*. 2022;58(1):46-9.
14. Widayasih RM, Nurshofi SE. HbA1c as Glycemic Control is Associated with Triglycerides Levels in Type 2 Diabetes Mellitus. *Atlantis Press*. 2018;13(2):239-42.
15. Zheng D, Dou J, Liu G, et al. Association Between Triglyceride Level and Glycemic Control Among Insulin-Treated Patients With Type 2 Diabetes. *JCEM*. 2019;104(4):1211-20.



Nicky Rayi Fernanda, Meita Hendrianingtyas, Edward Kumia Setiawan L.

16. Hyassat D, Al-Saeksaek S, Naji D, et al. Dyslipidemia among patients with type 2 diabetes in Jordan: Prevalence, pattern, and associated factors. *F Pub H*. 2022.
17. Ruze R, Liu T, Zou X, Song J, Chen Y, Xu R, Yin X, Xu Q. Obesity and type 2 diabetes mellitus: connections in epidemiology, pathogenesis, and treatments. *Front Endocrinol (Lausanne)*. 2023 Apr 21;14:1161521. doi: 10.3389/fendo.2023.1161521. PMID: 37152942; PMCID: PMC10161731.
18. Paublani H, López González AA, Busquets-Cortés C, Tomas-Gil P, Riutord-Sbert P, Ramírez-Manent JI. Relationship between Atherogenic Dyslipidaemia and Lipid Triad and Scales That Assess Insulin Resistance. *Nutrients*. 2023 Apr 27;15(9):2105. doi: 10.3390/nu15092105. PMID: 37432258; PMCID: PMC10180556
19. Tareh Al. Assessment of Lipid Profile and Clinical Manifestation of Obese Patients with Type 2 Diabetes. *Eur J Med Health Res*. 2024; 2(4): 105-10.