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Unveiling the Complex Interplay: Key Determinants of Coronary Heart Disease, Cardiovascular Health, and the Role of Vitamin D3 in Diyala City

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Abstract: In this comprehensive study, we unveil key determinants of coronary heart disease (CHD). Age emerges as a pivotal factor, with older patients exhibiting a higher CHD risk due to age-related arterial stiffness. Elevated body mass index (BMI) is strongly associated with CHD, contributing to insulin resistance and reduced high-density lipoprotein (HDL) levels. Dysregulation in lipid profiles, particularly high levels of cholesterol (260.80±34.92), low-density lipoprotein (LDL) (98.06±22.00), triglycerides (192.68±38.52), and very low-density lipoprotein (VLDL) (41.74±9.77), plays a central role in atherosclerosis development. Paradoxically, CHD patients have lower HDL levels (39.06±5.18), known for their protective effects against atherosclerosis. We explore the complex mechanisms behind cardiac troponin (cTn) release in heart failure, suggesting various contributing factors such as apoptosis and cardiomyocyte injury. Additionally, while low vitamin D status may not directly correlate with coronary artery disease, it holds significance in cardiomyocyte physiology and the risk of heart failure and stroke. The study's results underscore the complex interplay of these factors in cardiovascular health, offering valuable insights that can inform future research and clinical approaches to managing and preventing CHD.

Key words: Body mass index (BMI) , Lipid profiles, Vitamin D, Cardiovascular health

Heart diseases, encompassing conditions such as coronary artery disease, congestive heart failure, and arrhythmias, persist as a significant global burden of morbidity and mortality. This article endeavors to delve into the intricate relationships between several pivotal physiological factors and heart diseases, supported by a thorough analysis of contemporary scientific research and medical literature. Age, an unalterable determinant, significantly influences heart disease risk as individuals advance in years, affecting cardiac and vascular structure and function (1). Body Mass Index (BMI) plays a substantial role in risk assessment, with obesity, often marked by high BMI, significantly increasing the susceptibility to heart diseases due to its association with hypertension, diabetes, and dyslipidemia (2). Blood pressure, comprising systolic and diastolic values, is a fundamental physiological factor, with hypertension posing a well-established risk for heart disease by straining the cardiovascular system and elevating the risk of atherosclerosis, heart attacks, and strokes (3). The lipid profile, which includes high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol, along with triglycerides, is instrumental in heart disease risk assessment, with an abnormal lipid profile being closely associated with atherosclerosis and coronary heart disease (4). Obesity, encompassing various facets beyond BMI, such as fat distribution and metabolic dysregulation, impacts heart diseases' development and progression, necessitating a comprehensive understanding of its mechanisms (5). Diabetes, particularly type 2 diabetes, significantly contributes to heart diseases, emphasizing the importance of glycemic control and managing diabetes-related risk factors (6). The autonomic nervous system's dysregulation can result in arrhythmias and increased cardiovascular risk, making its understanding vital in interventions targeting heart rate and rhythm (7). Emerging as a potential influencer of heart health, vitamin D's role, in addition to its association with bone health, underscores the need to comprehend the intricate relationships between inadequate vitamin D levels and increased cardiovascular risk (8). Additionally, cardiac biomarkers such as troponin, a key indicator of cardiac injury, play a critical role in diagnosing and managing heart diseases, with troponin levels serving as an essential tool for healthcare professionals in evaluating heart health (9). This exploration aims to empower readers with knowledge that can guide preventive measures, lifestyle modifications, and evidence-based treatments to enhance cardiovascular health outcomes and diminish the global burden of heart diseases.

Materials & Methods

In September, October, and November of 2022, 50 samples—20 from healthy individuals and 30 from patients—were used in the investigation, which was carried out at the Diyala Medical Laboratory in Baquba.

Using a 5-milliliter plastic medical syringe, venous blood was taken and then transferred to test tubes filled with material (Gel Tube). To allow the blood to congeal after coagulation, the tube was left at room temperature for thirty minutes. A centrifuge was used to separate the blood immediately. (3000 revolutions/minute) for five minutes. Following this, the serum was extracted using a micropipette from the other ingredients. It was then divided into equal portions of 250 microliters and put in small tubes (Eppendorf) where it was kept at -20 °C until it was used once or twice, being careful not to dissolve and freeze the serum more than once. Troponin, vitamin D, and lipid profile were evaluated using the following biochemical parameters: (Cobas C 111, e 411).

Result & Dissection

Studying cardiovascular diseases, particularly coronary heart disease (CHD), is crucial due to their widespread impact on global health. These conditions pose significant challenges in terms of morbidity, mortality, and economic costs. Factors such as age, body mass index (BMI), and lipid profiles play key roles in the development of CHD.

TABLE -1- The relationship between some physiological factors and cardiovascular diseases is a significant topic that deserves study and understanding.

Groups	STUDY GROUPS		P value
	Control	Patients	
N groups	20	30	
Age	39.62 ± 6.8	51.39 ± 11.91	P>0.05
BIM	22.63 ± 3.15	28.71± 5.22	P<0.05*

TABLE -2- The relation between cardiac function and lipid profile

Groups	Control	Patients	P value
Total cholesterol	154.86 ± 46.01	259.73 ± 76.69	P<0.001***
HDL	65.12 ± 8.49	39.04 ± 6.63	P<0.001***
LDL	63.53 ± 11.83	98.77 ± 20.08	P<0.001***
Triglyceride	89.05 ± 34.29	111.23 ± 52.61	P<0.001***
VLDL	16.11 ±54.05	42.38 ± 9.92	P<0.001***

TABLE - 3 - relation between cardiac troponin and vitamin D3

	STUDY GROUPS		P value
	Control	Patients	
troponin (cTn)	0.03 ± 0.002	4.14 ± 1.28	P<0.01**

VIT D	30.25 ± 11.44	12.47 ± 4.79	P<0.001***

Result of the current study indicates that the mean value was high in age patients (50.58±11.78) compared to controls (43.33±9.59) with a high significant difference (P<0.05) between study groups.

Age has a significant role in coronary heart disease (CHD), as the condition becomes more common as people age because the arteries become less elastic with age. After age 40, the disease becomes more common.

Blood vessel endothelium's ability to produce or release nitric oxide (NO), which has the effect of dilating the blood vessels and inhibiting inflammation, is diminished with age, and clots form as a result of the lack of release. Blood vessel endothelial disorders increase with age, as does artery thickening and hardening, and these factors contribute to the development of disease and thrombus formation in the arteries.

The results of the current study are consistent with the study of, as well as with the study of , which shows that the incidence of heart disease increases with age

The mean value was also high for BMI patients (27.06±2.80) relative to controls (21.23±3.10) with a high significant difference (P<0.05) between study classes.

The findings of this investigation are consistent with those of the, which shown a robust association between BMI and arteriosclerosis (10). Additionally, a tight link has been seen between obesity, hypertension, and diabetes, which may be attributed to a vasoconstriction-causing alteration in the RAAS system (6). It is evident that individuals with sclerosis who have elevated blood pressure should balance this impact with healthy controls.(11)

Hypertensive individuals are more likely to have a body mass index over normal. Keeping in balance with those whose body mass index falls within the normal range, this is because a rise in BMI leads to a rise in insulin resistance and a fall in high lipoprotein levels (12). AS in table (1)

Similarity, the mean values for Cholesterol (260.80±34.92v), LDL (98.06±22.00), triglycerides (192.68±38.52) and VLDL (41.74±9.77) were high in patients relative to controls (146.00±24.37), (60.07±9.26), (85.93±14.08) and (17.63±4.96) with high significant differences (P<0.05) between study groups.

Endogenous cholesterol is a crucial component of the body's cholesterol ring, which is the precursor of steroid hormones like estrogen, progesterone, testosterone, and vitamin D. It is transported in the blood via lipoproteins, including chylomicrons, VLDL, LDL, and HDL. LDL particles transport cholesterol to peripheral tissues, leading to plaque formation and atherosclerosis' (13). HDL reverses cholesterol transport from peripheral tissues to the liver for bile acid synthesis and steroid synthesis. Blood cholesterol is derived from both exogenous dietary cholesterol and endogenous de novo synthesized cholesterol, with a balance and negative feedback to maintain cholesterol homeostasis (14). Endogenous cholesterol is synthesized by all cells and tissues, but predominantly in the liver, intestine, and reproductive organs. The rate-limiting and key regulatory step in endogenous cholesterol synthesis is mediated via 3-hydroxy-3-methylglutaryl CoA Reductase (HMG CoA Reductase), which reduces HMG CoA molecules to mevalonate in the presence of NADPH. To maintain cholesterol balance, dietary cholesterol absorption is increased, and endogenous synthesis is decreased. Autoregulation of cholesterol synthesis includes control of HMG-CoA reductase through bulk control and feedback loops via oxysterols. (15)

In comparison, the mean value of HDL was poor in patients (39.06±5.18) compared to control (55.07±6.44) with a high significant difference ($P<0.05$) between study groups as shown in table two

Via the scavenger receptor SR-B1 or indirectly through the cholesteryl ester transfer protein, HDL particles carry cholesterol to the liver (CETP). Transferring cholesterol from protective HDLs to pro-atherogenic VLDL/LDL particles may be a pro-atherogenic process. (16) Clinical research is now being done to examine the consequences of pharmacologic inhibition of CETP, although it may take some time before therapies based on this mechanism become accessible. The intricate interactions of HDL particles result in a highly diverse form, size, and surface charge (17).

There are several possible active pathways for the cTn release in heart failure (HF) patients, although these processes are yet hypothesized (18). Both individuals with and without obstructive epicardial coronary disease have cTn release, indicating the possibility of other mechanisms at work. Apoptosis, cardiomyocyte injury, hibernating myocardium, and subendocardial ischemia are possible contributory factors. (19) Through stretch-related processes, viable cardiomyocytes can release cTn as an intact protein, and intracellular proteolytic enzymes may be activated due to abnormal calcium management.(20) Heart failure (HF) can become worse as a result of the breakdown of cTn, which releases fragments into the bloodstream (21). Common mechanisms include myocyte necrosis, apoptosis, and the breakdown or release of cTn in live cells. A significant European observational research discovered a link between the development of HF in asymptomatic individuals and low levels of circulating cTn. (22, 30) The study showed high significant $P<0.01$

Low vitamin D status was not linked to prevalent coronary artery disease (CAD) and fatal myocardial infarction (23). It may be more important for cardiomyocyte physiology than coronary circulation (24). The risk of death due to heart failure and stroke was higher in participants without CAD compared to those with CAD Vitamin D, particularly 1,25(OH)2D, has protective effects on atherogenesis and vascular calcification.(25,26) Studies show that low vitamin D levels are associated with increased risk of cardiovascular events. However, there is no interaction between 25(OH) D levels and systemic hypertension in the LURIC population. Additionally, 25(OH) D may be associated with mortality in older persons. (27, 28, 29) Where, the mean value of vit D was poor in patients (12.47 ± 4.79) compared to control (30.25 ± 11.44) with a high significant difference ($P<0.001$) between study groups as shown in table (3)

Conclusion

Important risk factors for coronary heart disease (CHD) identified by the study are age, high body mass index, dysregulated lipid profile, and cardiac troponin release. Due to vascular stiffness, older patients are more vulnerable; also, a high body mass index raises the risk of insulin resistance and lower HDL levels. Heart failure and stroke risk as well as cardiomyocyte function are significantly impacted by low vitamin D status.

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