

Comparative Evaluation of Cardiovascular Biomarkers in Diabetic and Non-Diabetic Myocardial Infarction Patients in Saudi Arabia

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This study discusses the effect of diabetes mellitus (DM) and the importance of biochemical markers in the timely diagnosis, management and prognostication of acute myocardial infarction (AMI) through the measurement of cardiac enzymes in diabetic and non-diabetic patients with AMI. A cohort of 300 individuals of ages of 55-80 years were selected for case control study. Three groups of participants were identified: normal (N), Diabetic Acute Myocardial Infarction (D-AMI), and Non-diabetic Acute Myocardial Infarction (ND-AMI). Each participant underwent a thorough history, medical evaluation, and assessment of cardiovascular parameters. These parameters included fasting blood glucose, glycated hemoglobin (HbA1c), systolic and diastolic blood pressure, total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and the ratios of TC/HDL and LDL/HDL. The cardiac biomarkers measured included aspartate aminotransferase (AST), lactate dehydrogenase (LDH), C-reactive protein (CRP), creatine phosphokinase (CPK), creatine kinase-MB (CK-MB), and troponin-I. While TC, TG, and LDL-C levels were high, HDL-C levels were considerably lower in the D-AMI group than in the N-AMI group. Irrespective of whether they had diabetes mellitus, the study's findings demonstrated that individuals with myocardial infarction had considerably higher rates of cardiac biomarkers, including troponin I, CPK, CK-MB, AST, LDH, and CRP. Research indicates that individuals with D-AMI have higher cardiac indicators than those with ND-AMI.

Keywords: Acute Myocardial Cardiac Biomarkers, Diabetes Mellitus, Dyslipidemia, Infarction, Inflammatory Markers.

Acute myocardial infarction (AMI) and other cardiovascular diseases (CVDs) are the major causes of death worldwide, causing high morbidity

and healthcare costs. AMI is a major cardiovascular disease caused by myocardial ischemia, which leads to ischemic injury and the following

myocardial necrosis.¹ People with diabetes have a significant clinical burden of AMI. Diabetes mellitus (DM) is a metabolic disease characterized by chronic hyperglycemia due to insulin resistance or insufficiency. Diabetic persons are 2 to 4 times more likely to experience AMI than are non-DM, and their prognosis is often impaired because of prolonged ischemic insult, delayed diagnosis and atypical presentations.²

Globally, Saudi Arabia is showing a rapid increase in both DM and CVDs as a result of rapid urbanization, sedentary lifestyles and changes in people's diets.³ The prevalence of diabetes is estimated to be 18-20% in Saudi Arabia among adult population, however, in certain areas like Jazan, the prevalence rate is even higher. The Jazan region in the south-western part of Saudi Arabia is especially affected by high rates of diabetes and its complications such as cardiovascular events. This regional disparity highlights the need for investigations specific to this issue that can focus on addressing the unique population health issues in the region.³⁻⁵

AMI diagnosis, treatment, and prognosis all heavily depend on biochemical markers.⁶ Cardiac biomarkers, specifically troponin I and creatine kinase -MB (CK -MB) are indispensable for identification of myocardial injury. Lipid panels provide important information on dyslipidemia, an underlying pathophysiological contributor to atherogenesis and subsequent evolution to AMI. Moreover, inflammatory markers, including C-reactive protein (CRP) and high sensitivity CRP (hs-CRP), are a measure of systemic inflammation which is typically high in diabetic populations and promotes the progression of cardiovascular pathology.⁷⁻⁹

Chronic hyperglycemia exacerbates oxidative stress, systemic inflammation, and endothelial dysfunction in diabetes mellitus patients, all of which increase the severity of cardiac damage in AMI.¹⁰⁻¹² Glycaemic control as measured by glycated haemoglobin (HbA1c) has been shown to be closely related to cardiovascular outcomes in diabetics. The interaction of these biochemical indicators in patients with and without diabetes still has to be researched fully in the geographical environment of Jazan.^{11,13,14}

Given the high burden of diabetes and cardiovascular diseases in Jazan, elucidating

the differences in biochemical markers between patients with and without diabetes with AMI is critically important. This study aimed to provide data on differences in cardiac injury, lipid abnormalities, and inflammatory responses that may be useful for early diagnosis, better treatment, and improved risk stratification. These findings could inform clinicians to implement personalized management strategies that would lead to improved outcomes for patients with AMI in nearby regions.

MATERIALS AND METHOD

Study Design and Population

This case-control study included 300 participants divided into three groups. The first group was the control group and consisted of 100 people (45 men and 55 women) with normal blood glucose levels and ECG readings (normal). The second group included 100 participants (65 men and 35 women) with normal blood glucose levels but with a diagnosis of acute myocardial infarction (non-diabetic and AMI, ND-AMI). The third group consisted of 100 participants (82 men and 18 women) with diabetes in conjunction with acute myocardial infarction (diabetic and AMI, D-AMI). All participants provided written informed consent. The institute is indebted to offer services to the local population of the Jazan region. The study was carried out following the Declaration of Helsinki.¹⁵ The study protocol was reviewed and approved by the Institutional Research Ethics Committee (Approval No.: REC-43/02/017; Approval Date: 16 September 2021)

The inclusion criteria were as follows:

1. Adults aged 55-80 years with confirmed diabetic and non-diabetic AMI diagnosis.
2. Availability of complete biochemical and clinical data.

The exclusion criteria were as follows:

1. Patients with chronic kidney disease (CKD) or renal failure.
2. Major operations or trauma occurred in the past three months.
3. Patients with acute infections or inflammatory disorders at admission.

Sample Collection and Biochemical Analysis

Upon admission, venous blood samples were collected after obtaining informed consent from the patients. Blood samples were processed

immediately for biochemical analyses. The following parameters were measured.

- Cardiac Troponins (cTnI): Quantitative analysis was performed using high-sensitivity immunoassays to detect myocardial injury.
- Creatine Kinase-MB (CK-MB): Measured using automated enzymatic assays.
- C-Reactive Protein (CRP): Immunoturbidimetric methods were used to measure the level of serum CRP to determine systemic inflammation.
- Lipid Profiles: The enzymatic colorimetric analyses were done to assess the levels of total cholesterol, TG, LDL, and HDL.

All tests were performed in certified hospital laboratories under strict quality control. All participants were recorded regarding demographic and clinical information, such as age, sex, blood pressure, glycemic condition, and history of diabetes.

Statistical Analysis

Data analysis was performed using IBM Corp.'s Version 25 SPSS, Armonk, NY, USA. For continuous variables, which are represented as mean $\pm$ standard deviation (SD), independent t-tests were performed. A Bonferroni post hoc test was used to look for particular inter-group contrasts after a one-way analysis of variance (ANOVA) was performed to look for variances among the three groups. Statistical significance was defined as a two-tailed p-value of less than 0.05.

RESULTS

Demographic characteristics of subjects

Based on their medical circumstances, the research participants were split into three

groups: the normal group (100 persons), the ND-AMI group (100 non-diabetic patients with acute myocardial infarction (AMI)), and the D-AMI group (100 diabetic patients with AMI). The average age of patients with ND-AMI was 67.2 ± 19.0 years, whereas the average age of patients with D-AMI was 70.2 ± 11.4 years. Both the D-AMI and ND-AMI groups had higher systolic and diastolic blood pressures than the normal group. Compared to the normal and ND-AMI groups, the D-AMI group had substantially higher fasting blood glucose and glycated hemoglobin (HbA1c) concentrations ($p < 0.001$). Table 1 displays the fundamental demographic characteristics.

Assessment of cardiovascular parameters

Figure 1 shows how the concentrations of each lipid element changed during the study. The D-AMI cohort showed a significantly higher prevalence of total cholesterol (TC; 284.71 ± 8.2 mg/dL), triglycerides (TG; 309.34 ± 12.4 mg/dL), and low-density lipoprotein (LDL; 292.67 ± 18.7 mg/dL) compared to the ND-AMI cohort, which had a TC of 236.46 ± 9.6 mg/dL, TG of 211.43 ± 7.6 mg/dL, and the Normal cohort manifested TC levels of 179.21 ± 11.5 mg/dL, TG levels of 149.56 ± 8.5 mg/dL, and LDL levels of 134.56 ± 11.5 mg/dL, respectively (Fig. 1A-C). The D-AMI group also showed much lower high-density lipoprotein (HDL) concentration (24.67 ± 5.4 mg/dL) than the ND-AMI group (32.54 ± 2.7 mg/dL) and the Normal group (39.64 ± 4.6 mg/dL) (Fig. 1D). As a result, levels of LDL/HDL and TC/HDL ratios were significantly greater in subjects in the D-AMI category compared to the ND-AMI cohort (Fig. 1E & 1F).

Table 1. Demographic characteristics of the participants

Characteristics	Normal (100 subjects)	ND-AMI group (100 subjects)	D-AMI group (100 subjects)	p-Value
Male/Female (n)	45/55	65/35	82/18	
Age (years)	65.0 ± 10.1	67.2 ± 18.9	70.2 ± 11.4	$<0.002^*, @$
FBG (mm/L)	4.3 ± 0.32	4.9 ± 0.43	7.2 ± 1.03	$<0.002^*, @, \#$
HbA1c (%)	4.1 ± 1.12	5.6 ± 1.47	8.5 ± 1.29	$<0.005^*, @, \#$
SBP (mm Hg)	121 ± 4	130 ± 15	155 ± 20	$<0.005^*, @, \#$
DBP (mm Hg)	81 ± 5	85 ± 10	94 ± 15	$<0.005^*, @, \#$

All values are shown as mean $\pm$ standard deviation. *D-AMI vs. N-AMI p value. @D-AMI vs N group p value. #N-AMI vs N group p value. SBP refers to systolic blood pressure, DBP refers to diastolic blood pressure and FBG refers to fasting blood glucose, HbA1c refers to glycated hemoglobin, N refers to the latter commonly evaluated parameter, and D-AMI refers to the concurrence of acute myocardial infarction and diabetes mellitus.

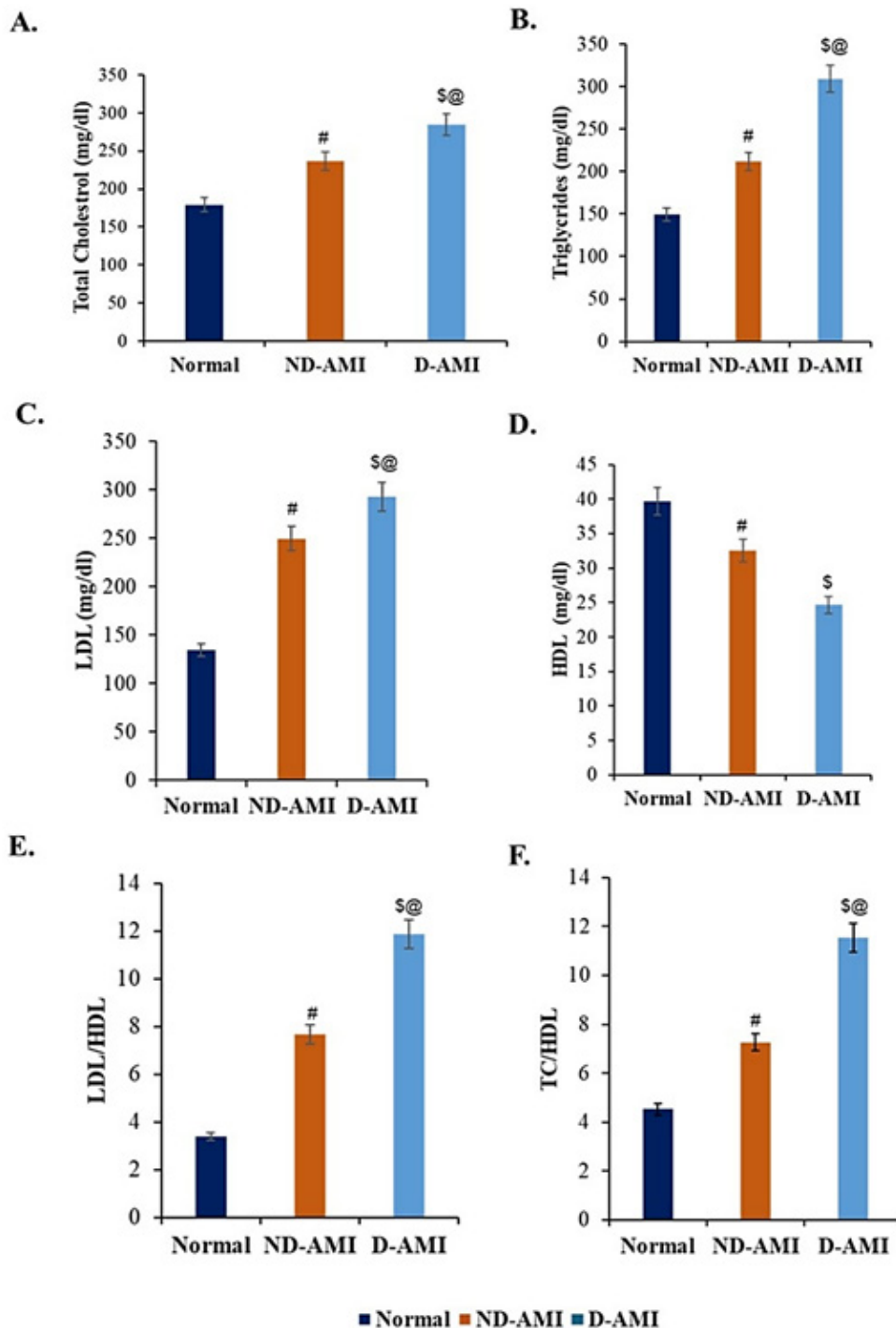


Fig. 1. Comparative Assessment of Biomarkers of Cardiovascular Disease - Where (A) TC, (B) TG, (C) LDL, (D) HDL, (E) LDL/HDL ratio, and (F) TC/HDL ratio. Statistical comparisons were performed between the groups as follows: D-AMI versus ND-AMI (*p < 0.05), D-AMI versus Normal (@p < 0.05), and ND-AMI versus Normal (#p < 0.05).

Data are presented as mean/ $\pm$ SD.

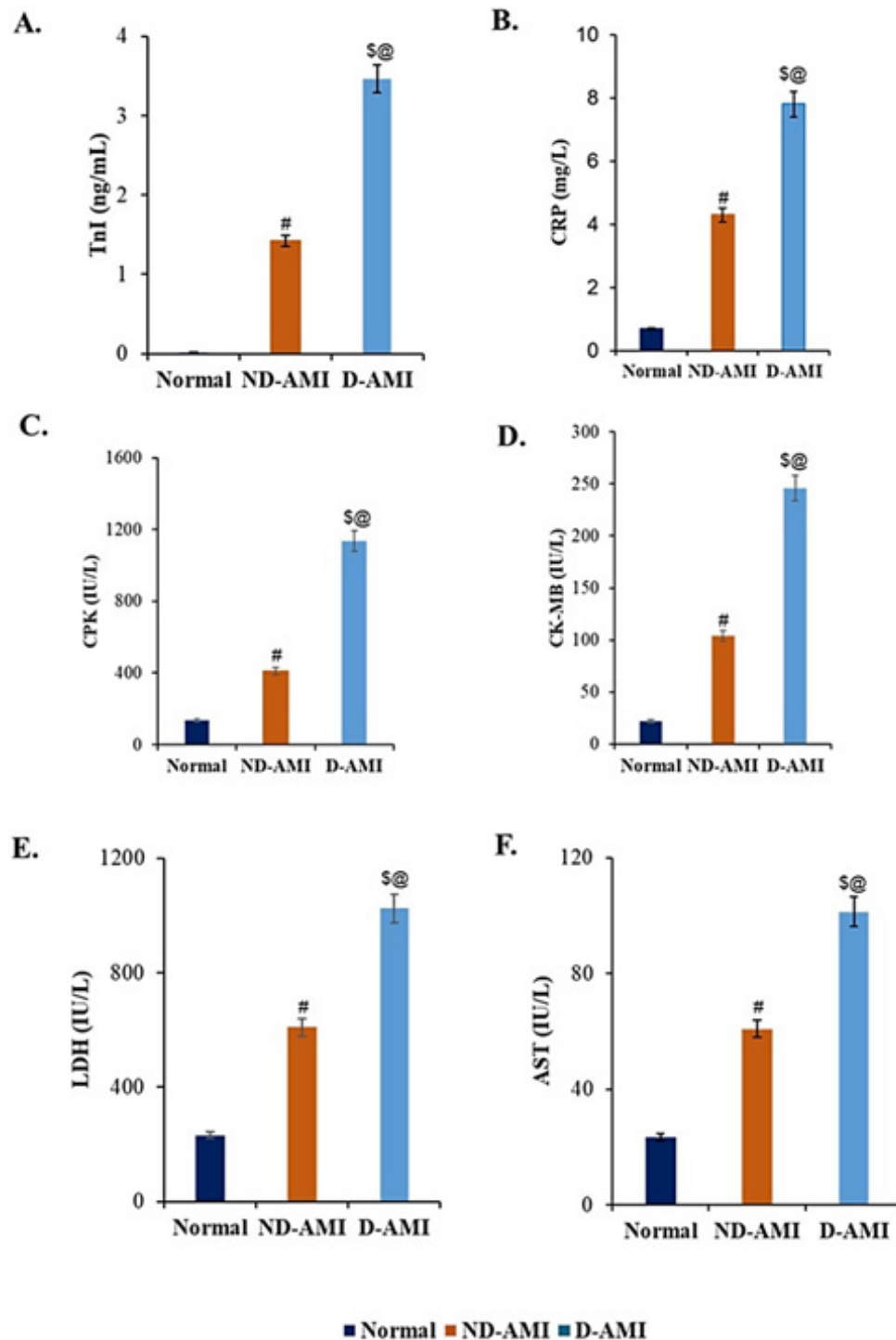


Fig. 2. Evaluation of Cardiac Biomarkers - The panels represent the concentrations of (A) TnI, (B) CRP, (C) CPK, (D) CK -MB, (E) LDH, and (F) AST. All values are expressed as mean ($\pm$ standard deviation). Statistically significant differences are indicated as follows: D-AMI vs. ND-AMI (* $p < 0.05$), D-AMI vs. Normal (@ $p < 0.05$) and ND-AMI vs. Normal (# $p < 0.05$).

Assessment of cardiac markers

Patients in the D-AMI group had a significantly elevated troponin I (TnI; 3.46 ± 0.7 ng/mL) compared with those in the ND-AMI group (1.42 ± 0.5 ng/mL) (Fig. 2A). Additionally, the D-AMI group had substantially higher C-reactive protein (CRP) levels (7.8 ± 0.8 mg/L) than the ND-AMI cohort (4.3 ± 0.4 mg/L). The data showed significant increases in creatine phosphokinase (CPK; 1134.0 ± 24.8 IU/L) and creatine kinase-MB (CK-MB; 246.0 ± 13.6 IU/L) in the D-AMI group compared to the ND-AMI group, which had a CPK of 410.0 ± 17.9 IU/L and CK-MB of 104.0 ± 6.4 IU/L (Fig. 2B-D). Serum lactate dehydrogenase (LDH) levels were significantly increased in the D-AMI group (1024.0 ± 26.4 IU/L) compared those to in the ND-AMI group (610.0 ± 15.9 IU/L). In addition, aminotransferase activity, as measured by aspartate aminotransferase (AST), was significantly elevated in the D-AMI cohort (101.34 ± 5.3 IU/L) compared to that in the ND-AMI cohort (60.87 ± 16.7 IU/L) (Fig. 2E and F).

DISCUSSION

Myocardial infarction (AMI) develops as a secondary event to myocardial ischemia triggered by enhanced formation of reactive oxygen species (ROS), activation of pro-inflammatory pathways, failure of antioxidant system, and enhanced lipid peroxidation.¹⁶⁻¹⁸ These pathophysiological processes collectively lead to the development of atheromatous plaques and to coronary obstruction and, subsequently, infarction of the myocardium.¹⁹⁻²¹ A large proportion of the population of Jazan suffers from acute myocardial infarction (AMI). There are a range of risk factors involved in the genesis of acute myocardial infarction, these include diabetes, dyslipidaemia, hypertension, tobacco addiction, obesity and aging.²²⁻²⁴ According to Henning's theory, people with diabetes are at higher risk of cardiovascular disease than people who do not have the disease.^{25,26} The effect of diabetes, hypertension and dyslipidemia on people suffering from diabetic AMI (D-AMI) was the main theme of this research. Atherogenic dyslipidemia is the outcome of lipid and lipoprotein metabolism changes induced by type 2 diabetes, according to research^{27,28} According to our results, the patients with D-WAMI had significantly higher levels of

TC, TG, and LDL and lower levels of HDL, which suggested that atherogenic dyslipidemia play an important role in the pathophysiology of AMI in diabetics.

Proteins and lipids, also especially LDL, become subject to oxidative modification due to atherogenic dyslipidemia, which results in local and systemic inflammatory responses.^{29,30} Serum C-reactive protein (CRP) levels can be used to measure the level of damage that these inflammatory cascades are causing to the cardiac tissue.³¹⁻³³ A source of predictive data for cardiovascular events including atherosclerosis and coronary artery disease (CAD), CRP is a systemic inflammatory measure.^{34,35} In comparison to those who have non-diabetic AMI (ND-AMI), results of the current investigation showed significantly higher CRP values in patients with D-AMI.

Cardiac contractility is evaluated by myocardial tissue-specific protein Troponin I (Trop-I) that is highly specific and sensitive biomarker of myocardial damage and has been used in the diagnosis of AMI in previous studies.³⁶ The present study reported the significant higher Trop-I levels in D-AMI patients compared with ND-AMI patients, thus showing the higher incidence of cardiomyocyte death in diabetics.

CPK and CK-MB are important myocardial necrosis markers and were significantly elevated in the D-AMI cohort during this study.³⁴ LDH and AST values were also significantly different between D-AMI and ND-AMI groups (these are traditionally proposed as markers of infarction).

Our findings support the importance of atherosclerosis and its sequelae, that is, inflammation and dyslipidemia, in patients with D-AMI. Accordingly, both non-conventional cardiac indicators, such as CRP, and conventional indicators, such as CPK, CK-MB, LDH, and AST, were found to be significantly higher in patients with D-AMI than in those with non-diabetic AMI. These observations are meant to be used by clinicians to inform the management of myocardial infarction in patients with diabetes mellitus.

When interpreting the findings of this study, a number of limitations should be noted. Due to resource constraints, historical data were used. Data collection was conducted over a short period and was obtained from numerous local hospitals.

This represents the first compiled dataset of a local population of patients with diabetes and AMI, despite existing research in this field.

Limitations of the study: The current investigation has several limitations that must be considered when interpreting the results. Owing to a lack of resources, the scope of this investigation was limited, and pre-existing datasets had to be used. To the best of our knowledge, despite previous findings on similar groups, this study is the first to systematically arrange a scientific study of local community diabetic patients and those with acute myocardial infarction.

CONCLUSION

This study showed that biochemical indicators between diabetes and non-diabetic AMI patients have significant variations compared to normal subjects in the Jazan region of Saudi Arabia. Diabetic patients with acute myocardial infarction show more myocardial injury, lipid abnormalities, and inflammatory responses; hence, the need for customized healthcare measures. Timely identification and vigorous management of diabetes are crucial for minimizing these risks and improving cardiovascular outcomes. The findings require comprehensive diabetes treatment programs, including community awareness programs, regular cardiovascular monitoring, and lifestyle modification programs directed towards glycemic and lipid control. To obtain a more complete picture of the relationship between diabetes and acute myocardial infarction, further studies should address the genetic and environmental factors specific to the Jazan population.

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Conflict of Interest

The author(s) do not have any conflict of interest.

Data Availability Statement

This statement does not apply to this article.

Ethics Statement

Ethical approval for this study was obtained from the Standing Committee for Scientific Research, Jazan University, Kingdom of Saudi Arabia (HAPO-10-Z-001) under Reference No. REC-43/02/017, dated 16 September 2021. All procedures involving human participants were conducted in accordance with institutional guidelines.

Informed Consent Statement

This study did not involve human participants, and therefore, informed consent was not required.

Clinical Trial Registration

This research does not involve any clinical trials.

Permission to reproduce material from other sources

Not Applicable.

Author Contributions

M o h a m m a d S h a n e A l a m : Conceptualization, Formal analysis, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing; Yahia Ali Kaabi: Conceptualization, Formal analysis, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing; Fakhra Jabeen: Visualization, Writing – original draft, Writing – review & editing; Mohammad Mazharul Hoque: Validation, Visualization, Writing – original draft, Writing – review & editing; Alaa Alhazmi: Validation, Visualization, Writing – original draft, Writing – review & editing; Mohammad Suhail Akhter: Conceptualization, Formal analysis, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing; Yahia Mjery: Formal analysis, Methodology, Validation, Visualization, Writing – original draft, Writing

– review & editing; Kamal Upreti: Validation, Visualization, Writing – original draft, Writing – review & editing; Rituraj Jain: Validation, Visualization, Writing – original draft, Writing – review & editing

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