Iraqi Journal of Biotechnology, 2025, Vol. 24, Special Issue 2, 246-256

Correlation Between NLRP3 Inflammasome Levels and Myocardial Infarction Diagnosis

[1]Zena Zmat Ghilan,[2] Noorhan Khalid Shafeeq

[1,2] Department of Chemistry/ College of Education, for pure Science (Ibn-Al-Haitham) University of Baghdad. Iraq

Received: February 20, 2025 / Accepted: May 5, 2025 / Published: November 16, 2025

Abstract:- Myocardial infarction (MI) is a prevalent disease and is expected to become the main cause of death globally in the future The pathophysiology of MI is tightly linked to the activation of the NLRP3 inflammasome. This study involves 60 subjects who were enrolled in the Intensive Care Unit (ICU) at Ibn Al-Bitar Center for Cardiac Surgery. Patients admitted to the ICU at Baghdad Teaching Hospital and Ibn Al-Bitar Cardiac Surgery Center were included in this study, conducted from November 26, 2023, to November 20, 2024. The control group also consisted of 60 subjects, In this study ,uric acid , urea , creatinine ,Glutamic Pyruvic Transaminase (GPT) Glutamic Oxaloacetic transaminase (GOT) , Gamma Glutamyl Transferase (GGT) ,NLPR3, NT-pro BNP , MYL2 and LRG1 were measured .The results showed a significant increase ($p \leq 0.05$) in age, weight ,BMI, SBP, DBP , uric acid , urea , Creatinine ,GPT , GOT , GGT ,TSB,NLPR3, NT-pro BNP , MYL2 and LRG1 and a significant decrease in height, also ,the results showed a significant positive correlations between NLRP3, BNP ,MYL2 LRG1 levels and uric acid , urea , Creatinine, GPT , GOT , GGT ,TSB in the MI group . In conclude ROC curve analysis demonstrates that all studied parameters (NLRP3, BNP, MYL, and LEU) are highly effective in distinguishing MI group from the control group, with perfect AUC values, statistically significant results, and high sensitivity and specificity. These findings highlight their potential as reliable biomarkers for diagnosing Myocardial Infarction.

Keyword: - Inflammasome, NLRP3 inflammasome, cardiovascular diseases, liver function, kidney function , Myocardial Infarction

Corresponding author : (Email: **noorhan.k.s@ihcoedu.uobaghdad.edu.iq)**

Introduction

Cardiovascular diseases (CVD) are one of the leading causes of death and morbidity worldwide.(1)cardiovascular disease. Coronary artery disease (CVD) encompasses a number of conditions, such as angina, myocardial infarction (MI), atherosclerosis, and stroke.(2)Ischemic heart disease, the most prevalent kind of cardiovascular disease (CVD), is the primary cause of death. The sensitivity of methods employed in modern laboratories to identify CVD and evaluate important traits known as CVD bio-indicators is increasing.(3)

Generally speaking, there are two categories of cardiovascular risk factors: modifiable and non-modifiable. Conditions including high blood pressure, diabetes, obesity, and inactivity are examples of modifiable levels. Risk factors that are unchangeable include age, gender, and a family history of cardiovascular disease.(4) The BAT algorithm's enhanced ensemble mechanism can be used to predict heart illnesses. It is well

known that the incidence of cardiovascular disease, particularly in places with low economic status, has a substantial impact on death rates globally (5) Myocardial infarction (MI) is a prevalent disease and is expected to become the main cause of death globally in the future. MI is described as myocardial cell death caused by persistent ischemia. The main functional effect of MI is the progressive deterioration of the left ventricle's pump function, which leads to heart failure. Furthermore, MI frequently results in fatal arrhythmias and electrical instability. Atherosclerosis of the coronary arteries is the primary cause of MI. In this condition, atherosclerotic plaques become unstable, burst, and allow thrombus formation, which leads to coronary artery obstruction and ultimately MI..(6) pathogen-associated molecular patterns (PAMPs) and damage-associated molecular patterns (DAMPs) cause the formation of large multicytoplasmic protein complexes called inflammasomes, which serve as platforms for caspase-1 activation. Apoptosis-associated speck-like protein with a caspase recruitment domain (ASC), the cysteine protease caspase-1, and one of the NLR family proteins are often found in the majority of inflammasomes.(7) NLRP3 is fellow to the family of NLR and plays an important role in increasing the production of inflammatory cytokine(8) A number of studies have revealed that inflammatory markers seem to be precursors of cardiovascular events, a major part of the pathogenesis of cardiovascular disease is inflammation.(9)

An inflammatory response triggered by reperfusion exacerbates the damage caused by a reduction in the blood flow to the tissue during an acute myocardial infarction. (10) By releasing IL-1β and encouraging inflammatory cell death through pyroptosis, activation of the NLRP3 inflammasome causes myocardial injury.(11) Inhibiting NLRP3 inflammasome activation during the early reperfusion phase reduces the overall infarct size and preserves normal cardiac function in animal models of myocardial ischemia–reperfusion injury. (12).

According to Van Tassell *et al*.,(13) IL-1 inhibition can help patients who have already had an acute myocardial infarction avoid having another one. In patients with heart failure, IL-1 blockage can enhance heart function and motor abilities while preventing heart failure.The pathophysiology of MI is tightly linked to the activation of the NLRP3 inflammasome. Increased ASC expression was seen in infiltrating cells, especially neutrophils and macrophages, in heart tissue samples from MI patients. Inflammasome component deficiency decreased inflammation and strengthened heart protection The NLRP3 inflammasome mediates pyroptosis, a type of programmed cell death that is essential to the development of MI. (14).

An analysis of cardiac tissues from MI patients revealed elevated expression of ASC and infiltration of inflammatory cells, indicating a potential role for the NLRP3 inflammasome in I/R damage. Myocardial I/R damage was originally linked to the inflammasome in 2011. (15) In mammalian striated muscle, three distinct genes encode the three primary isoforms of myosin light chain-2 (MYL2, often referred to as MLC-2). MYL2 belongs to the superfamily of EF-hand calcium binding proteins and is a sarcomeric protein with a molecular weight of about 19 kDa. Researchers are focusing on the regulatory functions

of MLC-2 in the embryonic and adult heart, specifically the phosphorylation-driven actions of MLC-2v in adult cardiac muscle, in order to obtain new insights into the mechanisms governing myosin cycle dynamics and human cardiac diseases. (16)Leucine α-2 glycoprotein-1 (LRG1), which is involved in signal transduction, is responsible for a number of diseases. Leucine-rich α2-glycoprotein 1 (LRG1), a member of the leucine-rich repeating family, was first isolated from human blood in 1977. It is made up of eight leucine-rich repetitions, the majority of which are 20–30 amino acid residues long.Based on omics data, metabonomics was a promising new biomarker for cardiovascular diseases. While LRG1 may be a potential serum biomarker for early onset myocardial infarction, a combined biomarker signature that included BNP (plasma brain natriuretic peptide) would be a more accurate predictor of heart failure than BNP alone.(17) This study investigate the correlation between NLRP3 inflammasome levels and myocardial infarction (MI) diagnosis, with the aim of assessing NLRP3 as a potential biomarker for identifying and understanding the pathophysiology of MI.

Subjects and Methods

This study is based on the 60 subjects enrolled in the in the intensive care unit that were recruited from Ibn Al-Bitar center for cardiac surgery. Patients admitted to the Baghdad Teaching Hospital's Intensive Care Unit, and Ibn Al-Bitar Cardiac Surgery Center were included in this study. for the period from 26/11/2023 t0 20/11/2024 and 60 subject as control croups. All patients and the control group were between the ages of 17 to 84 years. The excluded criteria included patients with Cancer and kidney failure patients. The study is approved by Training and Human Development Center in the Medical City Department and Baghdad Health Department / Karkh. All research procedures followed the directives of the Declaration of Helsinki.

Along with a control group of healthy people, blood samples were taken from MI patients. A 5 mL syringe was used to draw blood samples into a gel tube between 8 p.m. and 12 a.m., and they were then left to clot at room temperature. After that, we separated the serum by centrifuging the sample for 10 minutes at 5000 degrees per minute. About 2 mL was employed to ascertain the body mass index (BMI) (18),uric acid , creatinine ,Glutamic Pyruvic Transaminase (GPT), Glutamic Oxaloacetic transaminase (GOT) (19), urea (20), Gamma Glutamyl Transferase (GGT) (21).The leftovers were transferred to an Eppendorf tube and stored at -20 °C in a deep freezer in order to determine the quantities of NLPR3. (22) NT-pro BNP (23),MYL2 (24) and LRG1 (25) was measured using the Enzyme-Linked Immune Assay (ELIA) method by Ibn Al-Bitar Specialized Heart Center Laboratories Analysis of statistics The mean ± standard deviation was used to express the results. A t-test was used to compare the group differences' significance. Statistical significance was defined as a P-value of 0.05, whilst statistical non-significant was defined as a P-value of 0.05.

The relationship between the various parameters was examined, and it was described using the correlation coefficient (r). Statistical software for the social sciences (SPSS) version 23.0 and Microsoft Office 2010 were utilized in this work to compute the cutoff value, sensitivity, and specificity using a Receiver Operating Characteristics

(ROC) curve. When the p-value was less than 0.05, the findings were considered statistically significant.

Results and Discussion

Anthropometric and clinical features of the myocardial infraction (MI) and control groups in the study are listed in Table 1. There was a significant increase ($p \leq 0.05$) in age, weight , body mass index (BMI), systolic blood pressure(SBP), diastolic blood pressure (DBP), , a signif icant decrease ($p \leq 0.05$) in height in the MI group as compared to the control group.

Table (1): Anthropometric and clinical features of the MI and control group

Parameters	Means ± SD	Means ± SD	*p*-value
	MI (n= 60)	Control (n= 60)	
Age (years)	57.26±15.2	56.12±11.5	0.05
Height (cm)	165.1± 6.3	170.5±11.2	0.05
Weight (kg)	68.6±5.8	79.5±11.3	0.05
BMI (kg/m2)	26.38±0.5	27.39 ±1.2	0.05
SBP (mmHg)	160.79 ± 8.57	120.60 ± 2.44	0.001
DBP (mmHg)	92.17 ± 3.0	79.57 ± 2.34	0.001

$p \leq 0.05$: Significant, $p \leq 0.001$: high- Significant, $p \geq 0.05$ non-Significant

Due to its rising tendency in both developed and developing nations, obesity is a global health concern (26). obesity and metabolic syndrome is considered a risk factor for CAD(27). Obesity is increasingly common in the elderly (43% and 71%) in tandem with population aging, and the relationship between age and obesity is complicated and may differ by age group. There is relatively little information available about the possible relationships between age, body mass index, and outcomes in myocardial infarction patients undergoing percutaneous coronary intervention (PCI). (28) Age-related differences exist in the relationship between BMI and cardiovascular risk. While being somewhat overweight may be advantageous in old age, younger overweight persons may benefit from weight decrease.(29)

One risk factor, an atherogenic factor, and a hemodynamic factor for myocardial infarction is hypertension. Acute myocardial infarction is another situation in which it may occur. The heart is severely harmed by both of these disorders, which also significantly increase morbidity and mortality.(30) Among Iraqi ACS cases, MS is highly prevalent, while MI was substantially more common in men. (31)

Males and females experienced high diastolic blood pressure rates of 5% and 10.7%, respectively, while the corresponding rates for high systolic blood pressure were 6.7% and 2.9%. Overweight, normal weight,(31) when used under supervision, the low-level treadmill has been proven to be safe. It helps with patient care in the future and offers unbiased information regarding the patient's preparedness for discharge.(33)

Obesity is a major public health concern nowadays, as it is strongly linked to an increased risk of cardiovascular disease. Obesity-related hypertension is caused by the complex interplay of many processes, including poor pressure natriuresis, adipocyte dysfunction, incorrect SNS and RAAS activation, and physical kidney compression.(34)

The results of the study showed that modifiable risk factors, such as smoking, a lack of physical exercise, high blood pressure, being overweight,

and being obese, were much more common among male and female secondary school students in Sulaimani City. This poses a hazard to community health and reflects a concerning public health issue. Programs to raise awareness and promote health should be implemented. It is necessary to enhance ongoing monitoring for CVD risk factors and implement early identification and prevention initiatives.(32)

Table(2): kidney function of the MI and control groups

Parameters	Means ± SD	Means ± SD	p-value
	MI (n= 60)	Control (n= 60)	
Urea(mg/dL)	45.56±4.11	42.49±4.33	0.02
Creatinine (mg/dL)	1.29±0.28	0.88±0.15	0.02
Uric acid (mg/dL)	3.92±0.27	3.57±0.27	0.001

$p \leq 0.05$: Significant, $p \leq 0.001$: high- Significant, $p \geq 0.05$ non-Significant

To enhance the quality of life for individuals with coronary artery disease, especially those who have undergone percutaneous coronary intervention, a lifestyle modification program needs to be implemented.(35)

The heart and kidneys are primarily responsible for maintaining the proper blood pressure and fluid balance in the body. Under normal circumstances, the heart and kidneys work together to respond to variations in renal perfusion, such as overload or volume reduction, which can result in harm from hyper perfusion or ischemia.(36)

In contrast, a drop in one organ's function may be associated with a precipitous decline or chronic failure in another. Cardiomyopathic causes, such as myocardial infarction, left ventricular hypertrophy, and fibrosis, increase cardiac preload and afterload, resulting in volume and pressure overload, poor renal salt and water excretion, and inappropriate renin secretion.(36)

Acute alterations in kidney function biomarkers may arise from pharmacologic inhibition of neurohormonal pathways in patients suffering from acute myocardial infarction (MI).(37)

The glomerular filtration rate (GFR) is directly impacted by AMI, and it rapidly and significantly declines following the cardiac event. Due to abruptly decreased left ventricular function, some acute cardiovascular disorders can show clinically similarly to AMI.(38)

MI risk may increase due to impaired renal function. Further research and analysis are necessary. The findings' clinical implications the correlation between coronary artery disease and above-normal eGFR Arterial disease risk. The risk of MI with a parabolic shape is highly correlated with genetically predicted eGFR, indicating that renal function impairment, whether caused by decreased or supranormal eGFR, may be causally linked to an increased risk of MI. (39)

Table (3): Liver function of the MI and control groups

Parameters	Means ± SD	Means ± SD	*p*-value
	MI (n= 60)	control (n= 60)	
GGT(U/L)	51.10±5.01	184.83±30.20	≤ 0.001
GPT (U/L)	40.07±2.88	38.18±2.96	≤ 0.001
GOT (U/L)	0.97±0.25	28.45±8.70	≤ 0.001
TSB (mg/dL)	235.2Z±20.66	0.53±0.12	≤ 0.001

p ≤ 0.05: Significant, p ≤ 0.001: high- Significant, p ≥ 0.05 non-Significant

Ischemia, which results in myocardial necrosis and an imbalance in perfusion, is the cause of acute myocardial infarction (AMI), a global burden. Since the liver receives around 25% of the heart's overall output, hemodynamic abnormalities can affect it. Acute coronary syndrome (ACS) patients often show high levels of the liver enzymes alanine transaminase (ALT) and aspartate transaminase (AST), despite the fact that this ratio is a widely recognized indicator of liver disorders. Although myocardial damage is usually the cause, inadequate cardiac output and arterial hypoperfusion can also be to blame. There isn't many research on them, and their significance is usually underappreciated. Therefore, the purpose of this research is to ascertain the hepatic transaminase enzyme (AST and ALT) pattern in individuals who present with Assessing the value of liver and kidney function tests in forecasting the prognosis of individuals suffering from acute myocardial infarction (AMI) is the study's goal. The results confirmed that risk prediction in individuals with acute myocardial infarction could be influenced by hepatic and renal impairment.(40)

A prevalent cause of death and one that is linked to high mortality rates is myocardial infarction (MI). Myocardial infarction (MI) has become more common over time, despite improvements in diagnosis and treatment. Investigating new MI predictors is therefore essential Regardless of conventional variables, the risk of MI was elevated by metabolic dysfunction-associated steatosis liver disease (MASLD). In order to prevent MI, patients with MASLD must be closely monitored. Future studies should look into how active MASLD intervention can reduce the occurrence of MI. (41)

Patients with AMI who have chronic liver disease (CLD) are more likely to have poorer clinical outcomes and are less likely to obtain invasive treatment. Additional variations are noted based on the kind and severity of chronic liver disease.(42).

Numerous risk factors for cardiovascular disease, obesity, diabetes, and metabolic syndrome have been shown to activate the NLRP3 inflammasome and cause inflammation. Patients with coronary heart disease reported significantly increased serum levels of NLRP3, ASC, caspase-1, IL-1β, and IL-18 compared to healthy people.(43)

The nucleotide-binding domain leucine-rich repeat family The NLRP3 inflammasome complex regulates caspase-1 activation and subsequent IL-1β processing. Inflammasome complexes are activated in several inflammatory diseases.(44)

Table (4): Comparative the mean levels of NLPR3 , NT-proBNP ,MYL and LEU between the MI and control groups

Parameters	Means ± SD	Means ± SD	*p*-value
	MI (n= 60)	control (n= 60)	
NLPR3	6.24±1.29	2.38±0.68	≤0.0001
BNP	571.72±28.81	220.63±30.36	≤0.0001
MYL	4.30±1.42	1.61±0.66	≤0.0001
LRG1	120.71±25.76	37.13±4.28	≤0.0001

p ≤ 0.05: Significant, p ≤ 0.001: high- Significant, p ≥ 0.05 non-Significant

Reduced blood supply to the tissues is the primary cause of injury during an acute myocardial infarction (AMI). This is exacerbated by a significant and highly specialized inflammatory response that occurs during reperfusion. Several studies have indicated that the NACHT, LRR, and PYD domain-containing protein 3 (NLRP3) inflammasome plays an important role in this process. The inflammasome is a protein complex that regulates caspase 1 activation and the production of pro-inflammatory cytokines such as IL-1β and IL-18, making it a crucial part of the innate immune system. (45)

The expression of LRG1 is upregulated in human illnesses. These demonstrate the broad and pleiotropic function of LRG1 in illness.(23)

LRG1, a crucial upstream of the transforming growth factor-β (TGF-β) pathway, accelerates the development of atherosclerosis by promoting inflammation, pathological angiogenesis, and T helper (Th) 17 cell differentiation. By controlling hypoxia-inducible factor-1α (HIF-1α), LRG1 also contributes to hypoxia-induced cardiomyocyte apoptosis and autophagy. Because of its biological functions, current study has looked into how well LRG1 predicts the likelihood of cardiovascular events in high-risk groups. (49)

Metabonomic was a promising novel biomarker for cardiovascular illnesses, according to omics data. Among other biomarkers, TLRG1 was the most often used to forecast the pathological advancement of heart failure. (47) LRG1 was chosen to distinguish between patients with persistent atrial fibrillation and healthy controls. LRG1 and miRNA predictive molecules are involved in the pathological development of stable coronary artery disease to acute myocardial infarction.(48)

The regulatory light chain expressed in slow heart muscle is called the slow cardiac myosin regulatory light chain (MYL2). It is encoded by the gene MYL2. (49) By investigating the regulatory functions of MLC-2 in the embryonic and adult heart, with an emphasis on the phosphorylation-driven actions of MLC-2v in the adult myocardium, this work provides fresh insight into the mechanisms driving myosin cycle dynamics and human heart disease. (50) One important independent risk factor for death from CVD and other causes is NT-proBNP. NT-proBNP may be useful for risk monitoring in the overall adult population (51)

Across SBP, DBP, and PP categories, elevated NT-pro BNP is independently linked to CVD and mortality and aids in identifying the most at-risk individuals. The cardiovascular risk was higher for participants with stage 1 hypertension and elevated NT-proBNP than for those with stage 2 SBP and reduced NT-proBNP. The use of biomarker-based techniques for CVD risk assessment to

support the start or escalation of BP treatment requires further research.(52) Our results showed that people with MI and T2DM had a worse antioxidant system and a higher OS. Oxidative Street may therefore be essential to the etiology and outcome of T2DM and MI. (53)

Table (5) : Correlation between the studied parameters among control and MI groups

		Age	GGT	ALT	AST	TSB	Urea	Creatinine	Uric	NLRP3	BNP	MYL	LEU
NLRP3	r	.453**	.554**	.783**	.478**	.710**	.339**	.634**	.369**	1	.862**	.690**	.787**
	P-value	.000	.000	.000	.000	.000	.008	.000	.004		.000	.000	.000
BNP	r	.540**	.680**	.829**	.653**	.712**	.306*	.629**	.531**	.862**	1	.771**	.915**
	P-value	.000	.000	.000	.000	.000	.017	.000	.000	.000		.000	.000
MYL	r	.330*	.569**	.766**	.472**	.346**	.295*	.363**	.392**	.690**	.771**	1	.559**
	P-value	.010	.000	.000	.000	.007	.022	.004	.002	.000	.000		.000
LEU	r	.474**	.595**	.743**	.620**	.770**	.271*	.602**	.463**	.787**	.915**	.559**	1
	P-value	.000	.000	.000	.000	.000	.037	.000	.000	.000	.000	.000	

This table showed a significant positive correlations between NLRP3, BNP ,MYL2 LRG1 levels and uric acid , urea , GPT , GOT , GGT ,TSB in the MI group

Table (6): ROC curve analysis for studied parameters between MI and control groups

Test	Area	cutoff	SE	P-value	Asymptotic 95% Confidence Interval		Sensitivity	Specificity
					Lower Bound	Upper Bound		
NLRP3	1.000	4.26	.000	.000	1.000	1.000	96.7	100
BNP	1.000	264.19	.000	.000	1.000	1.000	100	97
MYL	.998	2.85	.003	.000	.992	1.000	97	100
LEU	1.000	66.72	.000	.000	1.000	1.000	100	100

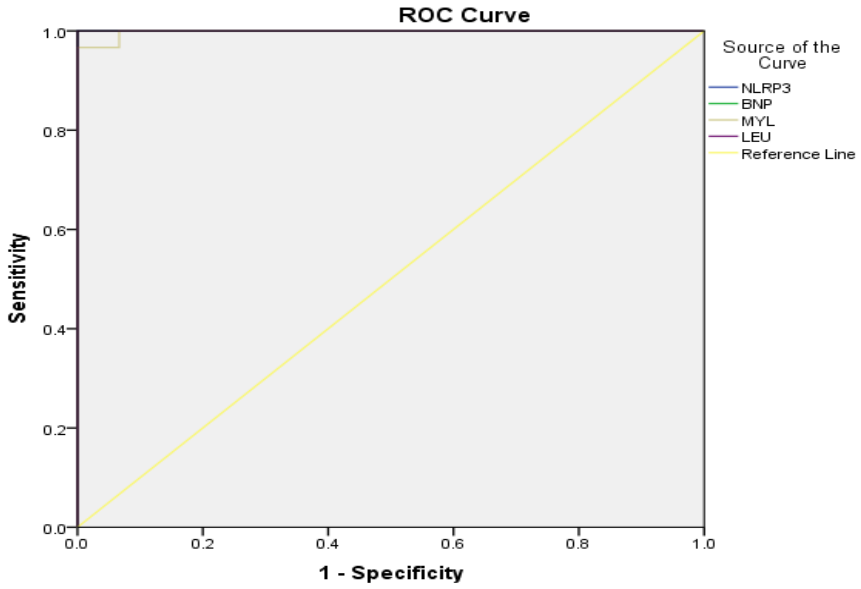

Figure (1): The ROC curve analysis

The ROC curve analysis demonstrates that all studied parameters (NLRP3, BNP, MYL, and LEU) are highly effective in distinguishing HF groups from the control group, with perfect AUC values, statistically significant results, and high sensitivity and specificity. These findings highlight their potential as reliable biomarkers for diagnosing Myocardial Infarction. (MI).

Conclusion

Elevated NLRP3 inflammasome levels show a significant correlation with myocardial infarction (MI), indicating their potential as a biomarker for risk assessment and early detection. The inflammasome's role in driving inflammation and cardiac damage highlights its clinical relevance in MI pathophysiology. Further research is needed to validate its diagnostic utility and explore therapeutic strategies targeting NLRP3 to improve patient outcomes.

Acknowledgements

The authors express their gratitude to the to the Baghdad Teaching Hospital's Intensive Care Unit and Ibn Al-Bitar Cardiac Surgery Center for their cooperation in obtaining samples

Funding Statement

There is no specific funding received during this study.

Ethical approval

All participants in this study were informed before collecting samples, and a verbal agreement was obtained from each of them. The subject data, permission form, and the study protocol were examined and approved by a local ethics committee, according to document number 243 on November 6, 2023.

References

1. Abid, H.; Abid, Z. and Abid, S. (2021). Atherogenic indices in clinical practice and biomedical research: A short review. *Baghdad Journal of Biochemistry and Applied Biological Sciences*, *2*(02), 60-70.
2. AL-Mashhadani, Z. I. (2012). Evaluation the Effect of Catechins Extract Intake for Iraqi Male Patients With Cardiovascular Diseases CVD. *Evaluation*, *25*(2).
3. Yousif, A. M.; Ismail, P. A. and Ismail, C. A. (2023). Analysis of Adipokines and some Steroid Hormones in Myocardial Infarction. *Baghdad Science Journal*, *20*(2), 0256-0256..
4. Al Jumaily, A. A. H. and ScN, M. (2012). Patients' awareness about Cardiovascular Disease and the Causes of Coronary Artery Disease. *Iraqi National Journal of Nursing Specialties*, *25*(1)..
5. Majumder, A. B.; Gupta, S.; Majumder, S. and Singh, D. (2024). An Ensemble Model for Predicting Cardiovascular Disease utilizing Nature Inspired Optimization. *Baghdad Science Journal*
6. Yellon, D. M. and Hausenloy, D. J. (2007). Myocardial reperfusion injury. New England Journal of Medicine, 357(11), 1121-1135.
7. Latz, E.; Xiao, T. S. and Stutz, A. (2013). Activation and regulation of the inflammasomes. Nature Reviews Immunology, 13(6), 397-411.
8. Maeh, R.K.H. and Fadhi, H.Y. (2024). Detection of NLRP3 gene polymorphism and evolution of some biomarkers in SARS-CoV-2 patient. Iraqi Journal of Biotechnology, 23(3)
9. Warka'a, T. (2017). Evaluation of IL-35 and hs-CRP in Iraqi Patients with Cardiovascular diseases. Ibn AL-Haitham Journal For Pure and Applied Science, 27(3), 493-500
10. Westman, P. C.; Lipinski, M. J.; Luger, D.; Waksman, R.; Bonow, R. O.; Wu, E. and Epstein, S. E. (2016). Inflammation as a driver of adverse left ventricular remodeling after acute myocardial infarction. *Journal of the American College of Cardiology*, *67*(17), 2050-2060
11. Takahashi, M. (2014). NLRP3 inflammasome as a novel player in myocardial infarction. International heart journal, 55(2), 101-105.
12. Sandanger, Ø.; Ranheim, T.; Vinge, L. E.; Bliksøen, M.; Alfsnes, K.; Finsen, A. V., *et al.* (2013). The NLRP3 inflammasome is up-regulated in cardiac fibroblasts and mediates myocardial ischaemia–reperfusion injury. Cardiovascular research, 99(1), 164-174.
13. Toldo, S.; Van Tassell, B. W. and Abbate, A. (2017). Interleukin-1 blockade in acute

myocardial infarction and heart failure: getting closer and closer. JACC: Basic to Translational Science, 2(4), 431.
14. Jin, L. and Piao, Z. (2024). Irisin protects against cardiac injury by inhibiting NLRP3 inflammasome-mediated pyroptosis during remodeling after infarction. International Immunopharmacology, 130, 111714.
15. Zheng, Y.; Xu, L.; Dong, N. and Li, F. (2022). NLRP3 inflammasome: The rising star in cardiovascular diseases. Frontiers in Cardiovascular Medicine, 9, 927061
16. Sheikh, F.; Lyon, R. C. and Chen, J. (2015). Functions of myosin light chain-2 (MYL2) in cardiac muscle and disease. Gene, 569(1), 14-20.
17. Zou, Y.; Xu, Y.; Chen, X.; Wu, Y.; Fu, L. and Lv, Y. (2022). Research progress on leucine-rich alpha-2 glycoprotein 1: a review. Frontiers in pharmacology, 12, 809225.
18. Mezzaroma, E.; Abbate, A. and Toldo, S. (2021). The inflammasome in heart failure. Current opinion in physiology, 19, 105-112.
19. Toldo, S.; Mezzaroma, E.; Buckley, L. F.; Potere, N.; Di Nisio, M.; Biondi-Zoccai, G., *et al*. (2022). Targeting the NLRP3 inflammasome in cardiovascular diseases. Pharmacology & therapeutics, 236, 108053.
20. Lee, E.; Liu, Z.; Nguyen, N.; Nairn, A. C. and Chang, A. N. (2022). Myosin light chain phosphatase catalytic subunit dephosphorylates cardiac myosin via mechanisms dependent and independent of the MYPT regulatory subunits. Journal of Biological Chemistry, 298(9).
21. Ito, M.; Okamoto, R.; Ito, H.; Zhe, Y. and Dohi, K. (2022). Regulation of myosin light-chain phosphorylation and its roles in cardiovascular physiology and pathophysiology. Hypertension research, 45(1), 40-52.
22. Song, W. and Wang, X. (2015). The role of TGFβ1 and LRG1 in cardiac remodelling and heart failure. Biophysical reviews, 7, 91-104.
23. Camilli, C.; Hoeh, A. E.; De Rossi, G.; Moss, S. E. and Greenwood, J. (2022). LRG1: an emerging player in disease pathogenesis. Journal of biomedical science, 29(1), 6.
24. Wu, Y.; Li, D. and Vermund, S. H. (2024). Advantages and Limitations of the Body Mass Index (BMI) to Assess Adult Obesity. International Journal of Environmental Research and Public Health, 21(6), 757.
25. Harrison, T. R. (1954). Principles of internal medicine. In Principles of internal medicine (pp. 1703-1703).
26. Ibraheem, R. K. N. S. R. (2022). The Relationship between Liver Enzymes Level and Obesity in a Sample of Iraqi Women. *Iraqi journal of biotechnology*, *21*(2).
27. Mahmud, M. S. and Ashoor, L. S. (2022). Risk Factors Associated with Coronary Artery Disease in Iraqi Patients with Non-Alcoholic Fatty Liver. *Iraqi journal of biotechnology*, *21*(2).
28. Kanic, V.; Frank, B.; Kompara, G. and Suran, D. (2022). Differential associations between body mass index and outcome in different age groups in patients with myocardial infarction. Indian Heart Journal, 74(4), 289-295.
29. Lee, H. J.; Kim, H. K.; Han, K. D.; Lee, K. N.; Park, J. B.; Lee, H., *et al*. (2022). Age-dependent associations of body mass index with myocardial infarction, heart failure, and mortality in over 9 million Koreans. European Journal of Preventive Cardiology, 29(10), 1479-1488.
30. Pedrinelli, R.; Ballo, P.; Fiorentini, C.; Denti, S.; Galderisi, M.; Ganau, A., *et al*. (2012). Hypertension and acute myocardial infarction: an overview. Journal of cardiovascular medicine, 13(3), 194-202
31. Aldaggistany, Z. S. A.; Ahmed, I. S. and Al-Johar, Z. (2023). Prevalence and Demographic characteristics of Metabolic Syndrome in Iraqi Patients with Acute Coronary Syndrome. Journal of the Faculty of Medicine Baghdad, 65(1), 7-13.
32. Qadir, M. S. and Weli, S. M. (2023). Prevalence of cardiovascular disease risk factors among secondary school pupils in Sulaimani city Kurdistan-Iraq. A cross-sectional study. Journal of the Faculty of Medicine Baghdad, 65(2), 129-134
33. AL-hamdi, A. T. and Hassan, H. S. (2005). Low level treadmill testing of 50 patients with acute myocardial infarction prior to discharge from hospital. Journal of the Faculty of Medicine Baghdad, 47(1), 40-43
34. . Shariq, O. A. and McKenzie, T. J. (2020). Obesity-related hypertension: a review of pathophysiology, management, and the role of metabolic surgery. Gland surgery, 9(1), 80.
35. Mousa, A. M. and Mansour, K. A. (2023). Assessment of patients' knowledge concerning healthy lifestyle-based secondary prevention after Percutaneous Coronary Intervention in Baghdad city. Research Journal of Pharmacy and Technology, 16(11), 5137-5141.
36. Szlagor, M.; Dybiec, J.; Młynarska, E.; Rysz, J. and Franczyk, B. (2023). Chronic

kidney disease as a comorbidity in heart failure. International Journal of Molecular Sciences, 24(3), 2988

37. Mc Causland, F. R.; McGrath, M. M.; Claggett, B. L.; Barkoudah, E.; East, C.; Fernandez, A., *et al*. (2024). Acute changes in kidney function and outcomes following an acute myocardial infarction: Insights from PARADISE-MI. European Journal of Heart Failure, 26(9), 1984-1992.
38. Santoro, D.; Gembillo, G. and Andò, G. (2020). Glomerular filtration rate as a predictor of outcome in acute coronary syndrome complicated by atrial fibrillation. Journal of Clinical Medicine, 9(5), 1466.
39. Park, S.; Lee, S.; Kim, Y.; Cho, S.; Huh, H.; Kim, K., *et al*. (2022). Nonlinear causal effects of estimated glomerular filtration rate on myocardial infarction risks: Mendelian randomization study. BMC medicine, 20(1), 44.
40. Hider, D. I.; Abdelraheim, S. R.; Hassuna, N. A. and Marey, H. (2024). The relationship between liver and kidney dysfunction with acute myocardial infarction. Minia Journal of Medical Research
41. Lv, Q. and Zhao, H. (2024). The association of metabolic dysfunction-associated steatotic liver disease (MASLD) with the risk of myocardial infarction: a systematic review and meta-analysis. Annals of medicine, 56(1), 2306192
42. Matetic, A.; Contractor, T.; Mohamed, M. O.; Bhardwaj, R.; Aneja, A.; Myint, P. K., *et al*. (2021). Trends, management and outcomes of acute myocardial infarction in chronic liver disease. International journal of clinical practice, 75(4), e13841.
43. Liao, Y.; Liu, K. and Zhu, L. (2022). Emerging roles of inflammasomes in cardiovascular diseases. Frontiers in Immunology, 13, 834289
44. Abdullaha, M.; Ali, M.; Kour, D.; Mudududdla, R.; Khajuria, P.; Kumar, A. and Bharate, S. B. (2021). Tetramethoxystilbene inhibits NLRP3 inflammasome assembly via blocking the oligomerization of apoptosis-associated speck-like protein containing caspase recruitment domain: in vitro and in vivo evaluation. ACS Pharmacology & Translational Science, 4(4), 1437-1448.
45. Toldo, S. and Abbate, A. (2018). The NLRP3 inflammasome in acute myocardial infarction. Nature Reviews Cardiology, 15(4), 203-214.
46. Luo, T.; Jiang, X.; Zhang, Z.; Gao, M. and Wang, H. (2024). Plasma leucine-rich α-2 glycoprotein 1 in ST-elevation myocardial infarction: vertical variation, correlation with T helper 17/regulatory T ratio, and predictive value on major adverse cardiovascular events. Frontiers in Cardiovascular Medicine, 11, 1326897.
47. Tonry, C.; McDonald, K.; Ledwidge, M.; Hernandez, B.; Glezeva, N.; Rooney, C., *et al*. (2021). Multiplexed measurement of candidate blood protein biomarkers of heart failure. ESC Heart Failure, 8(3), 2248-2258.
48. Xiao, S. J.; Zhou, Y. F.; Wu, Q.; Ma, W. R.; Chen, M. L. and Pan, D. F. (2021). Uncovering the differentially expressed genes and pathways involved in the progression of stable coronary artery disease to acute myocardial infarction using bioinformatics analysis. European Review for Medical & Pharmacological Sciences, 25(1).
49. Li, Y.; Wu, G.; Tang, Q.; Huang, C.; Jiang, H.; Shi, L., *et al*. (2011). Slow cardiac myosin regulatory light chain 2 (MYL2) was down-expressed in chronic heart failure patients. Clinical cardiology, 34(1), 30-34.
50. Markandran, K.; Poh, J. W.; Ferenczi, M. A. and Cheung, C. (2021). Regulatory light chains in cardiac development and disease. International Journal of Molecular Sciences, 22(9), 4351.
51. Echouffo-Tcheugui, J. B.; Zhang, S.; Daya, N.; McEvoy, J. W.; Tang, O.; Juraschek, S. P., *et al*. (2023). NT-proBNP and All-Cause and Cardiovascular Mortality in US Adults: A Prospective Cohort Study. Journal of the American Heart Association, 12(11), e029110.
52. Hussain, A.; Sun, W.; Deswal, A.; de Lemos, J. A.; McEvoy, J. W.; Hoogeveen, R. C., *et al*. (2021). Association of NT-ProBNP, blood pressure, and cardiovascular events: the ARIC study. Journal of the American College of Cardiology, 77(5), 559-571.
53. Alwan, M. H. and Hussein, S. Z. (2023). Evaluation of Oxidative Stress in Iraqi Male Patients with Myocardial Infarction and Type 2 Diabetes Mellitus. Iraqi Journal of Science, 4918-4929