Nursing Journal
Volume 11, Issue 1, Page 316-321
e-ISSN: 2354-6050

https://ejurnal.poltekkesjakarta3.ac.id/index.php/JKep
DOI: https://doi.org/10.32668/jkep.v11i1.2363

THE RELATIONSHIP AMONG HBA1C, LOW-DENSITY LIPOPROTEIN (LDL) CHOLESTEROL, AND SYSTOLIC BLOOD PRESSURE IN PATIENTS WITH DIABETES MELLITUS

1st Ni Made Juniari

2nd I Wayan Sukawana[1*]

3rd I Gusti Made Andika Putra

Poltekkes Kemenkes Denpasar, Denpasar, Bali, Indonesia

*email: wsukawanajkp@gmail.com

Keywords:
Blood glucose
Blood pressure
Cholesterol
Diabetes mellitus

Abstract

Diabetes mellitus is a chronic disease often accompanied by cardiovascular complications, one of which is hypertension. Controlling HbA1c and LDL cholesterol levels is a crucial component of diabetes mellitus management, aiming to reduce the risk of these complications. This study aimed to analyze the association between HbA1c control and LDL cholesterol control with systolic blood pressure control in diabetes mellitus patients at the Tejakula II Community Health Center. This study used an observational analytical design with a cross-sectional approach. The subjects were registered Diabetes Mellitus patients receiving services at the Tejakula II Community Health Center. The sample size of this research was 47 participants. Data on HbA1C, LDL cholesterol, and systolic blood pressure were obtained from patient medical records. Data were analyzed bivariately using appropriate statistical tests and odds ratio calculations. The results showed that HbA1C and LDL cholesterol control were not significantly associated with systolic blood pressure control ($p > 0.05$). The model explained 13.4% of the variation in systolic blood pressure control (Nagelkerke $R^2 = 0,134$). Although the odds ratios suggested a tendency toward a higher risk of uncontrolled systolic blood pressure among patients with uncontrolled HbA1C and LDL levels, these associations were not statistically significant. However, patients with uncontrolled HbA1C and LDL cholesterol levels had a higher risk of developing uncontrolled systolic blood pressure. Diabetes Mellitus management needs to be carried out comprehensively and multifactorially in primary health care facilities.

Received: January 2026
Accepted: January 2026
Published: May 2026

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disease caused by insulin deficiency, insulin inefficiency, or both. DM cases continue to increase. An estimated 537 million, or 10.5% of all adults aged 20-79 years worldwide, have DM. This number is projected to reach 643 million by 2030 and continue to increase to 783 million DM patients by 2045. An estimated 68.4% of DM cases are undiagnosed, and 51.3% of all undiagnosed DM patients are in Southeast Asia (1). The prevalence of DM in Indonesia is estimated to reach 20,4 million people (11,3% of the total adult population) by 2024. This puts Indonesia among the top five countries with the highest number of DM patients worldwide (2).

DM is a chronic, incurable disease that tends to be progressive. The progression of DM is accompanied by various complications. The most prominent complications are microvascular complications (retinopathy, nephropathy, and neuropathy) and macrovascular complications. (3). Macrovascular complications result in DM patients having a 2 to 4 times greater risk of developing cardiovascular disease. (4). These various complications occur due to chronic hyperglycemia and hypercholesterolemia, especially low-density lipoprotein (LDL) in DM.

Chronic hyperglycemia causes glucose to enter the tissues (glycosylation). Carbohydrate molecules (glycans) attach to tissue proteins or lipids, disrupting the structure and function of these tissues (5). The glycosylation parameter is HbA1C.

HbA1C is a glycosylation of hemoglobin as a parameter for blood glucose levels in the last three months (6). Important parameters targeted for diabetes management in adult patients in Indonesia are HbA1C and LDL cholesterol. The Indonesian Diabetes Association (Perkeni) has set a target of HbA1C less than 7% and LDL cholesterol less than 100 mg/dl(7).

Elevated LDL levels can potentially lead to plaque buildup on artery walls (atherosclerosis). Glycosylation and atherosclerosis cause arteries to narrow and stiffen, increasing peripheral resistance. (8). The characteristic of hypertension in DM, both type I and type II, is an increase in peripheral vascular resistance. (9).

Peripheral resistance causes increased blood pressure (hypertension). Hypertension is found simultaneously in 80% of DM patients.(10). A study at Dr. Chasbullah Abdulmadjid Regional Hospital in Bekasi City found that 46,57% of DM patients experienced hypertension.(11). Another study found that 37,4% of hypertension in diabetes mellitus was isolated systolic hypertension. Isolated systolic hypertension is defined as hypertension with a systolic blood pressure of ≥ 140 mmHg and a diastolic blood pressure of ≤ 90 mmHg(12). Perkeni sets the parameters for controlling systolic blood pressure in DM at less than 140 mmHg (7). Hypertension in DM increases the risk of cardiovascular disease. Results of a study prove that hypertension has a high risk of coronary heart disease. (13).

Considering that blood pressure and blood glucose levels, as well as lipid profiles, have a strong relationship, special attention needs to be given to controlling the glycemic and lipid profiles of DM patients. (10). The glycemic status of DM sufferers is evaluated through the results of the HbA1C examination.(7). Poor glycemic control in DM will hurt lipid and lipoprotein metabolism, so that LDL will increase. (14). Poor glycemic control and impaired lipid metabolism will impact blood pressure.

However, despite the established associations between glycemic control, lipid profiles, and hypertension, previous studies have often examined these factors separately. Limited research has explored the combined effect of HbA1C and LDL cholesterol control on systolic blood pressure, particularly among Indonesian populations. Furthermore, evidence regarding the contribution of simultaneous glycemic and lipid control to isolated systolic hypertension in DM patients remains insufficient. This gap highlights the need for integrated analysis to better understand the interplay between metabolic control and blood pressure outcomes in diabetes management. This study aimed to determine the relationship between HbA1C and LDL cholesterol control and systolic pressure in patients with diabetes.

METHODS

The research method used was a correlational study with a cross-sectional approach. The study population was 49 DM patients who regularly attended Tejakula 2 Community Health Center, underwent treatment according to the applicable standards at Tejakula 2 Community Health Center, and had available HbA1C, LDL, and blood pressure test results in December 2024. The exclusion criteria in this study were DM patients who had been diagnosed with primary hypertension. The sample size was calculated using the "10 events per variable (EPV)" guideline for binary logistic regression tests. Previous research found that the proportion of DM patients with hypertension was 46,57%(11). Then the number of samples (n)= 42,85. Plus a reserve for invalid data of at least 10%, the number of samples taken in this study was 47 DM patients. Samples were taken using a simple random technique. The research data consisted of HbA1C levels, LDL cholesterol levels, and systolic blood pressure taken from patient medical records at Tejakula 2 Health Center. HbA1C levels were categorized as controlled (<7%) and uncontrolled (≥7%), LDL cholesterol levels as controlled (<100 mg/dL) and uncontrolled (≥100 mg/dL), and systolic blood pressure as controlled (<140 mmHg) and uncontrolled (≥140 mmHg), based on PERKENI 2024 guidelines. Analysis of the effect of HbA1C and LDL levels on systolic blood pressure was performed using Binary Logistic Regression. Ethical approval for this study was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Denpasar (Approval No.: DP.04.02/F.XXXII.25/632/2025), and all procedures were conducted in accordance with ethical research principles.

RESULTS AND DISCUSSION

This study found the lowest HbA1C level was 6,66%, the highest was 11,20%, and the average was 7,93 ± 1,44%. The lowest LDL cholesterol level was 43 mg/dl, the highest was 196 mg/dl, and the average was 114,79 ± 33,42 mg/dl. The lowest systolic pressure was 100,17 mmHg, the highest was 132,55, and the average was 116,74 ± 1,44 mmHg.

Based on the DM control parameters established by the Indonesian Endocrinology Association (Perkeni) in 2024, out of 47 samples, only 4 (8,51%) DM patients had controlled HbA1C, LDL levels, and systolic pressure. The majority (91,49%) were uncontrolled based on these three parameters. An overview of the number of uncontrolled patients in each parameter is presented in Figure 1.

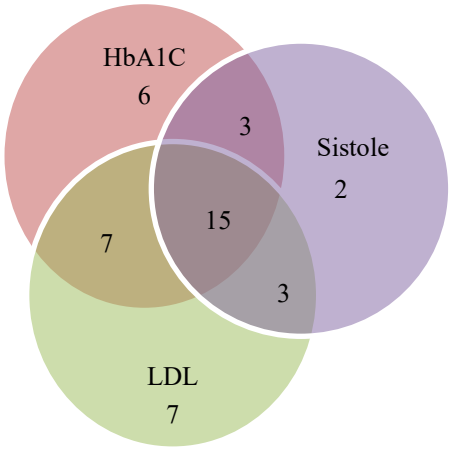

Figure I. Distribution of controlled and uncontrolled HbA1C, LDL cholesterol, and systolic blood pressure among DM patients

Figure 1 shows that 31 (65,96%) patients had uncontrolled HbA1C. This finding is similar to the findings of a study conducted at the Wangaya Regional Hospital Laboratory, which found that 60% of DM patients had uncontrolled HbA1C levels.(15). Uncontrolled HbA1C is a risk factor for cardiovascular disease and death.(16). Every 1% increase in HbA1c is positively correlated with the risk of cardiovascular disease (1,2 times higher risk of death) and the risk of death (1,14 times higher risk of death) (17). This study found that 68,09% f DM patients had uncontrolled LDL cholesterol levels. These results are similar to those of a study at Klungkung Regional Hospital, which found that 66% of DM patients treated had uncontrolled LDL levels. (18). Increased LDL with thick and small particles is caused by insulin resistance or deficiency, which disrupts lipid metabolism. LDL easily settles in the lining of blood vessels and oxidizes, leading to atherosclerosis (19). Insulinopenia causes increased lipolysis in adipose tissue. This increased lipolysis leads to increased release of free fatty acids into the circulation. This results in increased delivery of fatty acids to the liver for synthesis into LDL (13).

Nearly half (48,94%) of respondents had uncontrolled systolic blood pressure. This finding is similar to the findings of a study conducted at the Integrated Guidance Post (Posbindu) at the As-Sakinah Mosque in Banyumas, which found that 37% of diabetes patients had uncontrolled systolic blood pressure. (20). An increase in systolic pressure generally occurs due to a decrease in the elasticity of the arteries. (21). In cases of DM, decreased arterial elasticity occurs due to chronic hyperglycemia, which triggers atherosclerosis. (22). In general, the number of DM with hidden systolic hypertension reached 37,4%(12). DM with hypertension has a 12 times higher risk of experiencing Acute Myocardial Infarction, a 6 times higher risk of stroke, and a two times higher risk of hospitalization compared to hypertensive patients without DM. (23).

Analysis of the relationship between controlling HbA1C levels and LDL cholesterol levels with systolic blood pressure is presented in Table 1.

Table I. Analysis of the Relationship between HbA1C Level Control and LDL Cholesterol Levels with Systolic Blood Pressure in DM Patients at Tejakula 2 Community Health Center

Statistics	Test Value	Significance
Omnibus Tests of Model Coefficients		
Chi Square	4,981	0,083
Model Summary		
Nagelkerke R Square	0,134	0,500
Chi-Square Hosmer and Lemeshow	1,385	
Variables in the Equation		
a. Wald X1	2,669	0,102
b. Wald X2	1,821	0,056
c. Exp (B) X1 (HbA1C)	2,956	
d. Exp (B) X2 (Kadar Kolesterol LDL)	2,479	
	1,084	
e. B X1	0,908	
f. B X2	-1,394	
g. Constant		

In Table 1, the results of the Hosmer and Lemeshow Chi-Square test of 1,385 with a significance value of 0,500 (the same as the p-value), prove that the model is acceptable for hypothesis testing. The logistic regression model was acceptable (Hosmer–Lemeshow test p = 0,500). The model explained 13,4% of the variance in systolic blood pressure control (Nagelkerke R^2 = 0,134). However, HbA1C and LDL cholesterol control were not significantly associated with systolic blood pressure control (p > 0,05). The EXP (B) or Odds Ratio (OR) value of the HbA1C control variable of 2,956 states that patients with uncontrolled HbA1C levels have a 2,956-fold risk of having uncontrolled systolic pressure compared to patients with controlled HbA1C levels. The EXP (B) or odds ratio (OR) value of the LDL control variable of 2.479 indicates that patients with uncontrolled LDL levels have a 2,479-fold greater risk of having uncontrolled systolic pressure compared to patients with controlled LDL levels. The test results found BX1 = 1,084, BX2 = 0,908, and a constant of -1,394, so the probability or prediction value can be calculated as follows:

Probability or predicted = Exp(-1,394 + 1,084 + 0,908)/1 + Exp(-1,394 + 1,084 + 0,908).

Therefore, the probability or predicted group membership value is 0,654. This probability value is greater than the p-value (0,05), so it can be concluded that patients with uncontrolled HbA1C and LDL levels have a significant chance of experiencing uncontrolled systolic blood pressure.

Poor glycemic control results in moderate increases in LDL-C (14). Serum LDL-C levels increase vascular tone by increasing the response of vascular smooth muscle cells to angiotensin II and decreasing the bioavailability of nitric oxide (NO). This increases peripheral resistance, leading to increased blood pressure. (24). Optimizing glycemic control in diabetic patients will have secondary beneficial effects on lipid levels. (14). Insulin deficiency (insulinopenia) in diabetes mellitus results in increased lipolysis in adipose tissue. This increased lipolysis leads to increased release of free fatty acids into the circulation, thereby increasing fatty acid delivery to the liver. (13). Another factor that influences systolic pressure in DM is the patient's age. (12). As we age, blood vessels naturally become stiffer and less elastic. Other research has found several factors that significantly influence the development of hypertension in diabetes, namely: excess weight, lack of activity, age, and duration of diabetes. (25).

The findings of this study have several important implications for nursing practice. First, nurses play a critical role in early detection and continuous monitoring of glycemic status, lipid profiles, and blood pressure in patients with diabetes mellitus. Routine assessment of HbA1C, LDL cholesterol, and systolic blood pressure should be integrated into primary care services to identify patients at risk of cardiovascular complications earlier. (26). Second, the high proportion of uncontrolled HbA1C and LDL levels indicates the need for strengthening patient education programs. Nurses should provide structured education related to diet management, medication adherence, physical activity, and self-monitoring of blood glucose to improve patient self-management (27). Third, although this study did not find a statistically significant relationship, the increased odds ratio suggests a clinically meaningful risk. Therefore, nurses should adopt a holistic and preventive approach by simultaneously targeting glycemic control and lipid management to reduce the risk of hypertension and cardiovascular complications. (28). Fourth, nurses in community health settings, especially in primary healthcare centers, should optimize chronic disease management programs through regular follow-up, counseling, and collaboration with multidisciplinary teams. Family involvement should also be encouraged to support long-term adherence to therapy. (29).

Finally, this study highlights the importance of developing nursing interventions based on risk stratification, where patients with uncontrolled HbA1C and LDL levels receive more intensive monitoring and intervention to prevent worsening cardiovascular outcomes.

CONCLUSION

This study found that most patients with diabetes mellitus did not achieve target control of HbA1C, LDL cholesterol, and systolic blood pressure based on PERKENI guidelines. Statistical analysis showed that HbA1C and LDL cholesterol control were not significantly associated with systolic blood pressure control.

Although the odds ratios indicated a tendency toward a higher likelihood of uncontrolled systolic blood pressure among patients with uncontrolled HbA1C and LDL levels, these findings were not statistically significant. Therefore, the results should be interpreted with caution.

These findings highlight the complexity of blood pressure control in patients with diabetes mellitus, which may be influenced by multiple factors beyond glycemic and lipid control. Further studies with larger sample sizes and inclusion of potential confounding variables are needed to better understand these relationships.

Comprehensive and multifactorial management remains essential in primary healthcare settings to reduce the risk of cardiovascular complications in patients with diabetes mellitus.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the Head of Tejakula II Community Health Center and all staff members for granting permission and providing valuable support and facilitation throughout the research process.

REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas, 10th edn. Brussels, Belgium; 2021.
2. Persatuan Diabetes Indonesia. Diabetes in Indonesia (2024) [Internet]. International Diabetes Federation. 2024. Available from: https://idf.org/our-network/regions-and-members/western-pacific/members/indonesia/
3. Tomic D, Shaw JE, Magliano DJ. The burden and risks of emerging complications of diabetes mellitus. Nat Rev Endocrinol. 2022;18(9):525–39.
4. Gupta N, Elnour AA, Sadeq A, Gupta R. Diabetes and the heart: coronary artery disease. e-Journal Cardiol Pract. 2022;22(10).
5. Yapislar H, Gurler EB. Management of Microcomplications of Diabetes Mellitus: Challenges, Current Trends, and Future Perspectives in Treatment. Biomedicines. 2024;12(9):1–25.
6. Yedla N, Kuchay MS, Mithal A. Hemoglobin e disease and glycosylated hemoglobin. Indian J Endocrinol Metab. 2015;19(5):683–5.
7. Pengurus Besar Perkumpulan Endokrinologi Indonesia (PERKENI). Pedoman Pengelolaan dan Pencegahan Diabetes Melitus Tipe 2 di Indonesia Tahun 2024. Pb Perkeni. Pb Perkeni; 2024.
8. Brutsaert EF. Complications of Diabetes Mellitus. Braunstein GD, editor. New York Medical College; 2025.
9. Epstein M, Sowers JR. Diabetes mellitus and hypertension. Hypertension. 1992;19(5):403–18.
10. Al-Azzam N, Al-Azzam S, Elsalem L, Karasneh R. Hypertension prevalence and associated factors among patients with diabetes: A retrospective cross-sectional study from Jordan. Ann Med Surg. 2021;61(December 2020):126–31.
11. Ayutthaya SS, Adnan N. Faktor Risiko Hipertensi pada Penderita Diabetes Mellitus Tipe 2. J Ilmu Kesehat Masy. 2020;9(02):60–71.
12. Ephraim RKD, Saasi AR, Anto EO, Adoba P. Determinants of isolated systolic hypertension among diabetic patients visiting the diabetic clinic at the Tamale Teaching Hospital, Northern Ghana. Afr Health Sci. 2016;16(4):1151–6.
13. Damayanti VW, Yonata A, Kurniawaty E. Hipertensi pada Diabetes Melitus: Patofisiologi dan Faktor Risiko. Medula. 2023;14(1):1253–7.
14. Feingold KR. Dyslipidemia in Patients with Diabetes. 2023.
15. Sarihati IGAD, Karimah HN, Habibah N. Gambaran Kadar HbA1C pada Pasien Diabetes Melitus Tipe 2 di RSUD Wangaya. Meditory J Med Lab. 2019;6(2):88–98.
16. Palta P, Huang ES, Kalyani RR, Golden SH,

Yeh HC. Hemoglobin A1c and mortality in older adults with and without diabetes: Results from the National Health and Nutrition Examination Surveys (1988-2011). Diabetes Care. 2017;40(4):453–60.

17. Chen YY, Lin YJ, Chong E, Chen PC, Chao TF, Chen SA, et al. The impact of diabetes mellitus and corresponding HbA1c levels on the future risks of cardiovascular disease and mortality: A representative cohort study in Taiwan. PLoS One. 2015;10(4):1–12.
18. Oka Kusuma Jaya IG, Sukawana IW, Sukarja IM, Juniari NM. Gambaran Profil Lipid Pasien Diabetes Melitus Tipe 2. J Gema Keperawatan. 2024;17(1):1–10.
19. Lee J, Lee S-H. Lipid variability in patients with diabetes mellitus. Cardiovasc Prev Pharmacother. 2023;5(4):126–33.
20. Rakhmawati A. Profil Nilai Tekanan Darah Penderita Diabetes Melitus dengan Kadar Glukosa Darah yang Tidak Terkontrol. J Bina Cipta Husada. 2025;21(2):106–15.
21. Tan JL, Thakur K. Systolic Hypertension. StatPearls Publishing LLC; 2023.
22. Ye J, Li L, Wang M, Ma Q, Tian Y, Zhang Q. Diabetes Mellitus Promotes the Development of Atherosclerosis : The Role of NLRP3. 2022;13(June):1–12.
23. Sousa AC, Jardim TV, Costa TO, Magalhães FG, Paulo M, Montelo M, et al. Hypertensive diabetic patients : incidence of cardiovascular and renal outcomes in a historical cohort over 11 years. Diabetol Metab Syndr. 2017;1–9.
24. Lamarche F, Agharazii M, Nadeau-Fredette A-C, Madore F, Goupil R. Central and Brachial Blood Pressures, Statins, and Low-Density Lipoprotein Cholesterol: A Mediation Analysis. Hypertension. 2018;71(3).
25. Anjajo EA, Workie SB, Tema ZG, Woldegeorgis BZ. Determinants of hypertension among diabetic patients in southern Ethiopia : a case-control study. BMC Cardiovasc Disord. 2023;23(233):1–11.
26. Baharudin N, Ramli AS, Ramland SS, Badlie-Hisham NI, Mohamed-Yassin MS. Factors Associated With Achievement of Blood Pressure, Low-Density Lipoprotein Cholesterol (LDL-C), and Glycemic Targets for Primary Prevention of Cardiovascular Diseases Among High Cardiovascular Risk Malaysians in Primary Care. J Prim Care Community Heal. 2023;14:1–13.
27. Li C, Bao C, Xu S. Impact of public health nursing combined with dietary intervention on self-management in patients with diabetes mellitus and hypertension. Blood Press [Internet]. 2025;34(1). Available from: https://doi.org/10.1080/08037051.2025.2574924
28. Koshak NA, Khaymi MR, Mohammed H, Alhwsawi A, Najmaldeen YA, Mohammed K, et al. Primary Care Nursing Strategies For Diabetes, Hypertension, And Multi-Morbidity Management. Int J Philos Cult Axiolog. 2024;21:239–45.
29. Veronika EN. The Influence of Family Support on Therapy Adherence in Diabetes Patients: A Mixed-Methods Study. Int J Heal Med Sci. 2024;2(3):114–23.