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Association between Diabetes Mellitus and Acute Coronary Syndrome in Adults: A Cross-Sectional Study in Dhamar City, Yemen

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Abstract

Background: Diabetes mellitus is one of the most serious chronic diseases worldwide and greatly increases the risk of cardiovascular complications. Acute coronary syndrome (ACS) is a critical outcome of diabetes, resulting from sudden reductions in blood flow to the heart. When combined, diabetes and ACS pose major concerns for public health, especially in low-resource settings. This study explored the relationship between diabetes and ACS in adult patients in Dhamar City, Yemen. **Methods:** A cross-sectional study was carried out among 77 ACS patients admitted to several hospitals in Dhamar between February and May 2022. Sociodemographic characteristics, medical history, laboratory findings, and clinical outcomes were collected through interviews and patient records. Data were analyzed using SPSS version 23. **Results:** Of the participating ACS patients, 74.03% were male and 67.5% had diabetes, with 51.9% diagnosed with type 2 diabetes. Most patients were between 40 and 60 years old, overweight, uneducated, and hypertensive. Troponin was positive in 94.8% of cases. STEMI accounted for 36.4% of ECG findings, while NSTEMI represented 57.1%. Diabetic patients showed higher LDL and lower HDL levels than non-diabetics, and significantly higher blood glucose indices. The hospital mortality rate was 9.1%. **Conclusion:** The findings indicate a strong association between diabetes and ACS among adults in Dhamar City. Poor lipid control, elevated blood glucose levels, hypertension, and overweight may contribute to ACS development in diabetic patients. Routine follow-up, improved screening, and early detection are important to reduce ACS-related complications in this population.

Keywords: Diabetes Mellitus; Acute Coronary Syndrome; Dhamar; Yemen

1. Introduction

Diabetes mellitus (DM) is the seventh leading cause of death globally and a major cause of costly and debilitating complications such as heart attacks, strokes, kidney failure, blindness, and lower limb amputations [1-3]. More than 420 million people live with diabetes, and this number is estimated to rise to 570 million by 2030 and to 700 million by 2045, according to the World Health Organization .The Middle East has the highest prevalence of diabetes in the world with Egypt (17.2%), United Arab Emirates (16.3%), Saudi Arabia (15.8%), Qatar and Bahrain (15.6%), (Syria 13.5%), Jorden (12.7%), Kuwait (12.2%), Iran (9.6%) and Yemen (5.4%) [4, 5].

Diabetes is a significant global cause of death, mostly because of its vascular consequences. According to the International Diabetes Federation (IDF), diabetes claimed the lives of four million people in 2017 and was the primary cause of 10.7% of all deaths worldwide among persons aged 20 to 79 [6]. Hypertension, dyslipidemias, pro-inflammatory and pro-thrombotic effects of hyperglycemia, and hyperinsulinemia that impair vascular autoregulation are some of the mechanisms by which vascular diseases develop. These include glycosylation of serum and tissue proteins with the formation of advanced glycation end products (AGEs), superoxide production, activation of protein kinase C, accelerated hexamine biosynthetic and polyol pathways, and. Insulin resistance and

hyperglycemia are the mediators of all of the aforementioned pathways [7-11]. Two important and related risk factors for atherosclerotic cardiovascular disease, which include acute ACS [12, 13]. Diabetes and hypertension are. Because of common pathogenic processes like inflammation, insulin resistance, and obesity, they commonly co-occur [14]. However, when they appear together, their combined risk for cardiovascular events is higher than the sum of their separate effects; this phenomenon is known as synergistic [15].

The complications of DM can be divided into two main types. The microvascular complication that affects small vessels in the retina, peripheral nerves, and kidneys, leading to retinopathy, neuropathy, and nephropathy, respectively [16, 17]. And macro-vascular complications that affect large vascular, including: peripheral artery disease, coronary artery disease (CAD), and cerebrovascular disease [18]. Diabetes-associated cardiovascular autonomic neuropathy (CAN) damages autonomic nerve fibers that innervate the heart and blood vessels, in turn causing abnormalities in heart rate and vascular dynamics. It is known to affect multiple organ systems and is a major cause of morbidity and mortality in patients with diabetes [19-22].

Diabetes is a growing pandemic and a leading cause of morbidity and mortality. About 18 million people die every year from cardiovascular disease (CVD), for which diabetes and hypertension are major predisposing factors [23, 24]. People with diabetes have a cardiovascular risk that is 2–4 times higher than that of individuals without the disease, and the risk increases as glycemic control deteriorates. Diabetes has been associated with a 75% increase in mortality rate in adults. People with diabetes remain at significantly higher cardiovascular risk compared with people without diabetes, and CVD is a major cause of comorbidity and death among people with diabetes [24, 25].

Ischemic heart disease (IHD) is the main global cause of death, accounting for >9 million deaths in 2016 according to the World Health Organization (WHO) estimates [26, 27]. Patients with diabetes, especially those with type 2 diabetes mellitus (T2DM), frequently have silent myocardial ischemia, which is likely caused by cardiac autonomic dysfunction. In our research population, the prevalence of silent cardiac ischemia is strongly influenced by age, history of smoking, history of hypertension, fasting blood sugar (FBS) level, body weight, and body mass index (BMI) [28, 29].

The main cause of death in the United States is still coronary artery disease (CAD) [30], in which atherosclerotic plaque accumulates inside the coronary arteries and inhibits blood flow, hence decreasing oxygen supply to the heart. Despite the time and money invested in educating doctors and the public on its risk factors, symptoms, and treatment, one woman or man encounters a coronary artery disease episode every 25 seconds. Acute coronary syndrome (ACS), a disorder characterized by signs and symptoms of abrupt myocardial ischemia—a rapid decrease in blood supply to the heart—can develop as a result of coronary artery disease (CAD) [31]. Because it was thought that the name ACS better represented the illness course associated with myocardial ischemia, it was chosen. According to the American Heart Association (AHA), 785,000 People will encounter a myocardial infarction (MI) this year, and roughly 500,000 of them will experience another one the following year. These two conditions are both included under the ACS umbrella [32]. In 2006, almost 1.4 million patients were released from the hospital with either a primary or secondary diagnosis of ACS, including 537,000 with Unstable Angina (UA) and 810,000 with a non-ST-segment-elevated myocardial infarction (N-STEMI) or an ST-segment-elevated myocardial infarction (STEMI). Some patients also had both UA and MI [32, 33].

The International Committee of the Red Cross (ICRC) reported that more than 80% of Yemen's population lacks food, fuel, drinking water, and access to health care services, which makes it particularly vulnerable to chronic diseases like diabetes. Economic crises, reduced health services, and increased costs made most of the people in Yemen unable to discover most of the chronic diseases until a long time after they occur, which also made diabetic patients incompetent to make a regular investigation for treating and managing their disease [34]. Despite this alarming trend, we have observed an increased prevalence of diabetes mellitus compared to previous years, and an increase in the incidence of ACS, where there is a relationship between diabetes and CVD. Furthermore, there is limited data regarding ACS, and the factors linked to its increase among DM patients remain poorly understood in Yemen. Additionally, no study has addressed the extent of diabetes's effect on ACS occurrence or the relationship between diabetes and ACS patients in the government of Dhamar, Yemen.

This study aimed to investigate the association between diabetes and ACS in Dhamar City, Yemen. Determination of the prevalence of ACS in a patient with/without diabetes according to (gender, marital status, employment, residence, occupation, income level, age, and education) in Dhamar City, Yemen. 2. To evaluate the risk factors (habitus and body mass index) in ACS patients in Dhamar, Yemen. To evaluate the clinical manifestations and hospital course of ACS in diabetic and non-diabetic patients in Dhamar City, Yemen. Estimation of biomarker tests (cardiac enzymes, lipid profile, HbA1c, FBS, and RBS) and Echo and ECG.

2. Materials and Methods

2.1 Study Design, Setting, and Period

This study was conducted in Dhamar City, Yemen Figure 1. Dhamar City is located in the central part of Dhamar province, 100 km south of the capital Sana`a (about 130 km south of the capital Sana`a airport. Ibb governorate of the south, Al-Bida province, and part of Sana`a in the east, Al-Hudaydah governorate, and part of Sana`a (the capital of Yemen), and a governorate to the west. The area of the governorate is about 7586 km2, and the population of the governorate, according to the results of the general census of population, housing, and establishments for 2004, is about 1330108 (https://yemen-nice.info/gover/thamar/classoff).

A Cross-sectional study conducted between February 2022 and May 2022 involved patients with ACS, with or without diabetes, at various health facilities, including Al-Riyada International Hospital, Taiba Consulting Hospital, Dar Al-Shifa Hospital, and Dhamar General Hospital Authority.

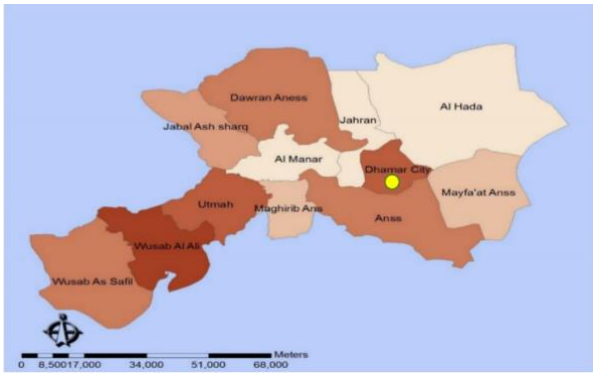

Figure 1: Dhamar city, Yemen (https://yemen-nice.info/gover/thamar/classoff).

2.2. Participant Recruitment and Eligibility Criteria

Upon the treatment of the physician identifying an eligible patient, a member of the research team approached the patient (or their next of kin in cases where the patient was critically ill or unable to communicate). The study's purpose, procedures, potential risks, benefits, and the voluntary nature of participation were explained verbally in Arabic. Written informed consent was obtained from all participants (or their legally authorized representatives) prior to data collection.

ACS patients who agreed to participate in this study. Patients were enrolled consecutively upon hospital presentation. The Study included both sexes, adults aged 77, ACS patients, and diabetic and non-diabetic patients. Some ACS inpatients were excluded who refused to participate in this study, and some who had not completed answering the questionnaire questions, who did not have the required investigation in this study, or were non-adults. This study deals with the city of Dhamar in Yemen under very difficult circumstances. It was performed during a period when there were no cardiology departments in local hospitals, and choosing a sample size was practical and necessary. These limitations, coupled with the difficulty of collecting data in such an environment, limit the scope of the study but are justified under the circumstances. Despite these challenges, the study provides valuable local insights into a critical health issue within this specific context. It is a laudable effort, and it lays the foundation for future research in more stable conditions. The criteria for classifying diabetes (history, medication, or HbA1c > 6.5%) and the classic triad for diagnosing ACS (symptoms ECG abnormalities, and troponin elevation) were established as diagnostic criteria.

2.3 Operational Definitions

Based on the combination of the following, the attending physician diagnosed ACS: Clinical Presentation (typical signs of acute myocardial ischemia, such as pressure, dyspnea, or chest pain); Electrocardiographic (ECG) Findings (new or suspected new significant ST-segment-T wave

changes (ST-elevation, ST-depression, or T-wave inversion) at least two consecutive leads. Biochemical Evidence (an increase or decrease in cardiac troponin levels, with at least one value above the assay's 99th percentile upper reference. The diagnosis was based on troponin tests performed in emergency rooms at all participating institutions, using ECG machines and basic laboratory capabilities.

2.4 Data Collection Procedures

2.4.1 Questionnaire Interview

A pre-tested questionnaire was used in a face-to-face interview to collect data on sociodemographics, medication use, medical history (diabetes, hypertension), and lifestyle choices (smoking, khat use, physical activity).

2.4.2 Biochemical Tests and Blood Samples Collection

Standard commercial assays were used for on-site analysis of blood samples at the collaborating hospital laboratories. The blood samples collected by the laboratory department in Al-Riyadh International Hospital, Taiba Consulting Hospital, Dar Al-Shifa Hospital, and Dhamar General Hospital Authority were used to check the following investigations: Fast blood sugar (FBS), Random blood sugar (RBS), HbA1c, Lipid Profile (total cholesterol, high-density lipoprotein (HDL), and LDL), and cardiac enzymes (CK-MB and troponin).

2.4.3 Anthropometric Measurements

The height of all patients was measured using tape in centimeters while the participant stood still without shoes, and the weight of all patients was measured with an electronic weight scale in kilograms, with the participant lightly clothed. The body mass index (BMI) is calculated by using the following formula:

$$BMI = \text{weight (kg)}/[Hight\ (m)]^2$$

2.4.4 Specific Investigation of Acute Coronary Syndrome

All ACS patients underwent investigations that confirmed the diagnosis of ACS, including an ECG and an echocardiogram (Echo). For the hospital management section, this section included Condition improved with medication, such as PCI (patients recommended a PCI, patients performed a PCI, and recommended the Type of PCI).

2.6 Data Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS Version 23), and descriptive statistics were reported using relative frequencies (percentages) for categorical data. The differences in biochemical parameters between the different glycemic status groups were assessed using a t-test or one-way ANOVA, depending on data distribution. The relationship of biomarker tests with DM was evaluated using the Chi-square test. Statistical significance was set at a p-value of ≤0.05.

3. Results

Statistical analysis of 77 individuals who participated showed that, the majority of the study population most likely to of ACS, 57 (74.03%) male, 71 (92.2%) married, 66 (85.7%) non-employed, 56 (72.7%) rural residents, 49 (63.6%) farmer, 45 (58.4%) mid-income level, 36 (46.8%) ages between 40-60-year-old and 40 (51.9%) non-educated and 36 (46.75%) over-weight as in the following Figures (2.A-I). (A–I) Distribution by sex, marital status, employment status, residence, occupation, monthly income level, age group, education level, and body mass index.

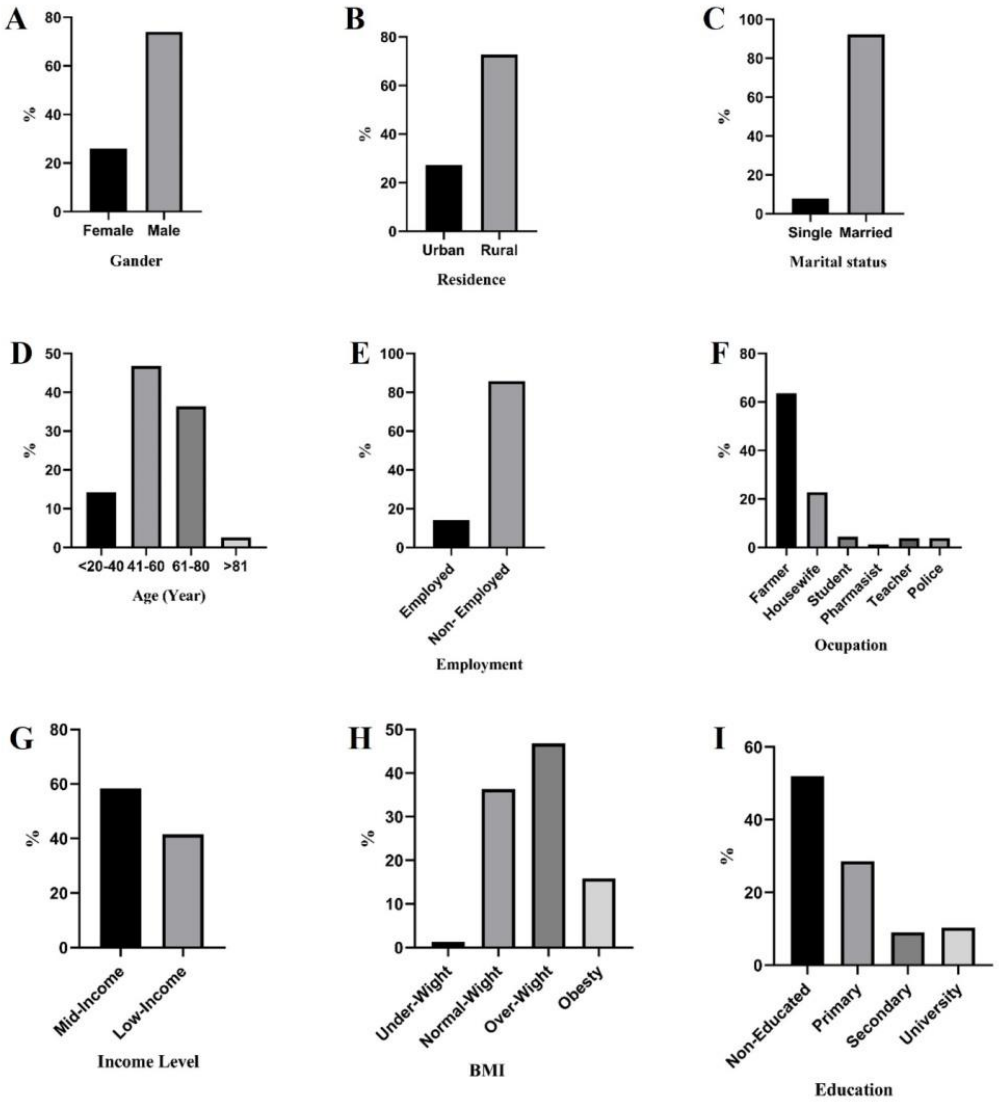

Figure 2: Sociodemographic characteristics of ACS patients with and without diabetes.

Regarding lifestyle habits. About 39 (50.6 %) of ssmokers patients, while 38 (49.4%) of patients are not smokers, 40 (51.9%) chew Khat (Yemeni plant) daily, 26 (33.77%) do not do anybody activities (sport), 41 (53.2%) do insufficient sport for less than 30 minutes and 44 (57.1%) do not follow a diet system, Table 1.

Table 1. Lifestyle characteristics of ACS patients, including smoking status, khat chewing, physical activity, and dietary habits.

Habits		Frequency	%
Smoking	Yes	39	50.6
	No	38	49.4
Type of smoking	Cigarettes	32	41.55
	Meekness	7	9.1
	Non-smoker	38	49.35
Chewing Khat (Yemeni plant)	Daily	40	51.9
	Sometimes	24	31.2
	Never	13	16.9
Body activities (sport)	Yes	29	37.66
	No	26	33.77
	Sometimes	22	28.57
Sports time	Less than 30 minutes	41	53.2
	More than 30 minutes	10	13.0
	Does not exercise	26	33.8
Diet system	Yes	33	42.9
	No	44	57.1

According to ACS patient's historical characteristics of DM which are shown in Table 2, out of 77 ACS patients, 61 (79.2%) had DM, 40 (51.9%) diabetes patients had T2DM and 14 (18.2%) do not know what type of diabetes they have, 28 (36.36%) had diabetes duration less than 3 years, 33 (42.85%) had a family history of DM, 54 (70.1%) numbness and 40 (51.9%) had a recurrent infection. Regarding treatment, 49 (59.7%) patients were receiving oral Anti-hyperglycaemic drugs, 6 (7.8%) patients were on insulin and tablets, and 38 (49.4 %) were not measuring their blood sugar regularly. Of the 77 ACS patients, 42 (54.5%) had hypertension. Twenty of them (25.97% of the group as a whole) had experienced hypertension for less than three years. Only 15 (19.5%) of the hypertensive patients reported routinely checking their blood pressure, even though all of them were on medication. 22 individuals (28.6%) had a family history of cardiac disease (Table 2).

Data analysis of the clinical manifestations of ACS showed that, in this sample, the presentation was often abnormal. All 77 patients complained of chest discomfort; however, only 23 (29.9%) said it was painful. Among individuals who were in pain, the most prevalent characteristics were burning 9, 11.7%) or heaviness 14, 18.2%). Interestingly, 54 patients (70.1%) reported no chest pain, suggesting that non-painful chest discomfort is the most common presentation. Dyspnea was associated with all patients, 35 (45.5%) were associated with nausea and vomiting, and 13 (16.9%) were associated with loss of consciousness, Table 3.

As for the investigation to confirm the diagnosis of ACS shown in Table 4, regarding cardiac enzymes, 73 (94.8%) had troponin-positive results, and 70 (90.9%) had CK-MB-positive results. Regarding ECG, 28 (36.4%) had ST-segment elevation (STEMI) in at least two leads, 44 (57.1%) had Flat or inverted T wave (N-STEMI) in at least two leads, and 5 (6.5%) had a normal ECG in all 12 leads. Regarding the echocardiogram, 32(41.6%) had IHD, and 42 (54.5%) had IHD and HTN. Based on clinical management of ACS, Table 4 showed that, regarding treatment, 32 (41.5%) did not improve their condition with medication, 50 (64.93%) needed PCI, 36 (46.75%) did not undergo PCI, and 27 (35.06%) underwent PCI for therapeutic purposes. The total of those who have performed PCI and will do it later is 41(53.24%), which matches the recommended type of PCI 41 (53.24%) (Diagnostic 8 (10.39%), Therapeutic 24 (31.17%), and both types, diagnostic and therapeutic 9 (11.68%).

Table 2. History of diabetes and hypertension among ACS patients, including disease duration, medication use, monitoring habits, and family history.

Characteristics		Frequency	%
History of DM:			
Diabetes	Diabetic	61	79.2
	Non-Diabetic	16	20.8
Type of Diabetes	T1DM	7	9.1
	T2DM	40	51.9
	I don't know	14	18.2
	Non-diabetic	16	20.8
Period Diabetes	Less than 3 years	28	36.36
	4-6 Years	14	18.18
	7-10 Years	13	16.88
	More than 10 years	6	7.8
	Non-diabetic	16	20.78
Family history of diabetes	Yes	33	42.85
	No	31	40.25
	I don't know	13	16.9
Numbness in the extremities	Yes	54	70.1
	No	23	29.9
Recurrent infection	Yes	40	51.9
	No	37	48.1
Measurement of Sugar	Always	14	18.2
	Sometimes	38	49.4
	No	25	32.5
Ant-hyperglycemic drugs	Insulin	6	7.8
	Tablets	46	59.7
	Both (Insulin and Tablets)	6	7.8
	Do not use	3	3.9
	Non-diabetic	16	20.8
History of Hypertension:			
Hypertension	Yes	42	54.5
	No	23	29.9
	I don't know	12	15.6
Hypertension Duration	Less than 3 years	20	25.97
	4-6 Years	10	12.98
	7-10 Years	5	6.5
	More than 10 years	7	9.1
	Normal blood pressure	35	45.45
Regularity Measurement for Blood Pressure	Always	15	19.5
	Sometimes	34	44.1
	No	28	36.4
Family History of Heart Disease	Yes	22	28.6
	No	55	71.4
Anti-hypertensive Drugs	Yes	42	54.5
	No	22	28.6
	Normal blood pressure	13	16.9

Table 3. Clinical manifestations reported by ACS patients, including chest discomfort, radiation of pain, associated symptoms, and frequency and duration of episodes.

Clinical Manifestation		Frequency	%
Feel Chest Discomfort	Yes	77	100.0
	No	0	0
Chest Discomfort in The Form of Pain	Yes	23	29.9
	No	54	70.1
Character of Pain	Heaviness	14	18.2
	Burning	9	11.7
	There is no pain	54	70.1
Pain Radiated	Left arm	23	29.9
	There is no pain	54	70.1
Chest Discomfort or Pain Related to	Muscular effort	26	33.8
	Nervous excitement	20	26.0
	With rest	31	40.2
Chest Discomfort or Pain Occur	Frequently	4	5.2
	For first time	73	94.8
Period of Chest Discomfort or Pain	Less than 15 minutes	2	2.6
	More than 15 minutes	75	97.4
Use Pills to Expand the Blood Vessels Under the tongue is the Pain	It disappears in less than 15 minutes	2	2.6
	The pain persists for more than 15 minutes	75	97.4
Pain Accompanied by Difficulty Breathing	Yes	77	100.0
	No	0	0
Pain Accompanied by Nausea And Vomiting	Yes	35	45.5
	No	42	54.5
Lost Consciousness	Yes	13	16.9
	No	64	83.1

Table 4. Diagnostic and hospital management findings among ACS patients, including cardiac enzyme results, ECG interpretation, echocardiography findings, and PCI recommendations.

Investigation for a confirmed diagnosis			Frequency	%
Cardiac Enzyme	CK-MB	Positive	70	90.9
		Negative	7	9.1
	Troponin	Positive	73	94.8
		Negative	4	5.2
ECG	ST segment elevated		28	36.4
	Flat or inverted T wave		44	57.1
	Normal ECG		5	6.5
Echo.	IHD		32	41.6
	IHD and HTN		42	54.5
	Not done		3	3.9
Hospital management:				
Condition improved with medication	Yes, greatly		16	20.77
	Yes, moderately		29	37.66
	Not getting better		32	41.55
Recommended PCI	Yes		50	64.93
	No		27	35.06
Performed the PCI	Yes		27	35.06
	No		36	46.75
	later		14	18.18
Recommended Type of PCI	Diagnostic		8	10.39
	Therapeutic		24	31.17
	Both		9	11.68
	There is no PCI		36	46.75

P.C.I. = Percutaneous Coronary Intervention. CK-MB = MB Fraction of Creatine Kinase. Ech= Echocardiogram. E.C.G.= Electrocardiogram. IHD = Ischemic heart disease. H.T.N = Hypertension.

According to Table 5's biochemical analytical tests, individuals with diabetes had greater total cholesterol than those without the disease (239.80±33.86 and 226.39±37.31, respectively), although this difference was not statistically significant. Furthermore, those with diabetes had greater LDL than those without the disease (157.40±7.16) and 138.60±16.60, respectively, with a P value of 0.017. Furthermore, HDL is lower in diabetic patients than in non-diabetic patients (40.40±2.61 and 41.24±7.45, respectively), although this difference is not significant. Patients with diabetes have higher RBS than those without the disease (225.02±90.99 vs. 170.56±120.18, respectively), but the difference is not statistically significant. Furthermore, FBS is greater in diabetic patients than in non-diabetic individuals (155.60±11.94 and 117.80±3.26, respectively) without statistical significance. Also, with 0.031 p-values, the HbA1c in diabetics is greater than in non-diabetics (8.42±2.40) and 5.60±0.49, respectively. CK-MB is positive in 58 (75.3%) of ACS patients with DM, according to cardiac enzyme biochemical tests. But only 12 (15.6%) of the individuals did not have diabetes. Additionally, 60 individuals (77.9%) with DM had Troponin enzyme levels.

Table 5. Comparison of biochemical test results between diabetic and non-diabetic ACS patients, including lipid profile, blood glucose indices, and cardiac enzyme patterns.

Relationship between lipid profile and diabetes in ACS patients:

Lipid profile	T. cholesterol Mean ± S.D	HDL Mean ± S.D	LDL Mean ± S.D
Diabetic	239.80±33.86	40.40±2.61	157.40±7.16
Non-Diabetic	226.39±37.31	41.24±7.45	138.60±16.60
P value	No-Sig.	Non-Sig.	0.017

Relationship between blood glucose and diabetes in ACS patients:

Diabetes	RBS Mean ± S. D	FBS Mean ± S.D	HbA1c Mean ± S.D
Diabetic	225.02±90.99	155.60±11.94	8.42±2.40
Non-Diabetic	170.56±120.18	117.80±3.26	5.60±0.49
P value	No-Sig.	Non-Sig.	0.031

Patterns of cardiac enzymes and diabetes in ACS patients:

Diabetes	CKMB		P-Value	Troponin		P-Value
	Positive	Negative		Positive	Negative	
Diabetic	58 (75.3)	3 (3.9)	0.013	60 (77.9%)	1 (1.3)	0.006
Non-Diabetic	12 (15.6)	4 (5.2)		13 (16.9%)	3 (3.9)	

CE = Cardiac Enzyme. CK-MB = MB Fraction of Creatine Kinase. T. cholesterol = Total Cholesterol. HDL = High-Density Lipoprotein. LDL = Low-Density Lipoprotein. RBS = Random Blood Sugar. F.B.S. = Fasting blood sugar. H.b.A1c= Hemoglobin A1c

According to Table 6, the evaluation findings for ACS Diabetic and Non-Diabetic Patients showed 7 (9.1%) deaths.

Table 6. Clinical outcomes of ACS patients with and without diabetes during hospitalization.

Diabetes	Get better	Death	Not recorded	P-Value
Diabetic	52 (67.5)	7 (9.1)	2 (2.6)	/
Non-Diabetic	16 (20.8)	0 (0.0)	0 (0.0)	

4. Discussion

Diabetes mellitus is a medical concern and a broad field of research that plays a key role in the development of many serious and fatal complications. The present study was conducted on ACS patients presenting with diabetes and non-diabetic patients. In this study, we enrolled 77 ACS patients, 57 (74.03%) male and 20 (25.97%) female, and more than half of the study population, 47 (61.04%), were aged <60 years. This is in agreement with [35] on 331 ACS patients, 225 (68.0%) male and 106 (32.0%) female, and 221 (66.8) aged < 60 years. Regarding residence, the study revealed that rural residents are more likely to have ACS than urban residents, and this is not in agreement with [35]. The reasons and justifications may be due to differences in sample size and the period in which you are studying or may be due to the differences in race or environment between countries of the world. The current study showed that the uneducated group with diabetes is more likely to have heart attacks, constituting 51% (95%), while the educated group of people with diabetes constitutes a percentage of 10- 39 %. The proportion of people with diabetes who are principally educated is 28.57%, whereas the percentage of people with diabetes who are secondary educated is 9.09%. This study coincided with the study [36], which took place in China. Those with diabetes who were less educated had a 70% chance of having a heart attack, compared to 30% for those with diabetes who were better educated.

The results of the current study show that the number of individuals in the sample who chewed Khat was more prone to heart attacks by 51.9, and this is consistent with the study [37]. Conducted in Sana`a, the number of

individuals who chewed Khat was 54.5%. Also, 40 (51.9%) chew Khat daily, 26 (33.8%) do not exercise, 41 (53.2%) do not exercise adequately for less than 30 minutes, and 44 (57.1%) do not follow a diet. Which agreement with [38] reported on type 2 diabetes in Dhamar Governorate, and the percentage of those who used Khat was reported (at 63.6%) and those who do not use Khat (36.4%), while the percentage of smokers was (27.3 %) and non-smokers (72.77%).

Diabetes is significant, according to this study's comparison of the mean and standard deviation of ACS between patients with and without diabetes, and HbA1c with Mean±S.D (8.42 ±2.40) (p value = 0.031). This result is consistent with [4]in the United Arab Emirates for the lipid profile with Mean ± SD. (157.40±7.16) (p value=0.017). The study's findings indicated that individuals with diabetes had high levels of cholesterol (mean and standard deviation of 239.80±33.86), high-density lipoprotein (40.40±2.61), and low-density lipoprotein (157.40±7.16), whereas patients without diabetes had higher levels of cholesterol (226.39±37.31), high-density lipoprotein (41±7.45), and low-density lipoprotein (138.60±16.60) [39].. The difference may be justified by the size of the study sample, where the number of cases in the study was 77 cases, while the number of cases in the study of them was 738790 cases.

The results of the study showed that people with diabetes and high blood pressure are more likely to suffer a myocardial infarction, 54.5% of the total, than people without diabetes, who are only 29.9% at risk. This result is consistent with a different research [39] in Poland. Where the percentage of people with high blood pressure was represented (87.4%).

As for the extent of health awareness among the study samples, especially those with diabetes, 18.2% of them are interested in measuring and checking their diabetes continuously, while 49.4% of them follow up on measuring their sugar sometimes. Our findings align with the results recorded by Saghir et al. (2019) in Al-Hodeida. That study showed that diabetics measured regularly (23.6%, irregularly (76.4%), and 7.8 %. The study sample used insulin, while 70% of the patients used anti-diabetic pills such as metformin and others, where metformin was proven to be effective in regulating sugar and burning fat, and it matches this result is in line with the result of the study [38] In Dhamar, Yemen, 68.5% use tablets, while 24% use insulin.

As for the clinical manifestations of acute coronary syndrome, 29.9% suffer from chest discomfort in the form of pain, and in the same percentage, the results show that 29.9% of those who suffer from left arm pain, only because they are affected by an acute case of coronary syndrome. Also, the use of vasodilator pills and clotting drugs contributed to the disappearance of pain 15 minutes before, and the answer rate was 35.1%. For those who felt nausea and vomiting accompanied by chest pain amounted to 45.5%, and the death percentage from acute coronary syndrome among diabetic patients is 7 cases of acute coronary syndrome among 77 diabetic patients, 370 cases of acute coronary syndrome among 7323 diabetic patients. This result is consistent with the results of the study conducted in Poland by [39].

According to our research, those with diabetes had greater LDL than people without the disease. Furthermore, patients with diabetes have lower HDL than people without the disease. Numerous studies have connected diabetes mellitus to a reduction in the activity of the antioxidant system, as well as an increase in reactive oxygen species production[40, 41]. Increased oxidative stress hastens the development of atherosclerosis and raises the risk of cardiovascular events by triggering inflammatory responses, endothelial dysfunction, thrombogenic propensity, plaque instability, and the migration, proliferation, and transformation of smooth muscle cells [42]. Elevated plasma cholesterol, TG, or both are signs of dyslipidemia, as are low HDL or LDL levels. A well-known possible risk factor for atherosclerotic cardiovascular disease, which includes ischemic heart disease and cerebrovascular illnesses like strokes, is dyslipidemia [43].

We find that RBS in diabetes patients is higher than in non-diabetic patients. FBS in diabetes patients is higher than in non-diabetic patients. HbA1c in diabetes patients is higher than in non-diabetic patients. The HbA1c test measures chronic hyperglycemia levels, which are connected to the risk of diabetes complications. With the permission of many diabetic organizations throughout the world, this test may now be used to diagnose and screen for diabetes [44]. Through enhancing glycemic control and reducing the risk of cardiovascular disease (CVD), diabetes treatment primarily attempts to postpone the development of disease complications and slow down its course [45, 46].

This study's outcome showed that ACS Diabetic and Non-Diabetic Patients' outcomes recorded 7 (9.1%) deaths. CVD kills 50-80% of all diabetics, with cerebrovascular illness and renal failure also among the primary causes of mortality [47, 48]. T2DM is a well-known cause of disability and early mortality, mostly through CVD and other chronic consequences [49]. Some studies recorded that the significant co-prevalence of hypertension (54.5%) and diabetes mellitus in our ACS cohort underscores a critical cluster of synergistic cardio metabolic risk factors, a pattern consistently observed in other settings [50]. This concurrence is not merely additive; evidence suggests their combined pathological impact on vascular and renal systems is greater than the sum of their individual effects, accelerating atherosclerosis and complicating disease management [51, 52]. While hypertension is a potent risk factor, its high prevalence in our population is contextualized by local data indicating a substantial burden of hypertension among individuals with type 2 diabetes in Dhamar [53]. Therefore, the interaction between conditions needs integrated management strategies targeting this risk factor cluster in Yemen's resource-constrained setting.

5. Conclusions

This study concludes that there is a substantial correlation between Type 2 Diabetes Mellitus (T2DM) and Acute Coronary Syndrome (ACS), with a high incidence of T2DM in the studied group leading to higher mortality, increased healthcare costs, and systemic sequelae. Hyperlipidemia and poor glycemic control were found to be the most important modifiable factors for the development of ACS in diabetic patients. Other risk factors included age, male gender, hypertension, overweight, sedentary lifestyle, lower educational levels, and irregular diabetes monitoring. The unusual presentation of ACS in diabetic individuals is a major clinical problem that highlights how diabetes worsens the prognosis of ACS and increases the chance of misdiagnosis. Proactive management is therefore crucial, including routinely screening lipid profiles and HbA1c, maintaining a high clinical suspicion for ACS by carefully assessing the patient's history and any non-classical symptoms at the time of diagnosis, and providing regular medical follow-up for all diabetic patients.

List of Abbreviations

Term	The Meaning
ACS	Acute Coronary Syndrome
AGEs	Advanced Glycation End Products
AHA	American Heart Association
BMI	Body Mass Index
CAD	Coronary Artery Disease
CKMB	Mb Fraction of Creatine Kinase
CVD	Cardiovascular Disease
DM	Diabetes Mellitus
ECG	Electrocardiogram
FBS	Fasting Blood Sugar
HbA1c	Hemoglobin A1c
ICRC	International Committee of The Red Cross
IDF	International Diabetes Federation
IHD	Ischemic Heart Disease
MI	Myocardial Infarction
N-STEMI	Non-ST Segment Elevated Myocardial Infarction
PCI	Percutaneous Coronary Intervention
SPSS	Statistical Package for Social Sciences
STEMI	ST Segment Elevated Myocardial Infarction
T1DM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
UA	Unstable Angina
WHO	World Health Organization

Ethical Approval

Ethical approval was obtained from the deanship of the Thamar University Institute for Continuing Education (2021-12-25), in addition to obtaining approval from human resources in health facilities.

Subject Consent

Verbally informed consent was obtained from the parents or legal guardians of all participating children after a full explanation of the study's purpose and procedures. Participation was voluntary, and consent was reaffirmed prior to data collection. All collected data were anonymized and used solely for research purposes.

Data Availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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