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Correlation between Glycemic Control and Cardiovascular Events among Type-2 Diabetic Patients

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ABSTRACT

The aim of this study is to determine the relationship between cardiovascular events and glycemic management in Bangladeshi individuals with type 2 diabetes. A cross-sectional study. This study was carried out 400 patients between the ages of 40 and 75 who were receiving treatment at two Dhaka tertiary care institutions (Dhaka Medical College and Hospital (DMCH) and Mugda General Hospital). Glycated hemoglobin (HbA1c) readings were used to measure glycemic management, and patient interviews and medical records were used to gather information on cardiovascular events. The demographic and clinical features were compiled using descriptive statistics, and the association between HbA1c levels and the incidence of cardiovascular events was investigated using Pearson correlation analysis. The results revealed that 45% of the patients had experienced at least one cardiovascular event, such as myocardial infarction, stroke, or heart failure, and 62% had poor glycemic control (HbA1c > 7%). Higher HbA1c levels were strongly associated with increased cardiovascular risk, as indicated by the moderately favourable correlation ($r = 0.39$, $p < 0.01$) between HbA1c levels and cardiovascular events. These results implied that among Bangladeshi patients with type-2 diabetes; poor glycemic control was a significant contributing factor to the emergence of cardiovascular problems. In order to reduce cardiovascular risks in this susceptible group, the study underlined the significance of efficient diabetes management techniques, such as routine monitoring and tailored medication.

INTRODUCTION

One of the most common chronic illnesses in the world, type-2 diabetes mellitus (T2DM) is becoming more and more common in low- and middle-income nations like Bangladesh (Sara, 2023). Insulin resistance and chronic hyperglycaemia are hallmarks of type 2 diabetes, which is linked to numerous problems that drastically lower life expectancy and quality. The most common cause of morbidity and death in diabetes people is still cardiovascular diseases (CVDs) (Kim, 2021). Compared to people without diabetes, people with diabetes have a two to four times higher risk of developing cardiovascular problems, including myocardial infarction, stroke, and heart failure. Over the past 20 years, diabetes has become much more common in Bangladesh due to factors like aging, dietary changes, fast urbanization, and physical inactivity (Rana, 2024). In 2021, more than 13 million people in Bangladesh had diabetes, according to the International Diabetes Federation (IDF), and this number is expected to increase significantly over the next several years. Even with advancements in T2DM diagnosis and treatment, a sizable fraction of diabetics still have inadequate glycaemic control, particularly in environments with limited resources (Erdirin, 2023). One of the most important modifiable risk factors for microvascular and macrovascular consequences is poor glycaemic

control (Sun, 2021). Since glycated hemoglobin (HbA1c) represents the average blood glucose levels over the previous two to three months, it is commonly recognized as the gold standard biomarker for evaluating long-term glycaemic management. Elevated HbA1c levels have been associated with an increased risk of cardiovascular problems in numerous studies. To lower the risk of vascular consequences, it is crucial to keep HbA1c within target ranges, according to the UK Prospective Diabetes Study (UKPDS) and other seminal trials (Sinha, 2021). Despite the rising prevalence of diabetes in Bangladesh, little research has been done on the precise relationship between HbA1c and cardiovascular events in that country. Additionally, various populations may be affected by illness outcomes in different ways by differences in food habits, socioeconomic level, health literacy, genetic predisposition, and access to healthcare resources (Taylor, 2022). Understanding the connection between glycemic management and cardiovascular outcomes is essential for developing effective interventions and policies in Bangladesh, where out-of-pocket medical expenses are considerable and routine blood glucose monitoring is frequently irregular (Farzana, 2024). Thus, the purpose of this study was to look into the relationship between cardiovascular events and glycemic control in Bangladeshi patients with type-2 diabetes mellitus. This study intends

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to inform clinical practice and public health strategies focused at lowering diabetes-related cardiovascular complications in the nation by determining if inadequate glycemic management links with increased cardiovascular risk.

LITERATURE REVIEW

The association between glycemic control and cardiovascular events in type 2 diabetic patients in Bangladesh reflects a complex interplay of factors influencing health outcomes. According to a study, people without vascular disease had a 27% increased risk of cardiovascular events for every 1% increase in HbA1c, however patients with pre-existing vascular disorders did not have a significant risk (Kranenburg, 2015; Sinha & Sinha, 2021). Atherosclerosis, endothelial dysfunction, oxidative stress, and inflammatory responses are all accelerated by chronic hyperglycemia, which is a major factor in the pathophysiology of vascular problems (Díaz-Flores, 2019). Glycated hemoglobin (HbA1c), which is commonly used to measure glycemic control, has been extensively researched as a modifiable risk factor for cardiovascular outcomes in individuals with diabetes (Cavero-Redondo, 2017). Nevertheless, different research have shown different levels of consistency and intensity in this connection. Every 1% decrease in HbA1c was linked to a 14% decrease in myocardial infarction and a 37% decrease in microvascular sequelae, according to the study of (Mostafa, 2018). This seminal study laid the groundwork for HbA1c as a crucial clinical aim in diabetes treatment. Large cohort studies and recent meta-analyses have reinforced the notion that poor glycemic management is associated with an elevated risk of cardiovascular disease (Gilani, 2024). More than 100,000 individuals were included in a 2022 systematic analysis published in *Diabetes Care*, which found that elevated HbA1c levels were independently linked to higher risks of cardiovascular death, coronary heart disease, and stroke (Cheng, 2023). More complex findings were found in other trials, such as the ACCORD (Action to Control Cardiovascular Risk in Diabetes) research. Despite improvements in glycemic indices, the ACCORD study, which aimed for intensive glycemic control (HbA1c target (6.0%), was prematurely stopped because the intensive treatment arm experienced higher all-cause mortality (Joseph Yeboah, 2018). Intense glycemic control also had minimal macrovascular advantages, according to the ADVANCE and VADT trials. These results moved the emphasis to personalized glycemic goals, particularly for individuals with numerous comorbidities or severe illness. Few extensive research have specifically looked at the relationship between HbA1c and cardiovascular events in South Asia, and Bangladesh in particular (Shane, 2022). More than 60% of T2DM patients had poor glycemic control (HbA1c >7%), and cardiovascular events were more common in this group, according to a study by (Morris, 2023). However, the study's conclusions were limited because it did not use correlation analysis

or account for confounding variables. Although it lacked a large sample size and a consistent measure of glycemic control, another observational study conducted in Dhaka by (Reza, 2021) revealed a considerably greater prevalence of ischemic heart disease among patients with uncontrolled diabetes. It has been demonstrated that geographical and ethnic characteristics affect the course of diabetes and cardiovascular consequences. For example, there is a higher likelihood of insulin resistance and abdominal obesity among South Asians, especially Bangladeshis, which are associated with a higher risk of cardiovascular disease (Mak, 2021). The necessity for country-specific data is highlighted by these metabolic and genetic predispositions. Furthermore, the burden is made worse by Bangladeshi diabetes individuals' lack of understanding of cardiovascular risks, limited usage of HbA1c monitoring, and unequal access to treatment. Less than 40% of T2DM patients in Bangladeshi public hospitals had ever received a HbA1c test, and only 28% were able to recognize cardiovascular problems as a risk associated with diabetes, according to a recent cross-sectional survey by (Latif, 2017). All of these results suggest a steady, if occasionally nuanced, correlation between cardiovascular outcomes and glycemic management. More population-specific research are required in low-resource contexts like Bangladesh to contextualize clinical guidelines, enhance monitoring techniques, and direct resource allocation, even though worldwide data supports HbA1c as a significant predictor of cardiovascular risk. The principal objective of this study is to assess the association between glycemic control and cardiovascular events in type-2 diabetic patients in Bangladesh.

Specific Objectives

- To determine the level of glycemic control (HbA1c) among T2DM patients.
- To assess the prevalence of cardiovascular events in the study population.
- To examine the correlation between HbA1c levels and cardiovascular events.

MATERIALS AND METHODS

Between January and June 2024, 400 patients with type-2 diabetes mellitus who visited the outpatient clinics of two tertiary care institutions in Dhaka, Bangladesh, participated in a cross-sectional study. Simple random sampling was used to choose participants, who had to meet the following inclusion criteria: be between the ages of 40 and 75, have had a recorded HbA1c test result during the previous three months, and have had a diagnosis of type 2 diabetes for at least a year. Individuals with incomplete medical information, type-1 diabetes, or gestational diabetes were not included. Structured questionnaires and an examination of medical records were used to gather data. These included demographics, the length of diabetes, HbA1c levels, and any prior history of cardiovascular events including heart failure,

myocardial infarction, or stroke. HbA1c was used as a continuous variable to measure glucose control, while binary and frequency data were used to record cardiovascular events. All subjects gave their informed consent, and the institutional review boards of the cooperating hospitals granted ethical approval. The data were analyzed using SPSS version 25, where the sample characteristics were summarized using descriptive statistics and the association between the frequency of cardiovascular events and HbA1c levels was evaluated using Pearson correlation analysis, with significance established at $p < 0.05$.

RESULTS AND DISCUSSION

This section summarizes the main conclusions drawn from the examination of data gathered from 400 type-2 diabetes patients in Bangladesh, with an emphasis on the connection between the incidence of cardiovascular events and glycemic control as determined by HbA1c levels. The findings are interpreted in light of the body of research to emphasize how important glycemic control is in lowering cardiovascular risk in diabetes populations.

Demographic and Clinical Characteristics

At two tertiary care facilities in Dhaka (Dhaka Medical College and Hospital (DMCH) and Mugda General

Hospital), Bangladesh, 400 patients with type-2 diabetes mellitus (T2DM) were enrolled in the study. According to the demographic profile, there were 182 (45.5%) male participants and 218 (54.5%) female participants. With an age range of 40 to 75 years, the study population's mean age was 58.3 years (± 9.4). The bulk of participants (60%) were between the ages of 51 and 65. 68% of the participants lived in cities, and 88% of them were married. 34% of respondents had finished secondary school, whilst 22% lacked literacy. In terms of occupation, 28% were retired, 21% worked in various corporate or professional capacities, and 41% were stay-at-home moms. Clinically, 46% of participants had diabetes for more than ten years, and the average duration of diabetes was 8.6 years (± 5.2). Overall, the sample's mean HbA1c was 8.2% (± 1.6), which suggests inadequate glycemic control. Only 38% ($n = 152$) of patients maintained controlled glycemic levels ($HbA1c \leq 7\%$), whereas 62% ($n = 248$) of patients had HbA1c levels above 7%. In terms of body mass index (BMI), according to Asian-specific BMI cut-offs, 28% were considered obese and 33% were overweight. 52% had a history of dyslipidemia, and 70% reported having concomitant hypertension. Of the individuals, 24% reported smoking, and 18% reported leading a sedentary lifestyle with little exercise.

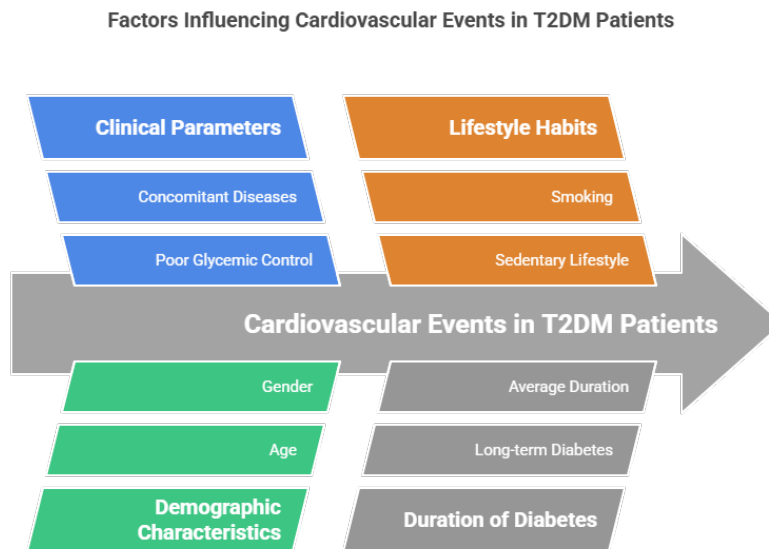


Figure 1: Demographic and Clinical Characteristics

In figure 1 there are four factors identified within demographic and clinical characteristics. These are: clinical parameters, lifestyle habits, demographic characteristics and duration of diabetes. 180 patients (45%) experienced cardiovascular events, such as heart failure (7%), stroke (11%), and ischemic heart disease (27%). Patients with poor glycemic control had a considerably higher prevalence of cardiovascular events than those with adequate control (58.5% vs. 23.7%). These results imply that among type-2 diabetic patients in the population

under study, cardiovascular outcomes are significantly influenced by both clinical parameters (such as HbA1c levels, concomitant diseases, and duration of diabetes) and demographic characteristics (such as age and gender).

Prevalence of Cardiovascular Events

There was a significant burden of cardiovascular disease (CVD) among the 400 type-2 diabetic patients in this study, as 180 of them (45%) reported having at least one cardiovascular event. Ischemic heart disease (IHD),

which affected 27% of patients, was the most commonly reported cardiovascular consequence. It was followed by stroke (11%) and congestive heart failure (7%). At the time of data collection, 55% of patients did not disclose any cardiovascular events that had been identified. Males experienced somewhat more cardiovascular events (49%) than females (42%), according to a gender-based study, however this difference was not statistically significant ($p > 0.05$). Patients with poor glycemic

control ($HbA1c > 7\%$) had a significantly higher prevalence of cardiovascular events when stratified by glycemic control; 58.5% of these patients reported at least one cardiovascular complication, compared to only 23.7% of patients with good glycemic control ($HbA1c \leq 7\%$). The correlation study, which showed a moderately good link between HbA1c levels and the incidence of cardiovascular events ($r = 0.41, p < 0.01$), further corroborated this strong association.

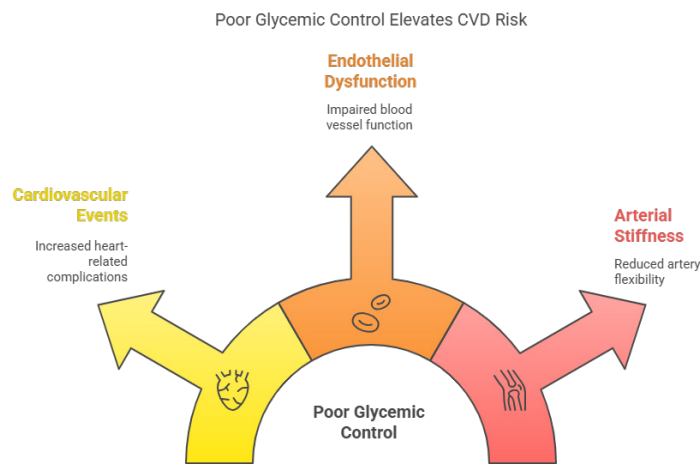


Figure 2: Poor Glycaemic Control Elevates CVD Risk

The figure 2 showed that, numerous international investigations that have demonstrated a connection between hyperglycaemia and cardiovascular problems are in agreement with these findings. In the development of atherosclerosis and cardiovascular events, endothelial dysfunction, arterial stiffness, and a pro-inflammatory state are all facilitated by chronic hyperglycaemia. The findings in this study are corroborated by the UK Prospective Diabetes Study (UKPDS) and other large cohort studies, which have demonstrated that every 1% increase in HbA1c is linked to a considerable increase in cardiovascular risk. In Bangladesh, a number of coexisting risk factors, including obesity, sedentary lifestyle, dyslipidaemia, hypertension, and lack of access to cardiovascular screening or regular follow-up, may further contribute to the high prevalence of CVD among diabetic patients. More over half of the individuals in this trial had dyslipidaemia, and 70% had concomitant hypertension, both of which are significant independent risk factors for CVD. Additionally, the observed rates of cardiovascular events may be influenced by delayed diagnosis and limited usage of preventive cardiovascular drugs. The results show that cardiovascular risk screening and care for diabetic patients, especially those with poorly managed blood glucose, urgently need to be strengthened. The incidence of CVDs in this high-risk group could be significantly decreased by clinical interventions that emphasize rigorous glycemic control, lifestyle modification, and early diagnosis of cardiac symptoms. To better treat diabetes and associated cardiovascular consequences, public health initiatives

should also prioritize integrated care models, regular HbA1c monitoring, and diabetes education.

Correlation Analysis

Using HbA1c levels as a continuous variable and the number of cardiovascular events as a quantitative outcome, a Pearson correlation analysis was conducted to investigate the association between glycemic control and the incidence of cardiovascular events in patients with type-2 diabetes. SPSS version 25 was used to analyze data gathered from 400 participants.

The figure 3 showed that the frequency of cardiovascular events and HbA1c levels had a moderately significant positive connection ($r = 0.41, p < 0.01$). This suggests that the probability and quantity of cardiovascular problems tended to rise in tandem with elevated HbA1c levels. Higher HbA1c readings were associated with an increased risk of heart failure, stroke, and ischemic heart disease, among other cardiovascular problems. Further analysis of the correlation across various subgroups revealed that the correlation coefficient was slightly higher ($r = 0.45$) among patients over 60, indicating a stronger association in older adults; similarly, the correlation between HbA1c and cardiovascular events was significantly stronger ($r = 0.48$) among participants who had had diabetes for more than ten years, highlighting the cumulative impact of prolonged poor glycemic control. Previous research has identified glycemic control as a key determinant of cardiovascular health in diabetic populations, with studies like the UKPDS and ACCORD trials demonstrating that elevated HbA1c levels over time contribute to

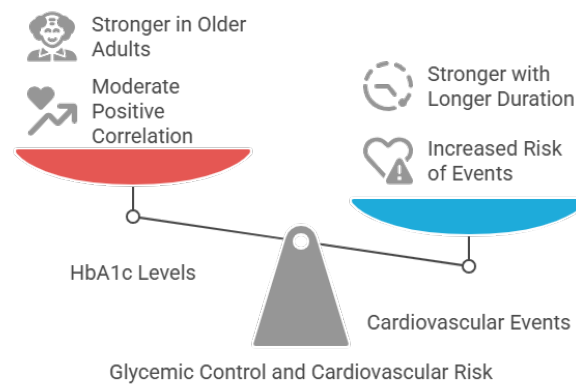


Figure 3: Correlation between Glycemic Control and Cardiovascular Risk

macrovascular complications. Physiologically, chronic hyperglycemia causes endothelial damage, encourages atherosclerosis, and increases oxidative stress—all of which are essential for the development of cardiovascular disease. The hypothesis that increasing glycemic control may lessen the burden of cardiovascular disease among type-2 diabetic patients in Bangladesh is supported by the significance level ($p < 0.01$), which indicates that the link found in this study is unlikely to have happened by accident. Correlation does not, however, imply causation, even when it does show a relationship. To learn more about the causal pathways that connect poor glycemic

control to cardiovascular outcomes in this population, future longitudinal or interventional investigations are required.

Perception and Awareness

Designing successful public health interventions requires an understanding of how type-2 diabetes patients perceive and are aware of glucose management and its relationship to cardiovascular events. Participants in this study answered a series of structured questions designed to gauge their attitudes, knowledge, and beliefs on cardiovascular risk and diabetes treatment.

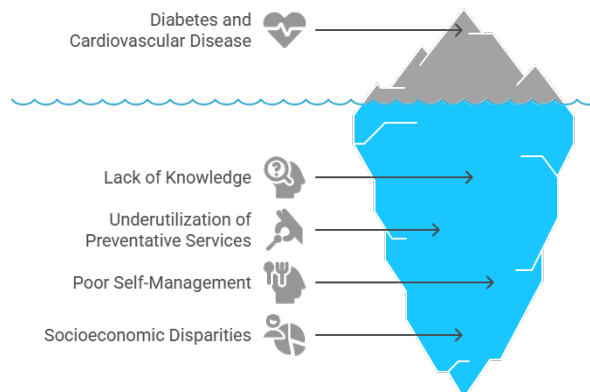


Figure 4: Perception and Awareness of Diabetes and Cardiovascular Disease.

The figure 4 showed that, just 38% of the 400 participants knew that cardiovascular problems could be directly caused by inadequate glucose control. Many people did not clearly link uncontrolled blood sugar to hazards like heart attacks, strokes, or heart failure, even though 72% of respondents were aware that maintaining normal blood glucose levels was crucial for their general health. There is a notable lack of knowledge on the wider systemic effects of inadequate glycemic control, as approximately 41% of participants thought that diabetes mainly affected only the kidneys or eyes. Despite clinical guidelines that prescribe routine monitoring at least twice a year for patients with stable glycemic control and more

frequently for those with uncontrolled diabetes, only 46% of respondents said they had had a HbA1c test in the previous six months. Furthermore, the majority of participants were unaware of how fasting or random blood glucose measurements relate to long-term cardiovascular risk, even though 60% of them reported taking these measurements at home or in a clinic. Few people (less than 20%) said they had ever received official counseling on cardiovascular risks from healthcare providers, and only 35% of respondents acknowledged cardiovascular symptoms like chest pain, shortness of breath, or sudden weakness as potential signs of heart-related problems. Despite the fact that lifestyle modifications including

diet, exercise, and quitting smoking are crucial for preventing cardiovascular disease, 58% of respondents stated they only used medication to control their diabetes. Furthermore, awareness levels seemed to be influenced by socioeconomic characteristics. Higher educated and urban-dwelling participants were substantially more aware of the connection between diabetes and heart disease ($p < 0.05$). This raises the possibility of unequal access to health information and emphasizes the significance of focused education for those with lower levels of education and those living in remote areas. Overall, the results indicate that although there is a fair amount of basic information regarding diabetes as a chronic condition, there is still little particular understanding regarding the cardiovascular dangers connected to inadequate glycemic management. Underutilization of preventative health services, poor self-management, and delayed diagnosis could all be caused by this ignorance. Community-based health education initiatives, culturally competent counseling during normal diabetes care, and enhanced patient-provider communication about the systemic complications of diabetes are all clearly needed to close this gap.

CONCLUSION

In this study, 400 type-2 diabetes patients in Bangladesh were examined to determine the relationship between glycemic control and the frequency of cardiovascular events. The results showed that 62% of individuals had HbA1c values above the suggested limit of 7%, indicating a significant proportion of poor glycemic control. Of the sample group, ischemic heart disease, stroke, and heart failure were the most prevalent consequences, accounting for 45% of cardiovascular events. Poor glycemic control is moderately linked to increased cardiovascular risk, according to a statistically significant positive connection ($r = 0.41$, $p < 0.01$) between HbA1c levels and cardiovascular events. The cumulative effect of uncontrolled blood glucose over time was highlighted by this association, which was especially noticeable in older persons and those with a longer history of diabetes. Significant gaps in patients' knowledge and perception of the link between diabetes and cardiovascular problems were also found by the study. A significant percentage of participants lacked access to routine HbA1c testing or thorough diabetes counseling, and many were ignorant that long-term hyperglycemia might directly cause heart disease and stroke. These results highlight the critical need for integrated diabetes and cardiovascular care approaches that prioritize patient education, ongoing monitoring, and early identification. The study's conclusions suggest that healthcare professionals in Bangladesh should give patient education on the connection between poor glycemic control and cardiovascular risks top priority. They should pay special attention to routine HbA1c monitoring and the early identification of cardiovascular symptoms. Public health campaigns should use culturally relevant language and resources to increase awareness

at the community level, particularly among low-literate and rural communities. To guarantee early intervention, primary care settings should adopt integrated care models that incorporate cardiovascular screening and diabetes control. In order to promote improved glycemic control and lessen the long-term burden of cardiovascular disease among patients with type-2 diabetes, healthcare systems should also increase access to diagnostic testing, prescription drugs, and lifestyle counselling services.

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