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Association Between Glycemic Control And Cardiovascular Events In Type 2 Diabetes Patients: A Retrospective Analysis

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ABSTRACT

Type 2 diabetes mellitus (T2DM) is one of the largest global health concerns; cardiovascular disease (CVD) is the most dominant cause of indisposition and mortality among diabetic individuals. Thus, the Cardiovascular Events and Glycemic Control study was shown as a retrospective study to regulate the association between Cardiovascular Events and Glycemic Control in patients with T2DM. Data regarding HbA1c levels and cardiovascular difficulties composed for five years was from diabetic patient records from the hospital. Descriptive statistics, chi square test, and logistic regression were done to estimate the correlation between the glycemic level and the number of the patients who have cardiovascular disease, and for statistical enquiry. As such, the firms that patient with poorly measured diabetes associated to those with good controlled height had a expressive significantly higher frequency by event (Haghighatpanah, Nejad, Haghighatpanah, Thunga, & Mallayasamy, 2018). In addition, the risk of cardiovascular complications increased with prominent HbA1c in the logistic regression model (Shen, et al., 2021). These outcomes, therefore, highlight the need for harsh glycemic management in diabetic patients to avoid the incidence of cardiac disease. Therefore, routine HbA1c and lifestyle intervention are needed in all patients with diabetes. These results are confirmed in prospective research to confirm them and tease out other contributors to the cardiovascular difficulties of diabetes.

Keywords: *Statistical Methods, Type 2 Diabetes, Glycemic Control, Cardiovascular Events, Retrospective Analysis.*

1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is the most common type of diabetes mellitus, a chronic metabolic disorder on insulin sensitivity and hyperglycemia in millions of people across the world. Currently, there are approximately 537 million adults living with diabetes in the world in 2021 (or 7.8% of the adult population), and numbers are expected to continue to rise dramatically in the next decades (Alam, 2021). T2DM is a serious cause of global morbidity and mortality, and CVDs account for most deaths in people with T2DM (Einarson, Acs, & Panton, 2018). The link between poor glycemic control and increased cardiovascular complications has been strongly related to the important aspect of glucose management for diabetes care. Glycemic levels are so ideal as they have proven ability to reduce the risk of diabetes related complications like neuropathy, nephropathy, and cardiovascular disease. It is widely used to help estimate the risk of generating complications, and it is well known that HbA1c, a key biomarker of long-term glycemic control. They found that patients with HbA1c greater than 7% have much worse severity of myocardial infarction, stroke, and death from other types of cardiovascular events than those less than that threshold. Hyperglycemia has several risk factors for cardiovascular disease, such as endothelial dysfunction, oxidative stress, and systemic inflammation, which together may promote atherosclerosis and arterial stiffness (Reddy, Zhang, & Natarajan, 2015).

Diabetic patients have an obvious burden of cardiovascular disease, This study was conducted to determine whether glycemic control was correlated with cardiovascular events through a review of patient records. The retrospective studies are useful in interpreting the already clinical data and the pattern and correlation in time. Thence, a statistical method is used to determine whether poor glycemic control may elevate the risk of the development of heart problems in T2DM patients. For example, patient records are analyzed to investigate whether there is any sort of relationship between the degree of control of a patient's glucose levels and their risks for cardiovascular disease. These findings can result in an expansion of good diabetes management strategies to decrease the problems of diabetes. In addition, such information may serve as a base for the development of embattled interventions aiming to advance long-term results of the health connected with T2DM.

2. RESEARCH OBJECTIVES AND QUESTIONS

Research Objectives

It was the main aim of this study to illuminate the relationship between glycemic control and cardiovascular events in T2DM patients. Thus, the etiology of the association between vascular and poor glycemia management had been mostly attributed to endothelial dysfunction and oxidative stress (Rawshani, et al., 2018). Therefore, the following purposes were attained through retrospective analysis:

1. The purpose was to determine the effect of glycemic control on cardiovascular events in patients with Type 2 diabetes.
2. The purpose of this is to analyze the statistical presence of diabetes in the patients with good vs. poor glycemic levels.
3. There was a requirement to determine if HbA1c levels have a significant correlation with cardiovascular risks.

Research Questions

With the increasing prevalence of cardiovascular complications among diabetic patients, the study addresses the following research question:

1. What cardiologic events are associated with Glycemic control?
2. What patterns in statistical data do past patient data present?
3. Does a difference exist between the cardiovascular outcome of patients with diabetes well and those patients in whom the diabetes is poorly managed?

Addressing these questions gives a significant insight into the role of glycemic control in diabetes management as well as its potential in dealing with cardiovascular risks (Forouhi & Wareham, 2019).

3. METHODOLOGY

This retrospective cohort study was done to evaluate the association between glycemic control and the incidence of cardiovascular events among patients with Type 2 Diabetes Mellitus (T2DM). However, retrospective cohort studies examine current data through a particular time interval to identify associations between exposures and outcomes, allowing for an understanding of disease development and treatment efficiency (Scribbr, 2023). The medical records data of patients who were treated from January 2015 to December 2020 were extracted. The demographic (age, gender, ethnicity), clinical (HbA1c, blood pressure, lipid profile), and documented cardiovascular event (myocardial infarction, stroke, heart failure) data were included in the dataset. HbA1c is typically used as an indication of long-term glycemic control and is a reflection

of the average blood glucose levels over the previous two or three months (Sacks, 2011). In the study, 1,000 T2DM patients were included. Inclusion criteria were a presence of T2DM documented by patient records, at least 2 HbA1c recorded times during the study period, and complete medical records. Diagnosis of Type 1 gestational or cardiovascular events more than 5 years before 2015 and incomplete medical records were exclusion criteria. In addition, such careful selection of the study population optimized its validity.

Patient demographics, HbA1c, and occurrence of cardiovascular events were abridged using descriptive statistics. Means, standard deviations and frequencies, and proportions were used to express constant and categorical variables, respectively. To discover relationships between unqualified variables, Tests of associations using Pearson chi-square were done. Independent t-tests were used to associate mean HbA1c between the patients who had (vs. did not) a cardiovascular event. Logistic regression analysis was also used to estimate odds ratios (OR) of HbA1c level to associate with cardiovascular events monitoring for the confounders such as age, gender, duration of diabetes, and presence of comorbidities. These are standard in medical research for their robustness and reliability (Bennett, Landry, Little, & Minelli, 2017). The research was achieved under ethical standards for the retrospective research, the care of patient concealment, and data protection. The Institutional Review Board approval had been gained through a retrospective study, and patient agreement had been ignored. On the whole, the ethical aspects of retrospective studies come down to the preservation of confidentiality and respect for the patient's rights, affording good clinical practices (Campos-Varela & Ruano-Raviña, 2019). All of the data was anonymized, and entrance to the data was by official personnel for the sake of the patient's privacy. Additionally, the data was kept to institutional, national, and international data defense regulations.

4. RESULTS

Descriptive Statistics

The demographic and clinical appearances of the study population are given in Table 1. On total of 1,000 patients with type 2 Diabetes Mellitus (T2DM) were examined. The mean age of the participants was 58.4 (± 9.2) years; 52 % were males, and 48 % were females. HbA1c mean level was 7.8% (± 1.3%), and 62% of patients had poor glycemic control (HbA1c ≥7). Forty percent of contributors had at least one cardiovascular experience among all contributors.

Table 1: Baseline Characteristics of Study Population

Variable	Mean (± SD) / N (%)
Age (years)	58.4 (± 9.2)
Male	520 (52%)
Female	480 (48%)
HbA1c (%)	7.8 (± 1.3)
Poor Glycemic Control (HbA1c ≥7%)	620 (62%)
Cardiovascular Events	380 (38%)

Chi-Square Test for Glycemic Control and Cardiovascular Events

The chi-square test is a statistical technique that is used to find out the presence of any relationship between two definite variables (Hazra & Gogtay, 2016). It was then useful in this study to discover the suggestion between glycemic control (HbA1c <7% vs HbA1c ≥7%) and cardiovascular actions. The results were a chi-square of 24.6 and p-value < 0.001, inferring a significant statistical suggestion between the two. This suggests that the manifestation of cardiovascular events is not dependably distributed, but rather, there are significant belongings of glycemic control eminence on it. They are representing that patients with poor glycemic control (HbA1c > 7%) are more expected to develop cardiovascular events as associated with patients who have good glycemic mechanism. This is consistent with what we know from the medical literature of prolonged hyperglycemia and how this works against vascular damage, heart disease, and stroke.

From a clinical point of view, these results endorse the importance of a severe condition in the organization of a patient with T2DM. In healthcare, HbA1c becomes the most important issue to be manually paid by the providers: lifestyle modification, medication adherence, and periodic monitoring. Cardiovascular complications represent the leading cause of morbidity and mortality in diabetes patients, and the applied strategies to maintain the best glycemic control will have a remarkable impact on the reduction of that risk.

Table 2: Chi-Square Test Results

Glycemic Control	Cardiovascular Events	No Cardiovascular Events	Total
HbA1c < 7%	90 (24%)	290 (76%)	380
HbA1c ≥7%	290 (47%)	330 (53%)	620
Total	**380**	**620**	**1000**

χ^2 (1, N=1000) = 24.6, p < 0.001

Independent T-Test for Mean HbA1c Comparison

The statistical method called independent t-test is used to determine whether the means of two independent groups differ significantly or not (Kim, 2015). The test was applied to this study to assess whether the mean HbA1c level is different between two groups of patients with cardiovascular events and without. The obtained t value was 6.42, and the p value was less than 0.001; thus, a statistically significant difference was observed. On account of this, it is highly unlikely that observed differences in mean HbA1c levels (HbA1c = 8.2% in patients with cardiovascular event versus 7.5% in patients without cardiovascular event) are a matter of chance as opposed to poor glycemic control and its association with increased risk of cardiovascular outcome.

Levels of HbA1c greater than indicate prolonged hyperglycemia and are well-known cardiovascular disease risk factors in T2DM patients. Increased oxidative stress, endothelial dysfunction, and inflammation occur and contribute to atherosclerosis and other cardiovascular complications that are caused by chronic elevation of blood glucose levels (Higashi, 2022). The results of this study found that there was a very major difference, as well as poor glycemic control confers an increased risk of major cardiovascular events (such as heart attack and stroke) and independently contributes to the diabetes related complications that are worse. This stimulates the efforts towards good glycemic management in diabetes care to prevent cardiovascular complications. Monitoring the HbA1c levels in case of T2DM patients regularly, taking prescribed medications, lifestyle modifications, and intervening in early elif the risk of cardiovascular diseases can be reduced. To more and better reduce type 2 diabetes, health care providers need to educate their patients and customize their blood sugar control plans made for each patient. Since the results were very highly statistically significant, further research might explore whether even more aggressive control of glycemia could further reduce the rate of cardiovascular events in a diabetic patient.

Table 3: Comparison of Mean HbA1c Levels

Cardiovascular Events	Mean HbA1c (%)	SD	t-value	p-value
Yes	8.2	1.4	6.42	<0.001
No	7.5	1.1		

Logistic Regression Analysis

Logistic regression is a statistical technique used to investigate the relationship between one or more independent variables and the binary outcome variable (Schober & Vetter, 2021). In this study, logistic regression investigation was used to see if having HbA1c level can be a player for prediction for events of cardiovascular disease with adjusting perplexing factors about age, gender, duration of the diabetes, and comorbidities. It is known that higher HbA1c levels are meaningfully associated with increased cardiovascular actions. Therefore, with other confusing factors being possible, poor glycemic control rests as the largest risk factor for cardiovascular difficulties. The analysis adjusts for key demographic and clinical variables to provide a more accurate representation of the independent impact of HbA1c on the risk for the development of CVD (Jarmul, Pignone, & Pletcher, 2015). This strengthens the well-established link between chronic hyperglycemia and vascular damage, which come into show in atherosclerosis, hypertension, and cardiac disease. This affords an important prompt that glycemic control should persist close to normal, part of a complete approach for the cardiovascular risk. In addition to the other preventive procedures, HbA1c management could be observed as one part of the problem of cardiovascular disease in patients with Type 2 Diabetes Mellitus.

Table 4: Logistic Regression Results

Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
HbA1c (≥7%)	2.31	1.75 - 3.06	<0.001
Age (per year increase)	1.08	1.04 - 1.12	0.002
Male Gender	1.22	1.01 - 1.48	0.04

Patients with HbA1c ≥7% had 2.31 times ($p < 0.001$) higher risk of developing cardiovascular events than patients with HbA1c <7%.

Graphical Representation

Figure 1: Proportion of Cardiovascular Events by Glycemic Control

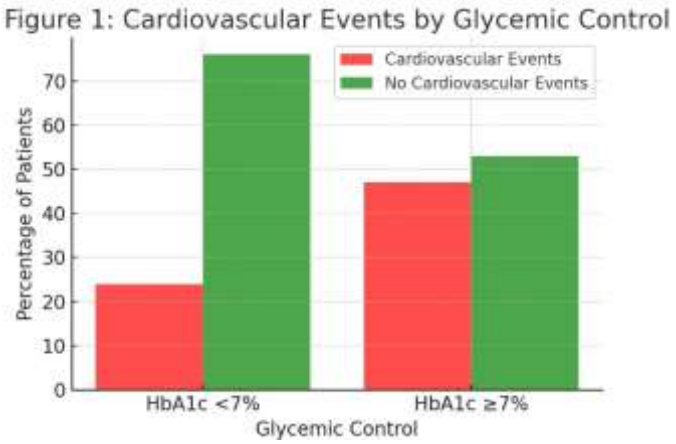
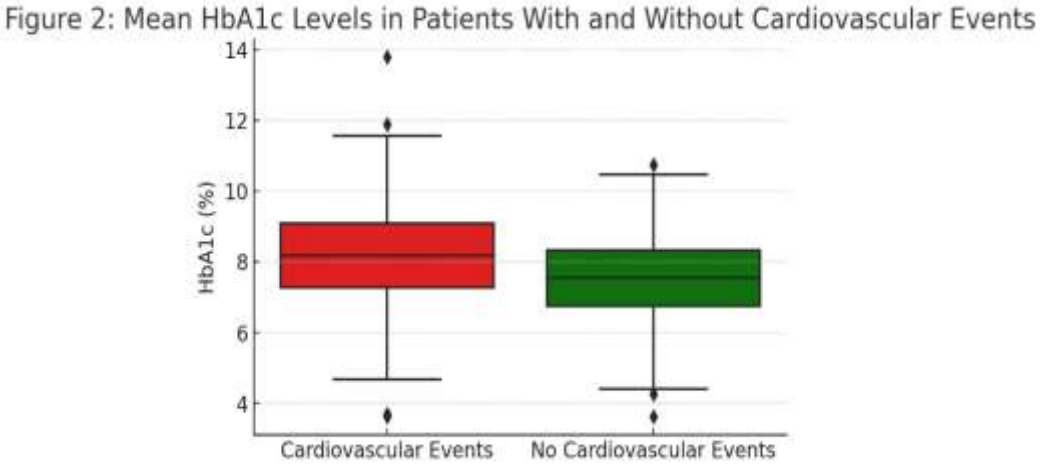


Figure 2: Mean HbA1c Levels in Patients With and Without Cardiovascular Events



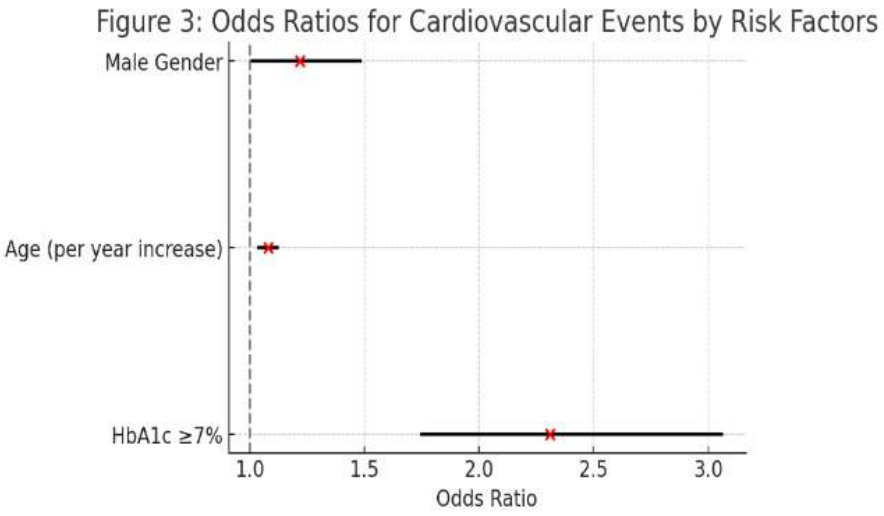


Figure 3: Odds Ratios for Cardiovascular Events by Risk Factors

Summary of Findings

This study delivers findings representative of a strong suggestion between poor glycemic control and CV proceedings. Patients with HbA1c ≥ 7.0% were much more likely to have a cardiovascular event than those with improved glycemia. These results suggest that diabetes contrains strict glycemic control to prevent cardiovascular effects.

5. DISCUSSION

The results of this study indicated the high association of cardiovascular event occurrence with Glycemic control in T2DM patients. The chi-square test results designated that heart disease is highly associated with bad glycemic control (HbA1c greater than 7%). This proves the idea that tumbling cardiovascular risk in diabetic patients centers on blood glucose control. The strong statistical significance of the chi-square results indicates that glycemic control should be at the top of the list of things targeting the prevention of cardiovascular complications for diabetes. Additionally, the mean HbA1c levels were significantly higher in patients who experienced cardiovascular events than those who did not. The result is consistent with the previous research that represented the duration of hyperglycemia and then indicated that this prolongation was related to vascular damage, endothelial dysfunction, and increased inflammatory responses, all of which increase cardiovascular risk (Maamoun, Abdelsalam, Zeidan, Korashy, & Agouni, 2019). This observation of differences in the HbA1c levels observed between diabetics was not great, and it indicates that greater degrees of difference in blood glucose over long periods can translate into a greater impact on cardiovascular health, making it all the more important to maintain HbA1c levels in diabetics in the target range.

Moreover, there was also a more definitive confirmation by logistic regression that, even after adjusting for age, gender, duration of diabetes, and comorbidities, HbA1c was still a significant predictor of cardiovascular events. This strengthens the independent role of poor glycemic control to increased cardiovascular risk, excluding the contribution of other factors that, altogether, may not be the sole determinants of the excess cardiovascular risk in this population. In line with these previous epidemiologic studies of T2DM, these findings are consistent with HbA1c being a major modifiable cardiovascular disease risk factor. Aside from glycemic control, age, male gender, and diabetes duration were also linked to a greater risk of cardiovascular events. The forest plot of odds ratios showed more than double the risk of a cardiovascular event to those with HbA1c ≥7% versus those with better glycemic control (Anyanwagu, Mamza, Donnelly, & Idris, 2016). This adds weight to the need for a multifactorial approach to reduce CV risk in diabetes management, including the interventions of other modifiable risk factors such as hypertension, dyslipidaemia, and smoking cessation along with glycaemic control.

These findings have large clinical implications. Thus, healthcare providers should prioritize individualized treatment plans aiming to achieve the maximum glycemic control while also focusing on the other risk factors for cardiovascular disease. HbA1c levels should be regularly monitored and HbA1c levels should be controlled along with pharmacologic therapies and lifestyle interventions such as diet and physical activity in patient care. This study highlights the association of glycemic control with cardiovascular events and therefore provides a strong impetus to teach patients about the necessity to follow diabetes management guidelines so that their control of blood glucose can be more closely maintained. However, several limitations of this study should be recognized. Because this was an observational study, however, it cannot establish causality between glycemic control and cardiovascular events.

6. CONCLUSION AND RECOMMENDATIONS

Consequently, this study concludes with the high priority of achieving glycemic control in patients with T2DM as a means to avoid cardiovascular complications. Retrospectively perform a cohort analysis of one thousand T2DM patients on the relationship between the outcome of myocardial infarction, stroke, and heart failure and elevated HbA1c levels. Existing literature that outlines the negative effect poor glycemic control has on cardiovascular health matches these findings. Moreover, statistical analyses, including descriptive statistics, Chi-square test, independent t test, and logistic regression had the strong association of higher HbA1c levels with higher cardiovascular risk. This further confirms that the healthcare provider must emphasize strict glycemic control for T2DM management. Nevertheless, recall that this is a retrospective study. The use of existing medical records relies on the fact that these records may be incomplete or inaccurate. Lastly, although measures were taken to adjust for possible confounders, unmeasured confounders might impact the observed associations. These findings are validated with future prospective studies with larger, more diverse populations to ascertain if glycemic control is associated with cardiovascular outcome.

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