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ORIGINAL

EVALUATING THE RISK FACTORS OF SEVERE ARRHYTHMIA IN ATHLETES WITH CORONARY HEART DISEASE AND DIABETES MELLITUS: THE ROLE OF LIPID METABOLISM DISORDERS

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ABSTRACT

Background: Athletes with coronary artery disease (CAD) and diabetes mellitus (DM) are particularly susceptible to severe arrhythmias, which can significantly impair their physical performance and psychological well-being. Identifying and managing risk factors for arrhythmias in this population is crucial for maintaining their health and athletic longevity. **Objective:** To investigate the risk factors for severe arrhythmia among athletes with CAD and DM, focusing on the association with lipid metabolism disorders. **Methods:** This study involved 120 athletes hospitalized with CAD complicated by diabetes from August 2020 to August 2022. Participants were divided based on the presence of arrhythmias as detected by dynamic electrocardiograms into an arrhythmia group (n=41) and a non-arrhythmia group (n=79). We analyzed general demographic data, glucose metabolism indices, and lipid profiles, and conducted univariate and multivariate analyses to explore the relationships between these variables and the occurrence of arrhythmias. **Results:** Of the participants, 34.17% experienced arrhythmias, primarily atrial extrasystoles and sinus tachycardia. Significant risk factors for arrhythmias included older age, a longer duration of diabetes, higher systolic blood pressure, and poor glycemic control as indicated by higher levels of fasting insulin, glycosylated hemoglobin (HbA1c), and the insulin resistance index (HOMA-IR). Lipid metabolism also played a role, with arrhythmic athletes displaying higher levels of high-density lipoprotein cholesterol (HDL-C). Logistic regression showed that age, duration of DM, systolic blood pressure, HbA1c, HOMA-IR, and HDL-C

levels were significant predictors of arrhythmias. **Conclusion:** Athletes with CAD and DM exhibit a heightened risk of severe arrhythmias influenced by multiple factors including glycemic and lipid control. Proactive management of these parameters is essential to minimize arrhythmic risks and support the health and performance of athletes with chronic conditions. Enhanced understanding and intervention strategies are vital for clinicians working with this unique population to ensure optimal outcomes both on and off the field.

KEYWORDS: Critical Medicine; CHD; DM; Arrhythmia; Lipid Metabolism Disorder

1. INTRODUCTION

The Unique Cardiac Challenges in Athletes with Chronic Conditions Athletes are typically celebrated for their exceptional physical capabilities and resilience, but underlying chronic conditions like coronary artery disease (CAD) and diabetes mellitus (DM) present unique challenges that can severely impact their performance and overall health. While the general population is vulnerable to the health detriments these diseases cause, athletes face the added risk of how these conditions can drastically influence their professional capabilities and longevity in sports(Malakar et al., 2019). For athletes, even minor cardiac irregularities, which might be less significant in non-athletes, can lead to serious consequences due to the high demands placed on their cardiovascular system during training and competition(Katsiki, Kotsa, Stoian, & Mikhailidis, 2020).

In athletes with concurrent CAD and DM, the risk of developing severe arrhythmias is significantly heightened(Duggan, Peters, Trachiotis, & Antevil, 2022). These arrhythmias are not just simple heartbeat irregularities; they are potentially life-threatening conditions that can cause sudden cardiac arrest during physical exertion(Fox, Metra, Morais, & Atar, 2020). The risk is compounded by the metabolic and vascular complications associated with diabetes(Arnold et al., 2020), which can exacerbate the underlying coronary artery disease, leading to deteriorations in cardiac function and rhythm(Fernandes et al., 2021).

Exploring the Link Between Cardiac and Metabolic Health The interplay between lipid metabolism disorders and cardiovascular health is well-established in clinical medicine(Bhosle, Chandekar, & Alimuddin, 2022; Pepera, Tribali, Batalik, Petrov, & Papathanasiou, 2022). For athletes, efficient energy utilization and metabolic health are crucial; disruptions in these areas, particularly lipid metabolism as seen in diabetic conditions, can exacerbate the formation of atherosclerotic plaques(Castiglione & Odening, 2020; Yurista, Silljé, Rienstra, de Boer, & Westenbrink, 2020).

These changes increase the risk of coronary events and arrhythmias by

compromising blood flow and heart rhythm stability, which are critical during high-intensity physical activity(Sinamaw et al., 2022). This study aims to explore and analyze the multiple risk factors contributing to severe arrhythmias in athletes suffering from CAD and DM, with a special focus on the role of lipid metabolism disorders(Heindl, Iskandrian, & Hage, 2021). Understanding these relationships is crucial for developing targeted strategies that address the specific needs of athletes, potentially aiding in the prevention and management of arrhythmias in this high-risk group.

By examining a cohort of 120 hospitalized athletes diagnosed with CAD and diabetes, this research intends to isolate and identify the unique triggers and underlying mechanisms contributing to arrhythmias in this specific population(Tomlinson, Patil, Fok, & Lam, 2021). Variables such as the insulin resistance index, glycosylated hemoglobin levels, and detailed lipid profiles are meticulously analyzed to establish their correlations with arrhythmic incidences(Ata & Abanoz, 2021). The implications of this research are broad and significant, extending from enhancing individual athlete care to influencing overarching training and health management protocols.

By identifying how arrhythmias manifest in athletes with CAD and DM, sports medicine practitioners can tailor more effective treatment plans and preventive strategies, thus safeguarding athlete health and optimizing their performance capabilities(Semczuk-Kaczmarek, Rys-Czaporowska, Platek, & Szymanski, 2021). (Sadlonova et al., 2022). Ultimately, this study not only aims to enhance our understanding of the complex interactions between chronic cardiac and metabolic conditions in athletes but also seeks to foster advancements in therapeutic and management strategies within sports medicine.

2. Materials and Methods

2.1 General Information

During August 2020 to August 2022, 120 patients with CHD complicated with diabetes cured in our hospital were enrolled as subjects, including 68 men and 52 women. They aged 33 to 89 years, with an average of (69.27 ±9.33) years. A list of the general characteristics of the patients is shown in Table 1, and the study has been approved by the hospital's ethics committee.

Inclusion criteria: (1) all patients in the group were clearly diagnosed as CAD complicated with diabetes (Arnett et al., 2019; Jarvie et al., 2019); (2) patients aged 18 to 85 years old, regardless of sex; (3) patients with complete clinical data.

Exclusion criteria: (1) patients with malignant tumor; (2) patients with

cardiovascular and cerebrovascular diseases, severe hepatorenal insufficiency and blood coagulation dysfunction; (3) patients with history of drug abuse or alcohol dependence; (4) patients with severe infectious diseases; (5) patients with severe mental diseases; (6) patients had participated in other clinical researchers at the same time. Calculation formula of sample size:

$$n_1 = \frac{\left[z_{\alpha/2}\sqrt{p(1-p)(1+c)/c} + Z_{\beta}\sqrt{p_1(1-p_1)+p_2(1-p_2)/c}\right]^2}{(p_1-p_2)^2}$$

A bilateral alpha of 0.05 and a beta of 0.2 were taken and parameters were set using the incidence of severe arrhythmias as an index of effect. p1=0.94 and p2=0.74. After calculation, the total sample size should be 109 cases, which should include 120 patients based on a 10% shedding rate.

2.2 Treatment Methods

(1) The general clinical data, glycemic and lipid metabolic indices, including age, sex, smoking, and body mass index (BMI), duration of diabetes, underlying disease, years of education, systolic and diastolic blood pressure were recorded for all patients on admission. TG, TC, LDL-C, HDL-C, FBG, insulin resistance index (HOMA-IR), fasting insulin levels (FINS), and glycated hemoglobin (HbA1C) were also collected and recorded.

(2) On admission, the patient underwent a 24-hour uninterrupted electrocardiogram (BMS Century 300012 lead dynamic ECG analyzer, USA) to record the occurrence and type of arrhythmias after admission, and the diagnostic criteria for arrhythmias were referenced in the literature (Al-Khatib et al., 2018). Specific types included supraventricular arrhythmias (atrial extrasystole, atrial fibrillation, atrial tachycardia, junctional tachycardia, ST, sinus bradycardia), ventricular arrhythmias (ventricular extrasystole, ventricular tachycardia or ventricular fibrillation), conduction block (atrioventricular block or ventricular block). The criteria of arrhythmias included in the study referred to the literature, including junctional arrhythmia, ventricular extrasystole or atrial extrasystole are paired or synchronized, or frequent, with an average frequency of > 5 / min; sinus tachycardia > 100 / min, persistent 30min > 55 / min, and persistent above 30min (Arnold et al., 2020; Fox et al., 2020). The duration of atrial tachycardia and ventricular tachycardia was at least 20min. Atrial fibrillation or ventricular fibrillation could be diagnosed as soon as it has occurred, regardless of how long it has persisted. According to ECG examination during hospitalization, the patients were classified into arrhythmia group (n=41) and non-arrhythmia group (n=79). The general data and related laboratory indexes were compared. (3) HbA1c% > 27% was the unqualified group; and FBG > 5.9 mmol/L was the substandard group (Khrema, Saad, Alnesser, & Capapé, 2022).

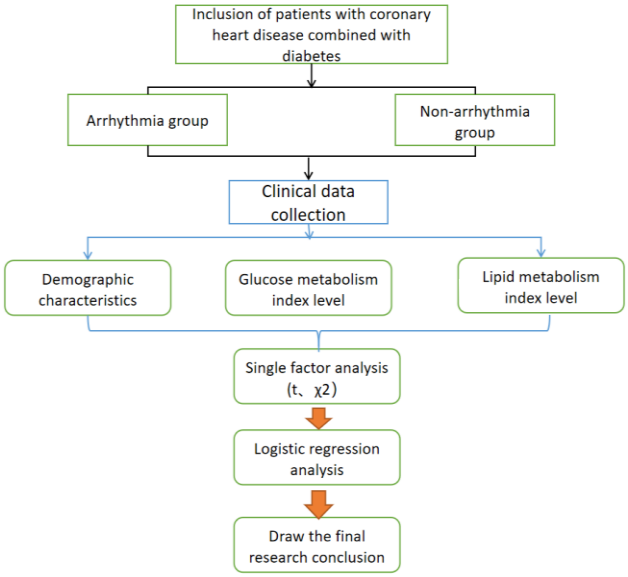

Figure 1: Research Roadmap

2.3 Statistical Analysis

Statistical software SPSS22.0 was used to analyze measurement data with a normal distribution and uniform variance expressed by ($\bar{x} \pm s$). Based on independent sample t tests, the comparison between groups was made. The counting data was presented by [n (%)], and the data was processed by χ 2 test. In correlation factor analysis, numerical variables were analyzed using multiple linear regression and binary variables were analyzed using logistic regression. P<0.05 was statistically remarkable.

3. Results

3.1 Types of Arrhythmias in Patients with Arrhythmia

Among the 120 patients included in this study, 41 patients had arrhythmias, and the incidence of arrhythmias was 34.17%. The main type of arrhythmia in the arrhythmia group was atrial extrasystole, followed by ST. Table 1 of 120 patients included in this study, 41 patients developed arrhythmias and the incidence of arrhythmias was 34.17%. The main type of arrhythmias in the arrhythmia group was atrial extrasystole, followed by ST (Table 1).

Table 1(a): Types of arrhythmias in patients with arrhythmia（n/%）

	TYPES	N	PERCENTAGE（%）
SUPRAVENTRICULAR ARRHYTHMIA	Atrial premature contraction	12	29.27
	Atrial fibrillation or atrial flutter	4	9.76
	Atrial tachycardia	2	4.88
	Junctional arrhythmia	3	7.32
	Sinus tachycardia	10	24.39
	Sinus bradycardia	3	7.32

Table 1(b): Types of arrhythmias in patients with arrhythmia（n/%）

	TYPES	N	PERCENTAGE（%）
VENTRICULAR ARRHYTHMIA	Ventricular premature beat	3	7.32
	Sinus tachycardia or ventricular fibrillation	1	2.44
CONDUCTION BLOCK	Atrioventricular block	2	4.88
	Intraventricular conduction block	1	2.44

3.2 Comparison of General Data of Patients

According to the results of dynamic electrocardiogram examination during hospitalization, 120 patients were classified into arrhythmia group (n=41) and non-arrhythmia group (n=79). Compared with the non-arrhythmia group, the arrhythmia group had older age, higher proportion of smoking, longer course of diabetes and higher systolic blood pressure (P<0.05, Table 2).

Table 2: The general data of patients

GROUPING	ARRHYTHMIA GROUP（N=41）	NON-ARRHYTHMIC GROUP（N=79）	*T/X2*	*P*
AGE (YEARS)	62.03±10.78	54.32±11.09	*3.646*	*<0.05*
GENDER（n/%）			*0.008*	*>0.05*
MALE	23（56.10）	45（56.96）		
FEMALE	18（43.90）	34（43.03）		
BMI（kg/m²）	24.56±2.37	24.19±2.28	*0.832*	*>0.05*
SMOKING（n/%）			*22.412*	*<0.05*
YES	24（58.54）	13（16.46）		
NO	17（41.46）	66（83.54）		
THE COURSE OF DIABETES IS MORE THAN 5 YEARS			*16.573*	*<0.05*
YES	26（63.41）	20（25.32）		
NO	15（36.59）	59（74.68）		
SYSTOLIC BLOOD PRESSURE（mmHg）	138.05±19.48	130.44±18.19	*2.121*	*<0.05*
DIASTOLIC PRESSURE（mmHg）	77.32±12.31	76.29±10.24	*0.487*	*>0.05*
MERGE COPD（n/%）			*2.880*	*>0.05*
YES	8（19.51）	7（8.86）		
NO	33（80.49）	72（91.14）		
COMPLICATED WITH CEREBROVASCULAR DISEASE			*1.097*	*>0.05*
YES	10（24.39）	13（16.46）		
NO	31（75.61）	66（83.54）		
NUMBER OF YEARS OF EDUCATION (YEARS)	9.66±1.27	9.58±1.30	*0.322*	*>0.05*

3.3 The Glucose Metabolism Indexes

No remarkable difference was found in FPG level (P>0.05). FINS, HbA1c and HOMA-IR values of patients with arrhythmia were remarkably higher compared to patients without arrhythmia (P<0.05, Fig.2).

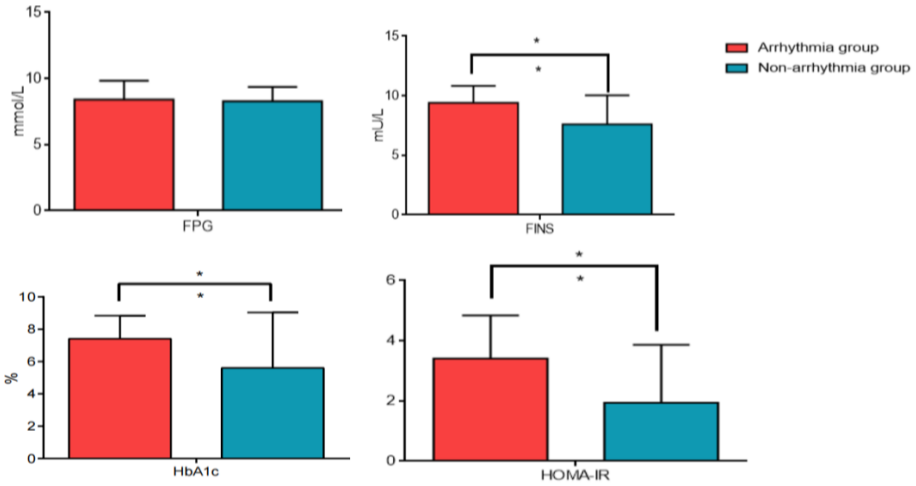

Figure 2: The glucose metabolism indexes

3.4 The Lipid Metabolism Indexes

No remarkable difference was found in TC, TG and HDL-C levels (P>0.05). The level of HDL-C in arrhythmia group was remarkably higher compared to non-arrhythmia group (P<0.05), as shown in Table 3.

Table 3: The lipid metabolism indexes（$\bar{x} \pm s$，mmol/L）

GROUP	N	TC	TG	LDL-C	HDL-C
ARRHYTHMIA GROUP	41	5.43±0.94	2.13±0.38	3.29±0.55	1.19±0.41
NON-ARRHYTHMIC GROUP	79	5.18±1.09	2.09±0.35	2.28±0.61	1.24±0.35
T		1.247	0.577	8.889	0.699
P		＞0.05	＞0.05	＜0.05	＞0.05

2.4 Analysis of Multiple Factors Affecting Severe Arrhythmia in Patients with CHD Complicated with DM

We take the statistically remarkable factors of univariate analysis as independent variables and the occurrence of arrhythmia (yes=1, no=0) as dependent variables. The specific assignment table is shown in Table 3, which is substituted into logistic regression model for multivariate analysis. The results indicated that age, duration of diabetes, systolic blood pressure, HbA1c level, HOMA-IR and serum HDL-C were all risk factors for severe arrhythmia in patients with CHD complicated with diabetes (P<0.05). In Tables 4 and 5, you can see all the results.

Table 4: The influencing factors of severe arrhythmia in patients with CHA complicated with DM

RELATED FACTORS	VARIABLE NAME	VARIABLE ASSIGNMENT
AGE	X_1	＞65 years old=1，≤65 years old =0
COURSE OF DIABETES MELLITUS	X_2	＞years =1，≤years =0
SYSTOLIC BLOOD PRESSURE	X_3	Actual value
HBA1C	X_4	Yes =1，No =0
HOMA-IR	X_5	Actual value
HDL-C	X_9	Actual value

Table 5: The logistic regression analysis of severe arrhythmias in patients with CHA complicated with DM

VARIABLE	B	S.E.	Wald X^2	P Value	OR Value（95%CI）
AGE	0.324	0.129	6.308	0.012	1.383（1.074-1.780）
COURSE OF DIABETES MELLITUS	0.818	0.211	15.209	0.000	2.266（1.498-3.427）
SYSTOLIC BLOOD PRESSURE	0.903	0.258	12.250	0.000	2.467（1.488-4.091）
HbA1c	0.512	0.177	8.367	0.004	1.669（1.179-2.361）
HOMA-IR	-0.791	0.101	61.335	0.000	0.453（0.372-0.553）
HDL-C	0.673	0.244	7.608	0.006	1.960（1.215-3.162）

3.5 Univariate Analysis of Blood Glucose Control Level and Lipid Metabolism Disorder in Patients with CHA Complicated with DM

According to the control level of HbA1c and FBG, the patients were classified into standard group and non-standard group, of which 51 cases reached the HbA1c standard and 69 cases failed to reach the standard. There were 56 cases of FBG reaching the standard and 64 cases of FBG failing to meet the standard. The levels of TC and TG of FBG failing to meet the standards were remarkably higher than those of FBG meeting the standards ($P<0.05$). In Table 6, you can see all the results.

Table 6(a): Univariate analysis of blood glucose control level on lipid metabolism disorder in patients with CHA complicated with DM

BLOOD GLUCOSE INDEX	GROUPING	TC	TG	HDL-C	LDL-C
HbA1c	Reach the standard	4.21±0.83	1.38±0.71	1.18±0.21	2.31±0.68
	Not up to the standard	4.78±1.24	1.81±1.14	1.23±0.35	2.62±1.03

Table 6(b): Univariate analysis of blood glucose control level on lipid metabolism disorder in patients with CHA complicated with DM

BLOOD GLUCOSE INDEX	GROUPING	TC	TG	HDL-C	LDL-C
FBG	Reach the standard	4.09±1.03	1.23±0.66	1.26±0.25	2.31±0.82
	Not up to the standard	4.66±1.29*	1.85±1.09*	1.21±0.34	2.66±0.81

Note: *Compared with the standard group, * P<0.05 variables have been adjusted by sex, age, BMI and course of disease. In order to avoid collinearity, all indicators are separately included in the model.*

3.6 Multi-Factor Linear Regression Analysis of the Effect of Blood Glucose Control on Lipid Metabolism Indexes such as TC, TC, HDL-C and LDL-C

After adjustment of sex, age, BMI and course of disease, TC [HbA1c (β = 0.423, 95% CIRV 0.071-0.977); FBG (β = 0.529, 95% CIRIA 0.083-0.981)], TGC [HbA1c (β = 0.471, 95% CIRAL 0.081; 0.853); FBG (β = 0.473, 95% CIRER 0.092; 0.877)] and LDL-C [HbA1c (β = 0.039, 95% CIRIA 0.081)] with the increase of HbA1c and FBG index. The level of FBG (β=0.287, 5.95%, 0.031, 0.742) indicated an upward trend (P<0.05), and had no remarkable effect on HDL-C (Table 7).

Table 7: Multi-factor linear regression analysis of the effect of blood glucose control on lipid metabolism indexes such as TC, TC, HDL-C and LDL-C

BLOOD LIPID INDEX	HbA1c			
	β	95%CI	*t*	*P*
TC	0.423	0.071，0.977	2.319	0.027
TG	0.471	0.081，0.853	2.401	0.013
HDL-C	0.039	-0.067，0.166	0.823	0.315
LDL-C	0.315	-0.038,0.681	1.805	0.076
TC	0.529	0.083，0.981	2.377	0.018
TG	0.473	0.092，0.877	2.351	0.012
HDL-C	-0.013	-0.124,0.092	-0.293	0.728
LDL-C	0.287	0.031，0.742	2.158	0.039

4. Discussion

Coronary heart disease (CHD) and diabetes are common clinical diseases, in which diabetes can increase the risk of cardiovascular and cerebrovascular diseases, while hyperglycemia can induce oxidative stress and endothelial cell dysfunction. The American Heart Association (AHA) pointed out in 1999 that type 2 diabetes is essentially a CAD, and the National cholesterol Education Program Adult treatment guidelines regard diabetes as a risk

condition such as CHD. Therefore, there is a close relationship between type 2 diabetes and CAD, and the risk of arrhythmia is remarkably increased. At present, the reports on the incidence of arrhythmias in patients with CHD complicated with CHD are not consistent. This study has shown that 41 of 120 hospitalized patients with CHD complicated with diabetes develop arrhythmias, with an incidence of 34.17% (Jungen et al., 2019). In addition, atrial extrasystole was the main arrhythmia in this study, followed by ST. On the one hand, the main reason for the difference may be the difference in sample size, and the second is that the basic condition and blood glucose control of patients are not consistent. The pathophysiological basis of arrhythmias in diabetic patients may be (1) abnormal glucolipid metabolism in type 2 diabetic patients leading to microangiopathy and cardiomyopathy (Tleyjeh et al., 2021), as well as focal myocardial fibrosis, affecting the cardiac conduction system of the heart; and (2) enhanced polyol bypass metabolism and microangiopathy can induce diabetic neuropathy in type 2 diabetic patients (Fernandes et al., 2021; Neuen et al., 2022; Viigimaa et al., 2020). The sympathetic nerve is excited and the vague nerve activity is decreased. The imbalance between the two will cause abnormal heart rate and conduction and increase the risk of arrhythmia. The abnormal glucose and lipid metabolism in diabetic patients with a long course of disease will aggravate the damaging effect of coronary vascular endothelial cells, accelerate the process of atherosclerosis, aggravate myocardial ischemia, and cause the ECG activity of cardiomyocytes to be in an unstable state, which is easy to induce arrhythmia. In addition, the abnormal glucose metabolism can accelerate left ventricular hypertrophy, while patients with left ventricular hypertrophy can compensate for increased heart rate due to decreased cardiac function, resulting in tachycardia cardiomyopathy. In this study, logistic regression analysis indicated that age, course of diabetes, systolic blood pressure, HbA1C, HOMA-IR, LDL-C and other factors were independently correlated with arrhythmias. Elderly patients have deterioration in the function of various tissues and organs throughout the body, increased myocardial fibrosis and reduced heart pump function, coupled with many cardiovascular complications, predispose them to arrhythmias. Patients with CAD complicated by diabetes have a certain degree of myocardial ischaemia, which is easily aggravated by abnormalities such as poor glycaemic control and blood glucose fluctuations, and even myocardial infarction, increasing the risk of arrhythmias (Barillas-Lara et al., 2021). An important pathophysiological basis for uremia is HOMA-IR, which is also an independent risk factor for CAD. the incidence of arrhythmias is higher in hypertensive patients with high HOMA-IR. It is hypothesized that insulin resistance can exacerbate left ventricular hypertrophy and indirectly induce arrhythmias by affecting myocardial electrophysiological activity through glucose and lipid metabolism (Shimizu et al., 2020). HbA1C effectively reflects a patient's average blood glucose concentration over 8-12 weeks and is clinically considered the "gold standard" for glycemic control in diabetic patients. the higher the HbA1C, the poorer the overall level of glycemic

control, the more severe the abnormalities in glucose metabolism and the greater the probability of cardiac arrhythmia. Diabetes causes microangiopathy and autonomic neuropathy in greater severity the longer it is present. In addition, the higher the proportion of metabolic syndrome, hypertension, and diabetes in these patients, the greater the risk of arrhythmia. Related studies have analyzed the risk factors for CHD in diabetic patients. The results indicated that it was closely relevant to the abnormal expression of blood glucose, blood lipids and other indexes. This study found that the change of serum LDL-C level is closely related to the occurrence of arrhythmia in patients with CHD complicated with DM. This may be because the body is in a state of hyperglycemia for a long time, resulting in vascular endothelial cell damage, when platelet activity increases and lipid metabolism disorders are formed, so TC, TG, LDL-C and HDL-C all show abnormalities. Excessive increases in lipid metabolism levels promote disease progression, exacerbate coronary artery involvement, lead to increased cardiac load and increase the risk of cardiac arrhythmias (Hallstroem et al., 2019). The disorder of lipid metabolism is one of the common complications in the occurrence and development of diabetes, which can be called "lip toxicity" and is an important factor in the pathogenesis of diabetes. The excessive accumulation of lipids in the body promotes the development of insulin resistance, which leads to disorders of glucose metabolism, and abnormal lipid metabolism is the "trigger" for disorders of glucose metabolism. T2DM patients are often accompanied by the increase of TG, LDL and TC, the decrease of HDL-C, the increase of LDL-C or normal (Bolat, 2020). High triglyceride is considered to be the decisive factor of dyslipidemia in diabetes. In this study, after adjustment for gender, age, BMI, and duration of disease, there was an increasing trend in TC, FBG, TGC, FBG, LDL-C, and FBG levels with increasing HbA1c and FBG indices, while there exhibited no remarkable effect on HDL-C. In insulin-resistant patients, the liver overproduces LDL-C and the intestine produces celiac particles, both of which are enriched in TG (Sakr et al., 2021). The production, release, and activity of lipoprotein lipase (LPL) is dependent on insulin. Inadequate insulin action and insulin resistance in diabetic patients result in a restriction in the synthesis and activity of LPL (Cherneva, Youroukova, & Cherneva, 2022). LPL is the main enzyme that hydrolyses high TG. As a result of reduced insulin action, the hydrolysis of TG is slowed down, which directly leads to increased levels of TG in the blood and a decrease in TG-produced off-sheet material. This study has some limitations, such as the sample size is small and comes from a single center, so there is a certain bias.

5. Conclusion

This study has provided crucial insights into the complex interplay between coronary artery disease (CAD), diabetes mellitus (DM), and severe arrhythmias in athletes, emphasizing the significant role of lipid metabolism disorders in this dynamic. By meticulously analyzing a cohort of 120 athletes

with CAD and DM, we have identified several key risk factors that contribute to the heightened incidence of severe arrhythmias in this population. These findings highlight the critical need for specialized management strategies tailored to athletes' unique physiological demands. The evidence suggests that factors such as age, duration of diabetes, systolic blood pressure, levels of glycosylated hemoglobin (HbA1c), insulin resistance (HOMA-IR), and lipid profiles, particularly HDL-C, are significant predictors of arrhythmic events in athletes. This association underscores the importance of rigorous, continuous monitoring and management of these parameters to mitigate the risks associated with arrhythmias. Moreover, the study's outcomes advocate for an integrated approach in the healthcare of athletes, involving collaboration among cardiologists, endocrinologists, and sports medicine specialists. This team approach is essential for developing comprehensive care plans that address both the metabolic and cardiovascular aspects of athlete health. The research also prompts a reconsideration of current guidelines and training practices for athletes with CAD and DM. There is a clear need for protocols that not only focus on optimal physical training and performance but also prioritize cardiovascular and metabolic health to prevent the onset of severe complications such as arrhythmias. Future research should aim to expand upon these findings by exploring intervention studies that assess the efficacy of specific treatment modalities in preventing arrhythmias in athletes with CAD and DM. Additionally, longitudinal studies could provide deeper insights into the long-term outcomes of these athletes, further refining management strategies. In this study reinforces the notion that athletes with chronic conditions require a nuanced approach to healthcare that goes beyond general medical guidelines. Tailored strategies that focus on precise monitoring and management of risk factors associated with CAD and DM are crucial in sustaining not only the athletic careers but also the overall quality of life of these individuals. The ultimate goal is to enable athletes to continue their sports endeavors safely while managing their chronic health conditions effectively.

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