



The Role of HbA1c Levels in DM Patients with Coronary Heart Disease Incidents

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Article Info

Article history:

Received 20 July 2026

Received in revised form 17

August 2025

Accepted 5 September 2026

Keywords:

Coronary Heart Disease

Diabetes Mellitus

Glycemic Control

HbA1c

Cardiovascular Complications

Atherosclerosis

Abstract

Diabetes mellitus is a major risk factor for coronary heart disease (CHD), particularly when long-term glycemic control is inadequate. Glycated hemoglobin (HbA1c) reflects average blood glucose levels over the previous two to three months and may serve as an indicator of cardiovascular risk. This study aimed to examine the role of HbA1c levels in the incidence, severity, and clinical outcomes of CHD among patients with diabetes mellitus. A narrative literature review was conducted using articles published between 2021 and 2026 and retrieved from Google Scholar, PubMed, ScienceDirect, and ResearchGate. Studies were selected according to predetermined inclusion and exclusion criteria and critically evaluated using the Joanna Briggs Institute appraisal instruments. A total of 29 relevant studies were reviewed and synthesized narratively. Most studies demonstrated that elevated HbA1c levels were associated with an increased risk of CHD, greater coronary artery stenosis, more severe atherosclerotic lesions, and poorer cardiovascular outcomes, including major adverse cardiovascular events, restenosis following percutaneous coronary intervention, hospital readmission, and mortality. However, several cross-sectional studies reported no statistically significant association, possibly because of differences in sample characteristics, study design, duration of diabetes, assessment methods, and accompanying cardiovascular risk factors. Overall, poor glycemic control contributes to the development and progression of CHD through chronic hyperglycemia, oxidative stress, endothelial dysfunction, inflammation, and accelerated atherosclerosis. Regular HbA1c monitoring and individualized glycemic control are therefore important components of cardiovascular risk prevention and diabetes management.

Introduction

Diabetes Mellitus (DM) is an increase in blood glucose levels above the normal fasting range of 80-90 mg/dL or the non-fasting range of 140-160 mg/dL. If DM is not promptly treated, it can lead to complications such as blurred vision, heart disease, kidney disease, and skin and nerve disorders (Alfreyzal et al., 2024). One parameter for measuring blood glucose levels is HbA1c (Hemoglobin Adult 1C). HbA1c levels can be used to measure the level of glucose bound to hemoglobin in the blood because they represent a person's glucose levels over the past 2-3 months (Muhajiriansyah & Binuko, 2023).

DM is a disease that results in complications in coronary heart disease and carries the highest risk of death. The risk of coronary death can be fivefold higher in individuals with fasting insulin levels >15 mU/mL. This condition is associated with atherogenic factors, which are suspected to trigger macrovascular complications (Amirudin & Yunitasari, 2021; Lu et al., 2023). Coronary heart disease (CHD) is a cardiovascular disease. Coronary Heart Disease (CHD) is a condition in which the heart is unable to pump enough blood effectively to adequately perfuse to vital organs and peripheral tissues. (WHO, 2013) Coronary heart disease is a group of cardiovascular diseases. Coronary heart disease is a narrowing of the coronary arteries, which are responsible for supplying nutrients and oxygen to the heart muscles, especially the left ventricle, which pumps blood throughout the body. Narrowing and blockage cause a cessation of blood flow to the heart muscle. In more severe cases, the heart can no longer pump blood throughout the body. This disrupts the heart rhythm control system and can ultimately lead to death (Ramatillah et al., 2023; Mijwil et al., 2022; Kanna & Eliyas, 2023).

Many studies have shown that HbA1c levels are positively correlated with the severity of CHD. A study by Patiung et al. (2025) in non-diabetic ACS patients using the Gensini score system also demonstrated a correlation between higher HbA1c levels and predicting a higher CHD burden. In addition, a study conducted by Garg et al., involving 120 ACS patients, found a strong association between high HbA1c levels and severe CHD. This study assessed the severity of CHD through angiographic patterns, namely by looking at the number of blocked coronary blood vessels, which are divided into normal vessels, single-vessel disease (SVD), double-vessel disease (DVD), triple-vessel disease (DTV). In this study, it was found that in the group of patients with HbA1c levels $\geq 10.5\%$, 10 people experienced DTV compared to the group of patients with HbA1c levels $< 6.5\%$, only 1 person experienced DTV. Meanwhile, a study conducted by Habib et al., using the Syntax score to assess CHD severity, found that HbA1c was not a predictor for assessing CHD severity. A similar finding, noting that there was no relationship between HbA1c levels and the severity of coronary heart disease in both diabetic and non-diabetic patients (Nugroho et al., 2023).

The high mortality rate from diabetes is a serious problem that requires follow-up with preventive measures to reduce prevalence. People with diabetes are at risk of developing adverse health complications, such as cardiovascular disease and chronic kidney disease (Nugroho et al., 2023; Matsushita et al., 2022; Pálsson & Patel, 2014). By understanding the relationship between HbA1c levels in diabetes patients and the incidence of coronary heart disease, it is hoped that this will increase public and healthcare professional awareness of the importance of optimal glycemic control as a way to prevent cardiovascular complications and improve the quality of life of diabetes patients.

Methods

Literature Review

A literature review is a research method that involves identifying, evaluating, and analyzing various research findings relevant to a specific topic or research question. A literature review is considered a secondary study because it uses data from previous research as the primary source. This method aims to gain a comprehensive understanding of the role of HbA1c levels in diabetes patients with incident coronary heart disease.

In this study, a literature review was used to collect and analyze various research findings related to the effect of HbA1c levels on the incidence of coronary heart disease in diabetes patients. The research used can be quantitative studies such as cohort studies, case-control studies, cross-sectional studies, or randomized controlled trials (RCTs).

Design Strategy

The literature review was conducted through several stages, starting with a search for relevant literature using electronic databases such as Google Scholar, PubMed, ScienceDirect, and ResearchGate. Keywords used included "HbA1c," "DM," "Coronary Heart Disease," "Coronary Heart Disease," and "Relationship between HbA1c and CHD."

The articles obtained were then selected based on their relevance to the research topic. Next, a journal quality assessment is conducted using critical appraisal instruments from the Joanna Briggs Institute (JBI), such as the Checklist for Cohort Studies, Checklist for Case-Control Studies, Checklist for Analytical Cross-Sectional Studies, and Checklist for Systematic Reviews.

Critical appraisal instruments are used to assess the quality of the research methodology, the appropriateness of the research design, the validity of the results, and the relevance to the research objectives. The assessment results are used to determine whether the article is suitable for use as study material in this study.

Implementation Flow

Before drawing conclusions from the various literature findings, researchers will identify and summarize each article in a table containing the author's name, year of study, study design, sample size, research instruments, research variables, research results, and conclusions. After all the literature has been collected, researchers will analyze the role of HbA1c levels in diabetes patients with incident coronary heart disease. The results of the analysis will then be compiled into a narrative discussion to address the research objectives.

Data Determination

The type of data used in this study is secondary data obtained from various scientific literature sources, such as national and international journals, scientific articles, textbooks, undergraduate theses, and e-books related to the role of HbA1c levels in diabetes patients with coronary heart disease.

Literature Inclusion and Exclusion Criteria

Inclusion criteria for this study included literature discussing the role of HbA1c levels in patients with diabetes mellitus and coronary heart disease, published between 2021 and 2026, and written in Indonesian or English. The literature used must originate from credible and reliable scientific journals or official websites, and be available in full text. Exclusion criteria included literature that was inaccessible, originated from personal blogs or non-scientific sources, did not specifically discuss the relationship or role of HbA1c in patients with diabetes mellitus and coronary heart disease, and duplicate articles found from different databases.

Data analysis

The analysis steps taken by the researcher were as follows: 1) Summarize: Rewrite important information from literature sources using your own words without changing the main meaning of the research; 2) Synthesize: Combine and summarize the results of various studies related to the role of HbA1c levels in the incidence of coronary heart disease in DM patients; 3) Compare: Compare the results of one study with another to find similarities and differences between the studies; 4) Contrast: Identify differences in the results, methods, and characteristics of previous studies with those of the study being reviewed; 5) Criticize: Examine the shortcomings and limitations of previous studies as material for evaluation in the research.

This study used a narrative approach by grouping extracted data based on similarities in variables and research results. Literature that met the inclusion criteria was then analyzed and

summarized to draw conclusions regarding the role of HbA1c levels in DM patients with incident coronary heart disease.

Literature Search Flow

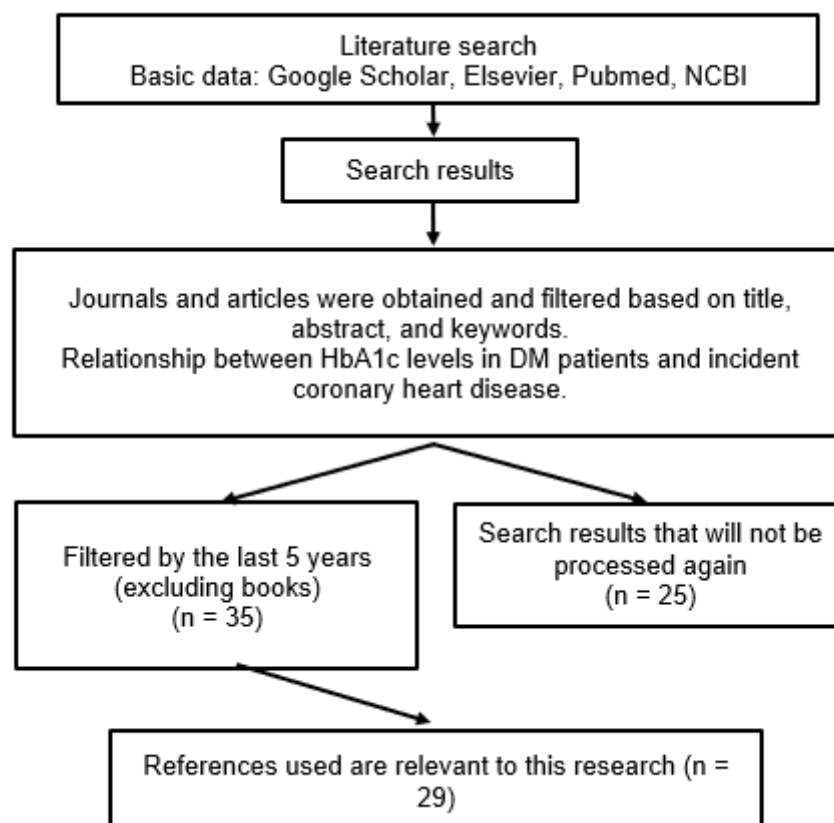


Figure 1. Literature Search Flow

Result and Discussion

This study employed a literature review method, collecting data through scholarly searches on the topic "The Role of HbA1c Levels in Patients with Diabetes and Coronary Heart Disease." Prior to the review, the literature was filtered according to the desired flow and criteria.

After filtering, 29 literature sources related to the topic and title of this study were used as references. These were then reviewed and summarized for discussion and conclusions. A description of the literature is presented in the table below:

Table 1. Research Results

Year	Title	Methods	Author	Result	Conclusion
2023	The Relationship between HbA1c and Macrovascular Complications in Type 2 Diabetes at Hermina Hospital Kemayoran	Analytical observation, cross-sectional, chi-square test	Faradilla Ardini, Samuel Halim	$p = 0.855$, indicating no significant association between HbA1c and macrovascular complications in T2DM.	There was no significant relationship between HbA1c levels and macrovascular complications in T2DM patients.

2024	The Effect of Glycemic Control in Type 2 Diabetes Patients on Coronary Heart Disease Complications	Observational analytical, cross-sectional	Serhen Esterany Ratulangi, Hari Sutanto	Patients with high HbA1c had a greater risk of CHD (86.5% vs. 63.3%), $p = 0.014$; PRR = 1.37.	There is a significant relationship between high HbA1c levels and an increased risk of CHD in type 2 DM.
2025	Relationship between HbA1c Levels and Severity of Coronary Artery Disease Based on Angiography Patterns in Acute Coronary Syndrome Patients at R.D. Hospital Kandou	Cross-sectional, total sampling, chi-square test	Gracia Margareth Patiung, Agnes Lucia Panda, Monique P. F. Rotty	The results of the analysis showed $p = 0.305$.	There was no significant relationship between HbA1c and CHD severity based on angiography.
2025	HbA1c Value and Severity of Coronary Heart Disease	Quantitative observational, cross-sectional, Spearman test	Aneka Pristi Ria Rimbayani, Noerma Shovie Rizqiea, Dewi Suryandari	$p = 0.415$ with a positive correlation of 0.108.	There was no significant relationship, but increasing HbA1c tended to increase the severity of CHD.
2025	The Relationship between HbA1c and Total Cholesterol Levels and the Severity of Coronary Heart Disease at Dr. Moewardi Regional Hospital	Observational, analytical, cross-sectional	Danang Kurniawan, Saelan, Rufaida Nur Fitriana	HbA1c is associated with CHD severity ($p = 0.000$; $r = 0.490$).	There is a significant relationship between HbA1c levels and CHD severity.
2025	Risk Factors for Diabetes and the Prevalence of Coronary Heart Disease at UKI Regional Hospital, 2021–2023	Retrospective, descriptive, analytical, cross-sectional	Desy Ria Simanjuntak, Reynard Alexander Nugroho	Diabetes patients have a 3.5 times greater risk of developing CHD.	DM is an important risk factor for CHD events.

2022	Treatment Adherence and Incidence of Coronary Heart Disease in Type 2 DM Patients	Retrospective cohort study	Baniu AS, Sauriasari R, Riyadina W	The non-adherent group had a 1.7 times greater risk of developing CHD than the adherent group, but this was not statistically significant (adjusted HR = 1.739; p = 0.564).	Non-adherence to medication in type 2 diabetes patients increases the risk of CHD.
2022	The Relationship Between HbA1c and Cardiovascular Events in Diabetic Patients with Coronary Angioplasty: A Cross-Sectional Study	Descriptive cross-sectional study	Seyed Mohammad Hassan Adel, Masoud Seyedian, Mehdi Nourizadeh	There was a significant association between HbA1c and the type of coronary angioplasty, hypertension, and heart block (p < 0.05).	HbA1c needs to be well controlled in diabetic patients undergoing coronary angioplasty.
2022	Correlation Between HbA1c and Triglyceride Level with Coronary Stenosis Degree in Type 2 DM with Coronary Heart Disease	Observational analytic cross-sectional study	Laily Adninta, Indranila Samsuria, Edward K. S. Limijadi	HbA1c correlated significantly with the degree of coronary stenosis (p < 0.001; r = 0.665).	Increased HbA1c and triglycerides are in line with increased degrees of coronary stenosis in type 2 DM patients with CHD.
2025	The Relationship between HbA1c Levels, Lipid Profiles, and T2DM Duration with Coronary Artery Disease Complexity in STEMI Patients with Type 2 Diabetes	Retrospective analytical observational cross-sectional study, chi-square test, logistic regression	Dwi Nurcahya Ananda Suwarya, Cyndiana Widia Dewi Sinardja, I Made Putra Swi Antara, Luh Oliva Saraswati Suastika	HbA1c $\geq 6.5\%$ was associated with LAD lesions (p = 0.031), but was not an independent predictor of MVD in multivariate analysis.	HbA1c is associated with the location of coronary lesions, but diabetes duration and LDL levels are more influential on the severity of CHD.
2023	HbA1c is a Predictive Factor of Severe Coronary	Retrospective cohort, logistic regression and	Xiaojuan Jiao, Qin Zhang, Ping Peng, Yunfeng Shen	HbA1c correlated with the severity of coronary stenosis (r =	HbA1c is an independent predictor of CHD severity and major

	Stenosis and Major Adverse Cardiovascular Events in Patients with Both Type 2 Diabetes and Coronary Heart Disease	Cox regression		0.207; $p = 0.001$), and follow-up HbA1c $\geq 8.6\%$ increased the risk of 3p-MACE (HR = 1.79; $p = 0.009$).	cardiovascular events in patients with type 2 diabetes.
2025	Association of Hemoglobin A1c Levels With All-Cause Mortality in Patients With Coronary Artery Disease	Longitudinal retrospective analysis, Cox regression and Kaplan-Meier analysis	Iryna Dykun, Natalie Kappo, Jürgen Kampf, Olga Babinets, R. Alexander Jánosi, Matthias Totzeck, Tienush Rassaf, Amir A. Mahabadi	Higher HbA1c levels were associated with increased mortality (HR = 1.16; $p < 0.001$) with a U-shaped relationship.	HbA1c is an independent predictor of mortality in patients with coronary artery disease; therefore, optimal HbA1c targets are necessary.
2024	The Relationship Between Repeated Measurements of HbA1c and Risk of Coronary Events Among the Common Haptoglobin Phenotype Groups: The Action for Health in Diabetes (Look AHEAD) Study	Prospective cohort, Cox regression analysis	A. S. Carew, R. A. Warren, M. P. Bancks, et al.	HbA1c $< 6.5\%$ reduced the risk of coronary events by 29% in the non-Hp2-2 group (aHR = 0.71; 95% CI 0.55–0.90), while HbA1c $\geq 8.0\%$ increased the risk of CAD in the Hp2-2 group with a history of CVD (aHR = 1.79).	Optimal HbA1c targets for CHD prevention vary based on haptoglobin phenotype and patient characteristics.
2022	Hyperglycemia Newly Detected by Glycated Hemoglobin Affects All-Cause Mortality in Coronary Artery Disease Patients: A Retrospective Cohort Study	Retrospective cohort, Cox proportional hazards regression	Wen Wei, Yan Liang, Dachuan Guo, et al.	Hyperglycemia based on HbA1c increases the risk of long-term mortality in patients with CAD (diabetes: aHR = 1.23; prediabetes: aHR = 1.17).	HbA1c is effective in detecting hyperglycemia in CHD patients and is associated with an increased risk of long-term mortality.
2023	The Association of Glycated Hemoglobin	Observational, multivariate logistic regression and	Yuanyuan Wei, Wenyan Li, Hui Luan, Gulinigaer Tuerhongjiang,	HbA1c is associated with the severity of coronary artery	HbA1c is associated with the presence and severity of

	A1c with Coronary Artery Disease, Myocardial Infarction, and Severity of Coronary Lesions	restricted cubic spline	Zuyi Yuan, Yue Wu	stenosis in patients without diabetes (OR = 1.306; p = 0.015). HbA1c <5.7% and >7.2% are associated with increased incidence of myocardial infarction.	CHD, with a U-shaped relationship to the incidence of myocardial infarction.
2026	HbA1c Levels Relate to the Severity of Atherosclerotic Lesions in Coronary Heart Disease Patients with Type 2 DM	Analytical observational, cross-sectional, Mann-Whitney test	Faridah Zulfa Rambe, Sheila Dhiene Putri	Uncontrolled HbA1c was associated with atherosclerotic lesion severity in CHD patients with T2DM (p = 0.027).	There is a significant association between HbA1c levels and the severity of atherosclerotic lesions in CHD patients with T2DM.
2024	Correlation between HbA1c Levels and Intrastent Restenosis Incidence in Patients with DM after Percutaneous Coronary Intervention	Analytical observational, retrospective cohort	Hayla Iqda Millisani, Indra Prasetya, Mohammad Saifur Rohman	HbA1c $\geq 6.5\%$ was associated with an increased incidence of in-stent restenosis in DM patients after PCI (p = 0.024).	There is a significant association between HbA1c levels and the incidence of in-stent restenosis in DM patients after PCI.
2023	HbA1c Control in Type 2 DM Patients with Coronary Artery Disease: A Retrospective Study in a Tertiary Hospital in South Africa	Retrospective observational, cross-sectional, multivariate logistic regression	Lona Mhlaba, Dineo Mpanya, Nqoba Tsabedze	Only 28.7% of T2DM patients with CHD achieved the HbA1c target of $\leq 7\%$; women were less likely to experience poor glycemic control (OR = 0.42; p = 0.038).	Most patients with T2DM and CHD do not achieve the recommended HbA1c target, necessitating more optimal glycemic control.
2024	Correlation of HbA1c, Triglyceride, HDL with the Degree of Stenosis in Coronary Heart Patients with Type 2 DM	Analytical observational, cross-sectional, Spearman test	Neydi F. Souisa, Budi Santosa, Edward Kurnia Setiawan Limijadi	There was no significant association between HbA1c and the degree of coronary stenosis (p = 0.685).	There was no significant association between HbA1c levels and the degree of coronary stenosis in patients with

					CHD and type 2 DM.
2025	Correlation between HbA1c Values and LDL Cholesterol Levels in Type 2 DM Patients at Waled Regional Hospital, Cirebon Regency	Analytical observational, cross-sectional, using secondary data with univariate and bivariate analysis	Fenni Nurian Ahyaeni, Muhammad Luthfi, Gara Samara Brajadenta, Isti Noviani, Irwan Meidi Loebis, Irene Max Emman	A significant association was found between HbA1c and LDL levels ($p = 0.000$). Elevated HbA1c is associated with elevated LDL levels, which is a major risk factor for CHD.	There is a positive correlation between HbA1c levels and LDL cholesterol levels in type 2 DM patients, so poor glycemic control has the potential to increase the risk of CHD through increased LDL.
2025	Cholesterol Low Density Lipoprotein: Biomarker Prediktor Risiko Aterosklerosis pada Penderita DM yang Dihubungkan dengan Profil HbA1c	Correlational research with a quantitative approach	Yaumil Fachni Tandjungbulu, Alfin Resya Virgiawan, Widarti, Rahman, Zulfian Armah, Cut Indriputri, Pradita Juliaris	There was a significant relationship between HbA1c and LDL levels ($p = 0.000$; $r = 1$), indicating a perfect positive correlation.	High HbA1c is associated with increased LDL levels, which accelerates atherosclerosis, thus increasing the risk of CHD in people with diabetes.
2025	The Relationship between HbA1c and Types of Cardiovascular Disease in Type 2 DM	Analytical observation with a cross-sectional approach	Clairine Elysia Pranowo, Santun Bhekti Rahimah, Ermina Widiyastuti	The analysis showed a significant relationship between HbA1c and cardiovascular disease in type 2 DM patients with a p-value of 0.001.	There is a significant association between HbA1c levels and cardiovascular disease events in patients with type 2 diabetes. Poor glycemic control increases the risk of CHD through atherosclerosis and myocardial damage.
2025	Association Between Glycated Hemoglobin and Severity of Coronary Artery Disease in Type 2 Diabetic Patients With	Cross-sectional analytic	Amna Rashid, Muhammad Salman Saeed, Mohamed Arshad Ghouse, et al.	HbA1c was positively associated with CAD severity ($r = 0.75$; $p = 0.002$) and was an independent predictor ($\beta = 3.11$; $p < 0.001$).	There is a significant association between high HbA1c levels and the severity of CHD in patients with type 2 diabetes.

	Myocardial Infarction				
2025	Association between HbA1c Levels with Severity of CAD and Short-Term Outcomes of STEMI in Nondiabetic Patients	Prospective cohort	Samad Ghaffari, Farhad Niafar, Ahmad Separham, et al.	HbA1c >5.8% was associated with more severe CAD (p = 0.001) and higher mortality and readmissions.	Higher HbA1c levels are associated with greater severity of CHD and poorer clinical outcomes.
2025	The Association Between HbA1c Levels and the Risk of Myocardial Infarction and Stroke in People with Type 2 Diabetes	Post hoc cohort	Irene Cristina Romera, Jennifer Redondo-Antón, Miriam Rubio-de Santos, et al.	HbA1c <6.5% decreased the risk of a first myocardial infarction (HR = 0.76).	Good HbA1c control is associated with a reduced risk of CHD in type 2 diabetes.
2025	Study of Coronary Artery Disease Severity with HbA1c in Patients with DM with SYNTAX Score II	Prospective observational	Keshavprakash Viruthagiri, Ashwin Srinivas B, Purnima R, et al.	Each 1% increase in HbA1c increased the risk of severe CAD (OR = 1.62; p = 0.014).	High HbA1c levels are significantly associated with the severity of CHD in diabetic patients.
2025	The Association of HbA1c with Severity of Coronary Artery Disease in Patients Presenting as Acute Coronary Syndrome	Retrospective observational	Ben Dali I, Ztati M, Ait Yahya A, et al.	HbA1c variability was associated with CAD severity in patients with ACS.	HbA1c is associated with the severity of CHD and can be a prognostic indicator.
2026	The Influence of HbA1c Levels on Clinical Outcomes in Diabetic Patients Following Percutaneous Coronary Intervention	Prospective observational	Gokila Shanmuganathan, D. Anandhi, Vijayakumar Subban, et al.	HbA1c >7% increased the incidence of MACCE up to 1 year (p = 0.001).	High HbA1c is associated with worse clinical outcomes in diabetic patients with CHD.
2024	Association Between	Retrospective cohort	Sonia Butalia, Luan Manh Chu,	HbA1c $\geq$ 6.0% increases the	Higher HbA1c levels are

	Hemoglobin A1c and Development of Cardiovascular Disease in Canadian Men and Women Without Diabetes at Baseline		Douglas C. Dover, et al.	risk of cardiovascular disease and hospitalization due to CVD.	associated with an increased risk of cardiovascular disease, including CHD.
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Analysis of the Role of HbA1c Levels in DM Patients with the Incidence of Coronary Heart Disease

HbA1c levels are the primary indicator for assessing long-term glycemic control in patients with diabetes mellitus (DM). HbA1c reflects the average blood glucose level over the past 2–3 months and is widely used as a measure of the success of diabetes therapy. Based on a synthesis of 29 analyzed literature, most studies indicate a relationship between elevated HbA1c levels and an increased incidence of coronary heart disease (CHD) in DM patients.

Research by Ratulangi and Sutanto (2024) showed that type 2 DM patients with high HbA1c levels had a greater risk of CHD than patients with good glycemic control (86.5% vs. 63.3%; $p=0.014$; $PRR=1.37$).²⁸ These results are supported by research by Simanjuntak and Nugroho (2025), which reported that DM patients had a 3.5-fold greater risk of CHD than individuals without diabetes.²⁹ Research by Carew et al. (2024) also showed that HbA1c levels $<6.5\%$ can reduce the risk of coronary events by 29%, while HbA1c $\geq 8.0\%$ increases the risk of coronary artery disease in certain groups.

Similar findings were reported by Wei et al. (2023), who showed that HbA1c levels were associated with the presence of coronary artery disease and myocardial infarction.³¹ A study by Pranowo et al. (2025) also found a significant association between HbA1c levels and cardiovascular disease events in patients with type 2 diabetes ($p=0.001$).³² Furthermore, Romera et al. (2025) reported that patients with HbA1c $<6.5\%$ had a lower risk of first myocardial infarction,³³ while Butalia et al. (2024) found that HbA1c $\geq 6.0\%$ increased the risk of cardiovascular disease and hospitalization for heart disease.

Overall, the results of this literature synthesis indicate that high HbA1c levels are associated with an increased incidence of coronary heart disease in patients with diabetes. Therefore, HbA1c can be used as an important biomarker in identifying the risk of coronary heart disease in the diabetic population.

4.2.2 The Effect of Glycemic Control (HbA1c) on the Risk of Coronary Heart Disease

Glycemic control, as assessed by HbA1c levels, influences the risk and severity of coronary heart disease. Several studies have shown that higher HbA1c levels increase the risk of coronary atherosclerosis and cardiovascular complications.

Research by Kurniawan et al. (2025) showed a significant association between HbA1c levels and coronary artery disease severity ($p=0.000$; $r=0.490$).³⁵ Similar results were reported by Adninta et al. (2022), who found a strong correlation between HbA1c and the degree of coronary stenosis ($p<0.001$; $r=0.665$).³⁶ Research by Jiao et al. (2023) showed that HbA1c correlated with the severity of coronary stenosis, and follow-up HbA1c levels $\geq 8.6\%$ increased the risk of major adverse cardiovascular events (3p-MACE) by 1.79 times.

Furthermore, research by Rashid et al. (2024) showed a strong positive correlation between HbA1c and coronary artery disease (CAD) severity ($r=0.75$; $p=0.002$),³⁸ while Viruthagiri et al. (2025) reported that every 1% increase in HbA1c increases the risk of severe CAD by

62.9%.³⁹ Research by Ben Dali et al. (2025) also showed that HbA1c variability is associated with the severity of coronary artery disease in patients with acute coronary syndrome.⁴⁰

Although some studies, such as those by Ardini and Halim (2023), Patiung et al. (2025), Rimbayani et al. (2025), and Souisa et al. (2024), did not find a statistically significant association, most studies show a trend that increased HbA1c is associated with an increased risk and severity of CAD. These differences in results are likely influenced by variations in sample characteristics, duration of diabetes, CAD assessment methods, and other risk factors such as hypertension, dyslipidemia, and obesity.^{41,42,43,44}

Therefore, poor glycemic control, as indicated by elevated HbA1c levels, contributes to the increased risk and severity of coronary heart disease in patients with diabetes.

The Role of HbA1c Level Control in Preventing Cardiovascular Complications in DM Patients

HbA1c level control is an important strategy in preventing cardiovascular complications in DM patients. Several studies have shown that good glycemic control can reduce the incidence of coronary heart disease, mortality, and major cardiovascular events.

Research by Dykun et al. (2025) also showed that elevated HbA1c levels were associated with increased mortality in patients with coronary artery disease (HR=1.16; $p<0.001$).⁴⁵ Furthermore, Wen Wei et al. (2022) reported that hyperglycemia, reflected by elevated HbA1c, increased the risk of long-term mortality in patients with diabetes and prediabetes.⁴⁶

Research by Ghaffari et al. (2025) showed that patients with HbA1c $>5.8\%$ had higher CAD severity and increased mortality and readmission rates.⁴⁷ Research by Shanmuganathan et al. (2026) also showed that HbA1c $>7\%$ increased the incidence of major adverse cardiovascular and cerebrovascular events (MACCE) up to one year after percutaneous coronary intervention (PCI).⁴⁸ Meanwhile, research by Millisani et al. (2024) showed that HbA1c $\geq 6.5\%$ was associated with an increased incidence of in-stent restenosis after PCI.⁴⁹

From the aspect of medication adherence, research by Baniu et al. (2022) showed that patients who were non-adherent to therapy had a greater risk of developing CAD than patients who were compliant.⁵⁰ Furthermore, research by Mhlaba et al. (2023) showed that only a small proportion of type 2 DM patients with coronary heart disease (CHD) successfully achieved the HbA1c target of $\leq 7\%$, leaving many patients at risk of recurrent cardiovascular complications.⁵¹

Pathophysiologically, high HbA1c levels reflect chronic hyperglycemia, which causes oxidative stress, inflammation, the formation of advanced glycation end products (AGEs), endothelial dysfunction, and accelerated atherosclerosis. Therefore, optimal control of HbA1c levels plays a crucial role in preventing cardiovascular complications and improving the prognosis of DM patients. Overall, the literature synthesis indicates that good HbA1c control is an important strategy in preventing cardiovascular complications in DM patients, and therefore, routine HbA1c monitoring should be an integral part of diabetes mellitus management (Zakir et al., 2023; Jyotsna et al., 2023; Klein & Buse, 2020).

A literature review of twenty-nine studies, including twenty-five, on the relationship between HbA1c levels and coronary heart disease (CHD) showed a trend supporting the hypothesis that poor glycemic control plays a role in increasing the risk and severity of coronary heart disease, although the strength of this association was not always consistent across studies (Chen et al., 2023).

Most studies using a cohort design with long-term observation periods tend to find a significant association between HbA1c and cardiovascular outcomes. Jiao et al.'s (2023) study showed that HbA1c is an independent predictor of coronary stenosis severity and major cardiovascular

events in patients with type 2 diabetes, consistent with the findings of Dykun et al. (2025), who reported HbA1c as an independent predictor of mortality in patients with coronary artery disease. This finding is reinforced by Wei et al.'s (2022) study, which showed a positive association between hyperglycemia, based on HbA1c, and an increased risk of long-term mortality. The consistency of findings across these cohort-based studies is likely due to the study design, which captures the cumulative effect of hyperglycemia exposure on the atherosclerotic process over time, in contrast to cross-sectional designs that only describe conditions at a single point in time.

Another interesting finding is the U-shaped relationship reported by Dykun et al. (2025) and Wei et al. (2023), where both HbA1c levels that are too low and too high are associated with an increased risk of cardiovascular events. This pattern is clinically important because it indicates that aggressive HbA1c reduction efforts without considering the risk of hypoglycemia can actually increase cardiovascular risk. Therefore, determining the optimal HbA1c target needs to be individualized, as emphasized by Carew et al. (2024), who showed that the ideal HbA1c target can vary depending on the patient's phenotypic characteristics and history of cardiovascular disease.

In addition to the direct relationship between HbA1c and CHD, several studies have also revealed possible indirect pathways underlying this relationship, one of which is through increased LDL cholesterol levels. Research by Ahyani et al. (2025) and Tandjungbulu et al. (2025) showed a strong positive correlation between HbA1c and LDL levels, which indicates that poor glycemic control can accelerate the atherosclerosis process through the mechanism of dyslipidemia, in addition to the direct effect of hyperglycemia on endothelial dysfunction and oxidative stress of coronary blood vessels.

Overall, despite variation in results between studies, the majority of findings tend to support an association between HbA1c levels and the risk, severity, and clinical outcomes of coronary heart disease, particularly in studies with cohort designs and larger sample sizes. The variation in results found in cross-sectional studies is more due to methodological limitations than to the absence of an underlying biological relationship. These findings provide clinical implications that monitoring and controlling HbA1c levels should be an integral part of the management of patients with diabetes mellitus to prevent or slow the progression of coronary heart disease, while still considering an individualized approach according to each patient's clinical characteristics.

Conclusion

HbA1c levels in DM patients play a role in the incidence of coronary heart disease. High HbA1c levels are an indicator of poor glycemic control and contribute to an increased risk of coronary heart disease through the mechanisms of chronic hyperglycemia, vascular endothelial damage, oxidative stress, and atherosclerosis. The level of glycemic control influences the risk and severity of coronary heart disease. The higher the HbA1c level, the greater the risk of coronary atherosclerosis, coronary artery stenosis, and major cardiovascular events. Optimal control of HbA1c levels through pharmacological therapy, medication adherence, regular check-ups, and healthy lifestyle changes can help reduce the risk of coronary heart disease and improve the quality of life of DM patients.

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