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Assessment of Blood Ferritin and Vitamin D Levels in Patients Suffering from Myocardial Infarction to Determine Their Clinical Significance and Prognostic Value of Hematological Markers in Acute Myocardial Infarction: A Meta-analysis

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Acute myocardial infarction (AMI) is a major cardiovascular illness that causes death as well as disability on a global scale. Understanding how vitamin D contributes to the pathophysiology, epidemiology, and prevention of cardiovascular disease (CVD) is still of interest. Although vitamin D

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has been recognised as a potentially significant CVD marker, it is still unclear how vitamin D deficiency causes endothelial dysfunction, which in turn causes myocardial infarction and stroke. This review's objective is to present an updated analysis of the research on the fundamental science underlying vitamin D's potential effects on the cardiovascular system.
Ferritin is associated with unfavourable outcomes in individuals with a variety of clinical diseases, assessment for ferritin may be beneficial. Our goal was to carry out the first comprehensive analysis of the correlation between elevated ferritin levels and worse cardiovascular outcomes in individuals suffering from acute myocardial infarction (AMI).In patients with AMI, both low and high ferritin levels were linked to how long they spent in the hospital during their hospital stay and at longer follow-up. Ferritin assessment is a straightforward test that may be used to identify AMI patients at high risk who may benefit from more frequent follow-up and specific therapy. Regarding the state of modern treatments for AMI and heart failure, these findings ought to be validated by extensive clinical trials.
This review also discuss the role of hematological indices: Total white blood cells (WBC) count, neutrophil to lymphocyte ratio (NLR),eosinophil leucocyte ratio, diffrential lecocyte count, absolute values of WBCs, red cell distribution width (RDW), and platelet indices, such as , mean platelet volume (MPV),platelet to lymphocyte ratio (PLR) and platelet distribution width (PDW) etc and its diagnostic and prognostic value in MI and its complications which may shed fresh light on developing new treatment plans on MI patients and help doctors in the diagnosis and prognosis with or without complications.

Keywords: Myocardial infarction; ferritin; vitamin D; hematological indices.

1. INTRODUCTION

The condition known as myocardial infarction, or "heart attack," is brought on by a reduction in or interruption of blood supply to a section of the myocardium. MI can either be "silent" and go unnoticed, or it can be a catastrophic occurrence that results in hemodynamic decline and untimely death. “The primary cause of death, coronary artery disease, is the cause of the majority of MIs. Oxygen is not available to the myocardium when coronary artery blockage occurs. Long-term oxygen supply deprivation of the heart can result in necrosis and death of heart cells. As a result of gradual dilatation of local blood arteries and collateral blood flow to the infracted area through anastomotic channels, the area soon after the infarction begins to fill with stagnant blood. Simultaneously, the muscle fibre consumes the final vestiges of oxygen in the blood, causing haemoglobin to become completely deoxygenated. As a result, the infracted area appears bluish-brown. In later stages, the artery walls become highly porous and leak fluid; local muscle tissue becomes oedematous; and cardiac muscle cells begin to bulge as a result of impaired cellular metabolism. The heart muscle cells die after a few hours with essentially little blood supply. Cardiac muscle needs around 1.3 ml of oxygen per 100 grammes of muscle tissue each minute just to stay alive” [1]. There are two main forms of MI: transmural and subendocardial. Transmural: linked with atherosclerosis affecting the main coronary artery. It can be classed as anterior, posterior, or inferior. Transmural infarctions occur when the blood flow to a portion of the heart muscle is completely cut off. Subendocardial: refers to a tiny area of the left ventricle's subendocardial wall, ventricular septum, or papillary muscles. Subendocardial infarctions are hypothesised to be caused by a localised decrease in blood flow, probably due to coronary artery constriction. The subendocardial portion is the furthest from the heart's blood supply and is more vulnerable to this type of pathology.

“Clinically, MI is further categorised into ST elevation MI and non-ST elevation MI based on ECG abnormalities.

The primary symptoms of acute myocardial infraction include radiating pain (left arm and or shoulder, right arm and or shoulder, both arms and or shoulder, neck, back, epigastric), oppressive pain, nausea or vomiting, and perspiration” [2].

“Apart from clinical history, clinical examination and accurate ECG interpretation and Cardiac biomarkers such as cardiac troponin, CK-MB, AST, LDH and myoglobin levels are used to evaluate patients with myocardial infraction. According to WHO criteria which defined MI as the presence of two out of three characteristic, include: chest pain, development of Q wave in

ECG and increased activity of serum enzymes such as CK-MB, AST, LDH. The NACB proposes, use of two biomarkers for diagnosis of MI: an early marker -myoglobin and a definitive marker cardiac troponin. If cardiac troponin is not available the alternative test is CK-MB" [3].

Haematological measures are easily obtained, reasonably priced and practical in everyday clinical practice, They could be studied as markers for prognosis and diagnosis in myocardial infarction [3]. Previous research established the prognostic relevance of haematological markers for cardiac rhythm abnormalities, thrombosis, mortality and cardiovascular problems in patients with ACS [4].

As a biomarker of the inflammatory process and a key protein in iron metabolism, ferritin reflects the body's iron balance. Ferritin levels and cardiovascular outcomes after AMI may be pathophysiologically related to oxidative stress, inflammation, and atherosclerosis. Ferritin assessment is a straightforward test that may be used to identify AMI patients at high risk who may benefit from more frequent monitoring and targeted treatment approaches [6].

Cardiovascular health is influenced by vitamin D, and there is evidence that low vitamin D levels are associated with a higher risk of myocardial infarction (MI). This vitamin supplies the body with vitamin D and regulates over 200 genes. It enters the body through food and UV radiation on the skin. Cell differentiation, growth, and proliferation are all controlled by these genes. Consequently, a lack of this chemical may result in arrhythmias, cardiac failure, ventricular hypertrophy, and artery narrowing and blockage [88].

2. REVIEW OF LITERATURE

Myocardial infarction: Heart disease, also referred to as coronary heart disease (CHD), is an illness of the blood arteries that supply the heart muscle (myocardium). A myocardial infarction (MI) is the term used to describe the condition in which a portion of the heart muscle has either no flow or so little flow that it is unable to support cardiac muscle activity [1]. The recommended biochemical cardiac biomarkers for the diagnosis of ACS are cardiac troponin I (cTnI) and cardiac troponin T (cTnT) tests [5,87]. According to recent research, there is a correlation between a higher risk of cardiovascular complications and death and elevated levels of specific inflammatory markers, such as C-reactive protein, B-type natriuretic peptide, myeloperoxidase, placental growth factor, sCD40 ligand, ischemia-modified albumin, choline, and cystatin C [5,86]. Even though these novel biomarkers are helpful, their global applicability is limited by their high costs, irregular availability, and unconventional laboratory kits and techniques. Given these constraints, measures that are easily quantifiable, affordable, and accessible to all medical practitioners are sought after in order to identify patients who remain at risk of mortality even after a successful recanalization. Hemoglobin (Hb), red blood cell distribution width (RDW), mean platelet volume (MPV), white blood cell (WBC) count, neutrophil to lymphocyte ratio, and mean platelet volume (MPV) are a few of these fast and inexpensive measures that have been documented in the prior literature [7].

Hemoglobin: Anemia risk is greatly increased in the presence of cardiovascular (CV) illness. Patients with acute MI who have lower hemoglobin levels had increased short-term death rates [8].

Reduced venous return to the heart occurs in MI patients who also have acute anemia (such as abrupt blood loss), which raises the heart's workload and oxygen consumption. Acute anemia also causes tachycardia, which shortens the diastole and reduces the heart's blood flow even more. The risk of anemia is greatly increased in the presence of cardiovascular illness. Hypoxia-induced vasodilatation brought on by anemia increases cardiac output and sympathetic activity. Because of the high oxygen extraction rate in the heart circulation, patients with CAD already have a limited amount of coronary reserve, which is decreased by this mechanism [9]. Following a MI, anemic people are more prone to develop congestive heart failure and cardiogenic shock, which is linked to higher rates of morbidity and mortality in these individuals. Risk factors for anemia include the previously stated hypertension, hypothyroidism, rheumatological illnesses, chronic kidney disease, cancer, and congestive heart failure [10]. The relationship between arterial oxygen content and cardiac output determines how much oxygen is delivered to the tissue. Therefore, reduced hemoglobin concentration leading to anemia hypoxia, reduced cardiac output leading to stagnant hypoxia, or reduced hemoglobin saturation leading to hypoxic hypoxia are the factors that determine reduced oxygen delivery

to the tissues. Reduced blood flow (stagnant hypoxia) and oxygen-carrying capacity (anemic hypoxia) are the outcomes of acute anemia. The heart starts to beat quickly in order to maintain the tissue's oxygen supply. This means that the heart needs more oxygen to function. Approximately 60–75% of the oxygen supplied to the heart is used by the myocardium. The flow of blood through the coronaries determines how oxygen reaches the heart. However, the heart's blood flow gets restricted in MI patients [11].

Differential leukocyte count: Leukocyte count has been shown to be an easy-to-use, reasonably priced marker that is important for understanding the etiology and prognosis of CVD. Prior research has demonstrated a correlation between leukocyte count and an increased risk of coronary artery disease (CAD). Furthermore, in patients with AMI, leukocyte count was also associated with the degree of infarct size and the severity of coronary artery stenosis [12]. In addition, patients with stable CAD who had previously experienced MI, unstable angina pectoris, or ACS had increased short- and long-term mortality rates when their leukocyte count was elevated [13]. An increased WBC count may be a sign of a hypercoagulable or thromboresistant state because it was linked to decreased epicardial patency and increased thrombus formation at the ruptured plaque site [14].

Neutrophils and leukocytes, particularly those with STEMI, demonstrated a respectable prediction potential for a worse prognosis in ACS patients. Nonetheless, it has been discovered that high WBC and neutrophils are predictive of unfavorable cardiac outcomes in individuals with STEMI. Neutrophils have the potential to enter vascular walls and produce a range of proteolytic enzymes, cytokines, and superoxide radicals, which can lead to plaque instability. In ACS patients, it was discovered that the neutrophil and WBC counts had a respectable discriminative potential for predicting ventricular rhythm abnormalities. In a post-mortem analysis of people who died of sudden cardiac death, myocardial inflammation is maintained as a risk factor for ventricular arrhythmias, and in patients who had a MI, a relationship between inflammation and ventricular arrhythmia is hypothesized. WBC had a respectable discriminative capacity and was also connected with the incidence of heart failure in ACS and STEMI patients. Thus, in MI patients, greater WBC is linked to a higher likelihood of heart failure. [15]. Proteases are among the several inflammatory cytokines found in inflammatory monocytes, which are the first to react in AMI cases. These pro-inflammatory cytokines may result in myocardial necrosis. Numerous investigations have confirmed that individuals with AMI experience a systemic inflammatory response and that the plasma of these patients promotes leukocyte production of interleukin (IL)-1β and IL-8 [16]. One potential connection between thrombosis and inflammation in patients with coronary artery disease is the activation of monocyte procoagulant activity with either IL-6 or IL-8 [17].

On the other hand, lymphocytes may also stimulate the production of interleukin-10 and aid in tissue repair. However, because of increasing cortisol levels during AMI, people frequently have reduced plasma lymphocyte counts, which may be linked to an increased risk of death [18]. Since lymphocytes regulate the inflammatory process, a low lymphocyte count is associated with a worse prognosis in AM patients [19]. Moreover, eosinophils (EOS) are necessary for thrombosis. Potential roles for EOS in blood coagulation and thrombosis have been proposed throughout the preceding decades. The involvement of EOS in the process of thrombus formation was verified by multiple reports of thrombotic occurrences in patients with illnesses associated to EOS [54]. Patients with acute MI had the lowest peripheral eosinophil levels. In MI, there is a large drop in peripheral blood eosinophils, and this decrease is associated with a markedly elevated risk of heart disease events [20]. According to the previously described mechanisms, lymphocytes are important in immune system control, whereas neutrophils and monocytes are crucial for the inflammatory response [21].

Neutrophil to lymphocyte ratio: In a differential leukocyte count, NLR is simply calculated by dividing the number of neutrophils by the percentage of lymphocytes. It is among the most widely recognized hematological biomarkers in ACS that offers predictive and diagnostic data [22]. Calculating NLR from the differential WBC count is simple. A value >4.9 can predict stent thrombosis and increased mortality in patients with acute MI and interventional therapy. The neutrophil to lymphocyte ratio (NLR) is connected with higher in-hospital mortality in patients with acute MI [23]. The predictive risk of MI is integrated by elevated NLR, an independent predictor. Mortality according to NLR tertile in patients with unstable angina

pectoris, non-ST-segment elevation MI, and ST-segment elevation MI. NLR is a cheap, easily accessible marker that offers a higher level of risk stratification than traditional risk scores in predicting in-hospital and long-term mortality, in contrast to many other inflammatory markers and bioassays. Significant temporal change is seen in the number of neutrophils and lymphocytes following MI, indicating that NLR is a "dynamic" characteristic [24].

Eosinophil to leukocyte ratio: ELR is easily measured by dividing eosinophil percentage in differential leukocyte count by total WBC count. ELR ratio predicts clinical outcome and infarct size in patients who have undergone primary percutaneous coronary intervention.

Platelet count and Mean platelet volume: In individuals suffering from acute MI, an elevated MPV was discovered to be a significant predictor of compromised reperfusion and higher fatality rates [23]. The main job of platelets is to stop tissue or vascular endothelium from bleeding after an injury. Greater reactivity is shown in larger platelets derived from activated megakaryocytes in the bone marrow as opposed to regular platelets. Platelets have a lifespan of 8–12 days. Long before the acute coronary artery occlusion that causes the acute coronary event, large platelets are probably present [25]. It has been demonstrated that in AMI, mean platelet volume (MPV) is larger and platelet count is lower. Moreover, patients with diabetes mellitus, hypertension, hypercholesterolemia, smoking, and obesity had increased MPV, pointing to a potential shared mechanism by which these conditions raise the risk of cardiovascular disease. Elevated MPV has been identified as an independent risk factor for MI and stroke. Patients with MI and unstable angina have higher MPV levels than those with stable angina or noncardiac chest pain. In MI survivors, a higher MPV is linked to a worse clinical prognosis [26].

Red cell distribution width: A simple part of a routine complete blood count is red cell distribution width (RDW), a laboratory measurement of the variability in erythrocyte volume. RDW, a metric for erythrocyte size fluctuation in circulation. Automated blood cell counters compute it as part of the standard study of blood cell counts. A higher value of RDW, which is computed as a coefficient of variation of the mean corpuscular volume, indicates a larger degree of size dispersion in red blood cells. Mean corpuscular volume and RDW have historically been utilized in the differential diagnosis of anemia. Premature release of immature cells into the circulation can also cause situations that alter the morphology of red blood cells, which can lead to an elevated RDW". Red cell distribution width (RDW) is a predictor of mortality after acute MI" in a prospective study of Dabbah et al and is useful for risk stratification of ACS [27]. Increased RDW may result from alterations in the red cell membrane that are triggered by neurohumoral mediators and inflammation. RDW has been linked to heart failure and coronary artery disease severity, including both ST and non-ST elevation MI. It has been proposed that RDW is a biomarker for a proinflammatory state. Because they hinder iron metabolism, shorten the life span of red blood cells, and alter the bone marrow's reaction to erythropoietin, oxidative stress and inflammation raise RDW. Under some circumstances, poor oxygen delivery and impaired flow characteristics brought on by high RDW may encourage MI. A higher risk of venous thromboembolism is linked to RDW. An underlying pathophysiological condition that increases the risk of MI is indicated by RDW [28].

Acute myocardial infarction (AMI) is a prominent global cause of mortality. AMI circumstances are associated with a number of haematological markers, which may be investigated for their potential to forecast in-hospital mortality. Improved therapy and follow-up of high-risk patients can be facilitated by faster and more precise identification of these patients, which is particularly helpful in preventing the worsening of AMI patients' conditions [4,5]. However, very few studies have looked into how these haematological characteristics affect hospitalized short-term AMI patients' chance of mortality [6].

The pathophysiological processes underlying myocardial infarction (MI) significantly influence various hematological markers.

1. Inflammation:

- White Blood Cell (WBC) Count: Elevated WBC count in MI is a response to inflammation caused by myocardial injury. The body mobilizes leukocytes to the site of injury, contributing to tissue repair but also to the inflammatory milieu that can worsen myocardial damage [89].
- Neutrophil to Lymphocyte Ratio (NLR): An increased NLR is indicative of a systemic

inflammatory response. Neutrophils play a crucial role in the early phase of inflammation by releasing enzymes and reactive oxygen species that can further damage myocardial tissue.

2. Thrombosis and Platelet Activation:

Mean Platelet Volume (MPV): MPV is a marker of platelet activation, which is a critical component in the formation of atherothrombotic clots that can occlude coronary arteries, leading to MI. Larger platelets are more active and prothrombotic, contributing to the propagation of thrombosis.

Platelet Distribution Width (PDW): Elevated PDW reflects increased platelet production and activation. Activated platelets release factors that sustain and amplify the inflammatory response, exacerbating myocardial injury and promoting further thrombus formation.

Platelet to Lymphocyte Ratio (PLR): High PLR indicates increased platelet activation and systemic inflammation, both of which are implicated in the pathogenesis and progression of MI.

Red Cell Distribution Width (RDW): RDW is associated with variations in red blood cell size and reflects underlying inflammation and oxidative stress. Higher RDW values are linked to poorer outcomes in MI, possibly due to the role of oxidative stress and inflammation in destabilizing atherosclerotic plaques and promoting thrombus formation [90].

These hematological changes reflect the complex interplay between inflammation, thrombosis, and tissue injury that characterizes the pathophysiology of myocardial infarction. Understanding these markers helps in assessing the severity of the condition, guiding treatment strategies, and predicting patient outcomes [89].

Vitamin D plays a role in cardiovascular health, and there's some evidence suggesting a link between low vitamin D levels and an increased risk of myocardial infarction (MI). Low vitamin D levels, known as vitamin D deficiency, can lead to various health issues. Some potential consequences of low vitamin D levels include:

1. Weak bones: The absorption of calcium, which is necessary for keeping strong and healthy bones, is greatly aided by vitamin D. Low vitamin D levels raise the risk of fractures and osteoporosis and can cause soft, brittle bones.
2. Muscle weakness: A lack of vitamin D can worsen muscle weakness and poor function, which can limit movement and raise the risk of falls.
3. Increased risk of certain diseases: A higher risk of developing a number of chronic illnesses, including as diabetes, autoimmune disorders, cardiovascular disease, and several types of cancer, has been linked to low vitamin D levels.
4. Mood disorders: Some research suggests a link between low vitamin D levels and an increased risk of depression and other mood disorders. Vitamin D receptors are found in areas of the brain involved in mood regulation, and insufficient vitamin D may affect neurotransmitter function.
5. Impaired immune function: Vitamin D plays a role in modulating the immune system, and low levels may compromise immune function, increasing susceptibility to infections and autoimmune diseases [81].

The risk of cardiovascular issues with low vitamin D levels may stem from several factors:

1. Inflammation: Inflammation levels in the body have been linked to vitamin D deficiency. Since chronic inflammation can harm blood vessels and hasten the onset of atherosclerosis, which is the hardening and constriction of the arteries, it is recognized as a risk factor for cardiovascular disease.
2. Hypertension: Blood pressure is regulated in part by vitamin D, and there is a correlation between elevated blood pressure and low vitamin D levels. A significant risk factor for cardiovascular disease, which includes heart attacks and strokes, is hypertension.
3. Insulin resistance: Insulin resistance, a disorder where the body's cells become less receptive to insulin, has been linked to low vitamin D levels. Type 2 diabetes raises the risk of cardiovascular disease considerably, and one risk factor for the disease is insulin resistance.
4. Dyslipidemia: Unfavorable alterations in lipid profiles, such as elevated levels of triglycerides and LDL cholesterol (commonly referred to as "bad" cholesterol) and decreased levels of HDL cholesterol (often referred to as "good" cholesterol),

have been associated with vitamin D insufficiency. One of the risk factors for atherosclerosis and cardiovascular disease is dyslipidemia.

5. Endothelial dysfunction: In order for blood vessels to dilate and constrict properly, optimal endothelium function may be maintained in part by vitamin D. Atherosclerosis is preceded by endothelial dysfunction, which also plays a role in the development of cardiovascular disease [83].

Ferritin: The body accumulates iron in the form of ferritin, a protein whose levels might reveal information about an individual's iron status. High ferritin levels can indicate excess iron stores in the body, a condition known as iron overload. Iron overload can lead to oxidative stress, inflammation, and damage to blood vessels, which are all risk factors for cardiovascular disease, including MI. Inflammation: Elevated ferritin levels are often associated with inflammation in the body [69]. Chronic inflammation is a known contributor to the development of atherosclerosis, a condition characterized by the buildup of plaque in the arteries, which can lead to MI. Metabolic syndrome: Ferritin levels have been linked to components of metabolic syndrome, including obesity, insulin resistance, dyslipidemia, and hypertension. Metabolic syndrome increases the risk of cardiovascular disease, including MI. Genetic disorders: Certain genetic disorders, such as hemochromatosis, can cause excessive iron absorption and lead to elevated ferritin levels. Individuals with hemochromatosis may be at increased risk of cardiovascular complications, including MI, if the condition is not properly managed. Chronic diseases: Conditions such as chronic kidney disease, liver disease, and certain types of cancer can cause elevated ferritin levels. These underlying health conditions may also increase the risk of cardiovascular events, including MI [72].

Ferritin, a protein complex that stores iron and releases it in a controlled manner, plays a significant role in the context of myocardial infarction (MI).

1. Inflammatory Marker: Ferritin is an acute-phase reactant, meaning its levels increase in response to inflammation. During an MI, the inflammatory response leads to elevated ferritin levels. This is because ferritin not only regulates iron homeostasis but also participates in the body's defense mechanism against stress and inflammation. Elevated ferritin levels during an MI can reflect the degree of inflammation and oxidative stress occurring in the body. Higher ferritin levels have been associated with worse outcomes and increased mortality in MI patients [89].
2. Oxidative Stress: Ferritin helps sequester free iron, which can catalyze the formation of reactive oxygen species (ROS) through the Fenton reaction. During MI, the production of ROS increases, leading to oxidative damage of myocardial cells. Elevated ferritin levels can thus indicate heightened oxidative stress. Monitoring ferritin levels can provide insights into the oxidative status of the patient. High levels of ferritin may correlate with more extensive myocardial damage due to oxidative stress, helping to identify patients at higher risk for complications [89,91].
3. Iron Metabolism and Storage: Ferritin is crucial for iron storage and metabolism. Dysregulated iron metabolism is common in chronic diseases, including cardiovascular diseases. During MI, iron is released from damaged myocardial cells and macrophages, potentially leading to elevated serum ferritin levels. Abnormal ferritin levels may indicate disruptions in iron metabolism, which can contribute to the pathophysiology of MI and its complications. High ferritin levels may also be linked to conditions like hemochromatosis, which can exacerbate heart conditions [91].
4. Prognostic Value: Studies have shown that higher ferritin levels are associated with poorer prognosis in MI patients. This is due to its role as a marker of both inflammation and iron overload, which can lead to adverse cardiac remodeling and heart failure. Ferritin can be used alongside other biomarkers to improve risk stratification in MI patients. Elevated ferritin levels can help identify patients who might benefit from more aggressive treatment and closer monitoring.

In summary, ferritin serves as an important biomarker in myocardial infarction due to its roles in inflammation, oxidative stress, and iron metabolism. Elevated ferritin levels are generally associated with worse outcomes, making it valuable for risk assessment and management of MI patients [92].

Table 1. Summary of studies investigating diagnostic and prognostic role of the most important hematological indices

Serial no	Area of research/ research title	Findings/outcomes	Reference
1	"Association of white blood cell count with increased mortality in acute myocardial infarction and unstable angina pectoris. OPUS-TIMI 16 Investigators"	A WBC count of 10,000 or higher has been associated with increased 30- and 10-month mortality rates.	Cannon et al. [29]
2	"Association between white blood cell count, epicardial blood flow, myocardial perfusion, and clinical outcomes in the setting of acute myocardial infarction: a thrombolysis in myocardial infarction 10 substudy,"	A greater WBC count was linked to thromboresistance, decreased myocardial perfusion and epicardial blood flow, as well as an increased risk of dying from congestive heart failure.	Barron et al. [30]
3	"Relation ship between baseline white blood cell count and degree of coronary artery disease and mortality in patients with acutecoronary syndromes".	Elevated baseline WBC count was linked to increased six-month death rates, more severe CAD, and compromised myocardial and epicardial perfusion.	Sabatine et al. [31]
4	"Preprocedural white blood cell count and death after percutaneous coronary intervention"	Patients undergoing PCI who have a low or greater preprocedural WBC count have a higher chance of dying over the long run.	Gurm et al. [32]
5	"Association of leukocyte and neutrophil counts with infarct size, left ventricular function and outcomes after percutaneous coronary intervention for ST-elevation myocardial infarction"	Unfavorable cardiac events can be predicted by elevated neutrophil and leucocyte counts.	Chia et al. [33]
6	"Usefulness of an elevated neutrophil to lymphocyte ratio in predicting long-term mortality after percutaneous coronary intervention"	After coronary angiography, the NLR was a statistically significant independent predictor of long-term death in the patients.	Duffy et al. [34]
7	"Association between admission neutrophil to lymphocyte ratio and outcomes in patients with acute coronary syndrome"	For PCI patients, NLR was a predictor of 6-month and in-hospital mortality.	Tamhane et al. [35]
8	"Usefulness of the neutrophil to lymphocyte ratio in predicting long-term mortality in ST segment elevation myocardial infarction"	When a patient is admitted for STEMI, NLR is a helpful sign that can predict their later mortality better than total WBC.	Núñez et al. [36]
9	"Usefulness of neutrophil to lymphocyte ratio in predicting short and long term mortality after non-ST-elevation myocardial infarction"	For patients with NSTEMI, NLR is an independent predictor of both short- and long-term mortality.	Azab et al. [37]
10	"Pre-procedural elevated white blood cell count and neutrophil-lymphocyte (N/L) ratio are predictors of ventricular arrhythmias during percutaneous coronary intervention"	Significant ventricular arrhythmias in PCI patients were predicted by preprocedural NLR, increased WBC count, and neutrophils.	Chatterjee et al. [38]

Serial no	Area of research/ research title	Findings/outcomes	Reference
11	"Relation of neutrophil /lymphocyte ratio to coronary flow to in-hospital major adverse cardiac events in patients with ST-elevated myocardial infarction undergoing primary coronary intervention"	Patients undergoing primary PCI who had an ST-segment elevation myocardial infarction and developed no-reflow and in-hospital MACEs had an independent relationship between the NLR and these outcomes.	Akpek et al. [39]
12	"Neutrophil to lymphocyte ratio is associated with the severity of coronary artery disease in patients with ST-segment elevation myocardial Infarction"	In STEMI patients, NLR was the sole independent predictor of SYNTAX score.	Sahin et al. [40]
13	"Neutrophil to lymphocyte ratio predicts short- and long-term mortality following revascularization therapy for ST elevation myocardial infarction."	For patients with revascularized STEMI, NLR with an ideal cut-off value of 7.4 proved to be a very reliable indicator of both short- and long-term survival.	Sawant et al. [41]
14	"Neutrophil to lymphocyte ratio is related to stent thrombosis and high mortality in patients with acute myocardial infarction"	Preprocedural elevated NLR was linked to increased mortality rates and stent thrombosis in STEMI patients.	Ayça et al. [42]
15	"Neutrophil/lymphocyte ratio is associated with right ventricular dysfunction in patients with acute inferior ST-segment elevation myocardial infarction"	In patients receiving primary PCI for inferior STEMI, NLR was an independent predictor of RVD.	Yaylak et al. [43]
16	"Association between red blood cell distribution width and outcomes at six months in patients with acute coronary syndromes"	Higher RDW values are associated with unfavorable outcomes in patients with ACS in a graded independent manner.	Nabais et al. [44]
17	"Clinical usefulness of measuring red blood cell distribution width on admission in patients with acute coronary syndromes"	When classifying the risk of acute coronary syndrome (ACS) patients admitted to emergency rooms, RDW at admission may be taken into account alongside other traditional cardiac indicators.	Lippi et al. [45]
18	"Relation between red cell distribution width and clinical outcomes after acute myocardial infarction"	Following an AMI, RDW is a marker of death at some point. Furthermore, a rise in RDW while a patient is in the hospital also signals a poor clinical outcome.	Dabbah et al. [46]
19	"Red cell distribution width as a novel prognostic marker in patients undergoing primary angioplasty for acute myocardial infarction"	Cardiovascular mortality both in-hospital and long-term were predicted by RDW upon admission.	Uyarel et al. [47]
20	"The impact of admission red cell distribution width on the development of poor myocardial perfusion after primary percutaneous intervention"	The long-term prognosis is indicated by the RDW marker.	Isik et al. [48]
21	"Predictive impact on medium-term mortality of hematological	The prediction value for all-cause mortality is improved	Timóteo et al.

Serial no	Area of research/ research title	Findings/outcomes	Reference
	parameters in acute coronary syndromes: added value on top of GRACE risk score"	when RDW and GRACE score are combined.	[49]
22	"Value of platelet/lymphocyte ratio as a predictor of all-cause mortality after non-ST-elevation myocardial infarction"	Following NSTEMI, PLR is a strong independent predictor of long-term death.	Azab et al. [50]
23	"Association of platelet-to-lymphocyte ratio with severity and complexity of coronary artery disease in patients with acute coronary syndromes"	In patients with ACS, PLR at admission is substantially correlated with the complexity and severity of coronary atherosclerosis. When ACS patients receive urgent CA, increased PLR is an independent predictor of higher SYNTAX score.	Kurtul et al. [51]
24	"Relationship between hematologic indices and global registry of acute coronary events risk score in patients with ST-segment elevation myocardial infarction"	In STEMI patients, PLR, RDW, and monocyte were linked to the GRACE score.	Acet et al. [52]
25	"The utility of the platelet–lymphocyte ratio for predicting no reflow in patients with ST-segment elevation myocardial infarction"	In patients receiving primary PCI, high preprocedural PLR and NLR levels are substantial and independent predictors of no-reflow.	Yildiz et al. [53]
26	"Impact of platelet-to lymphocyte ratio on clinical outcomes in patients with ST segment elevation myocardial infarction."	In patients with STEMI, higher PLR was linked to all-cause mortality, heart failure, ischemic stroke, and recurrent myocardial infarction.	Sun et al. [54]
27	"Correlation of platelet to-lymphocyte ratio and neutrophil-to-lymphocyte ratio with thrombolysis in myocardial infarction frame count in ST-segment elevation myocardial infarction."	PLR and NLR were linked to the no-reflow phenomenon in STEMI patients receiving percutaneous coronary intervention.	Vakili et al. [55]
28	"Platelet distribution width and the extent of coronary artery disease: results from a large prospective study"	The degree of CAD and carotid IMT have no impact on PDW. PDW had a favorable correlation with diabetes prevalence, waist circumference, weight, and age.	De Luca et al. [56]
29	"Prognostic value of platelet indices after acute myocardial infarction treated with primary percutaneous coronary intervention"	Following MI, PDW and P-LCR serve as prognostic indicators.	Rechciński et al. [57]
30	"Predictive value of admission platelet volume indices for in-hospital major adverse cardiovascular events in acute ST-segment elevation myocardial infarction"	In patients with STEMI receiving pPCI, baseline PDW and MPV are independent predictors of no-reflow and in-hospital MACEs.	Celik et al. [58]
31	"Increased platelet distribution width is associated with severity of	The Gensini score was considerably higher in the	Bekler et al.

Serial no	Area of research/ research title	Findings/outcomes	Reference
	coronary artery disease in patients with acute coronary syndrome"	PDW > 17% group.	[59]
32	"Mean platelet volume on admission predicts impaired reperfusion and long-term mortality in acute myocardial infarction treated with primary percutaneous coronary intervention"	In STEMI patients receiving pPCI, MPV is a predictor of reduced reperfusion and mortality.	Huczek et al. [60]
33	"Baseline platelet size is increased in patients with acute coronary syndromes developing early stent thrombosis and predicts future residual platelet reactivity. A case-control study"	Patients with ACS who experience early stent thrombosis had larger baseline platelets, which are correlated with future residual platelet reactivity.	Huczek et al. [61]
34	"Mean platelet volume as a predictor of cardiovascular risk: a systematic review and meta-analysis"	Increased MPV is linked to restenosis after coronary angioplasty, mortality after myocardial infarction, and AMI.	Chu et al. [62]
35	"Combination of mean platelet volume and the GRACE risk score better predicts future cardiovascular events in patients with acute coronary syndrome"	Significant and independent predictors of CVD events were the GRACE score and MPV. The predictive value was enhanced when the scoring system and MPV were combined.	Wan et al. [63]
36	"Mean platelet volume on admission improves risk prediction in patients with acute coronary syndrome"	In patients with ACS, elevated MPV was an independent predictor of MI or 6-month death. The GRACE model's prediction value increased with the addition of MPV.	Niu et al. [64]

Table 2. An overview of research on vitamin D and serum ferritin levels in MI patients

Si no	Area of research/ research title	Findings/outcomes	Reference
1	"Serum Ferritin and CardiovascularDisease: A 17 Year Follow-up Study in Busselton, Western Australia"	Overall, the iron theory is not supported by prospective studies from collected evidence. Additional prospective research is needed, particularly on women and studies that can look into how serum ferritin interacts with other risk variables or works in concert with them.	M. W. Knuiman et al [65]
2	"Relationship of serum ferritin with cardiovascular risk factors and inflammation in young men and women"	Young men's and women's serum triglyceride levels, HDL cholesterol, obesity, and inflammation are all correlated with ferritin levels. Reports of a correlation between ferritin and cardiovascular disease may be influenced by confounding.	Williams MJ et al [66]
3	"Ferritin levels and risk of heart failure—the Atherosclerosis Risk in Communities Study"	Even in the absence of concurrent anemia, abnormalities in iron metabolism, defined as low or high ferritin serum levels, were linked to an increased risk of incident heart failure in the general population. These results imply that an iron deficiency may contribute to the development of HF.	Odilson M. Silvestre et al [67]
4	"Serum Ferritin and Death from all Causes and Cardiovascular Disease: The NHANES II Mortality Study"	For either group, there was no statistically significant correlation seen between serum ferritin and any of the cardiovascular outcomes. Serum ferritin was found to have a u-shaped, albeit non-significant, correlation with mortality from all causes in black men and with cardiovascular disease (CVD) mortality in white women.	Sempos CT et al [68]
5	"Relationship between serum ferritin and risk factors for ischaemic heart disease in 2235 Danes aged 30–60 years"	Serum ferritin levels have been linked to a number of male and female ischemic heart disease risk factors.	Milman N et al [69]
6	"Serum ferritin levels and other indicators of organic iron as risk factors or markers in coronary artery disease"	Ferritin and other organic iron indicators, such as hemoglobin and hematocrit, transferrin saturation, total iron-binding capacity, and serum levels of ferritin, were not associated with an increased risk of coronary atherosclerosis.	Armaganijan D et al [70]
7	" Serum ferritin, cardiovascular risk factors and ischaemic heart diseases: a prospective analysis in the SU. VI. MAX"	Data do not indicate that iron status plays a significant effect in the development of IHD in the general population. .	Galan P et al [71]
8	"Plasma Ferritin Levels, Incident Heart Failure, and Cardiac Structure and Function: The ARIC Study"	Lower plasma ferritin levels are linked to an increased risk of incident HF, HFpEF, and elevated measures of left ventricular filling pressure in older persons without prevalent HF or anemia.	Aboelsaad IA et al [72]

Si no	Area of research/ research title	Findings/outcomes	Reference
9	"Serum ferritin and risk for new-onset heart failure and cardiovascular events in the community"	Women in the community who have elevated serum ferritin levels are at an independent risk of developing new-onset heart failure.	IJsbrand T. Klip et al [73]
10	"Association of serum ferritin with coronary artery disease."	These results suggest a slight positive correlation between serum ferritin and the risk of CAD. Additional research is required to confirm this risk.	Zhou Y et al [74]
11	"Relation between the serum ferritin level and the risk for acute myocardial infarction."	Serum ferritin levels that are elevated, particularly in STEMI, may be predictive of AMI.	Moradi M et al [75]
12	"Significance of serum ferritin and vitamin-D level in coronary artery disease patients".	A increased risk of CAD was also linked to low vitamin D levels. In this investigation, blood ferritin levels were up, vitamin D levels were low, and lipid profile status was changed in CAD patients.	Vasudevan E et al [76]
13	"Prevalence of vitamin D deficiency in patients with acute myocardial infarction".	A multicenter cohort of individuals with acute myocardial infarction in the United States shows that nearly all of them had a vitamin D deficit.	Lee JH et al [77]
14	"Vitamin D and prognosis in acute myocardial infarction"	A significant 74% of the patients had low vitamin D levels (less than 20 ng/ml 25-(OH)D).	[78]
15	"Study of vitamin D deficiency prevalence in acute myocardial infarction"	In this investigation, vitamin D deficiency was linked to numerous risk factors for acute myocardial infarction and was found in the majority of patients.	Karur S et al [79]
16	"Vitamin D deficiency in patients with acute myocardial infarction: an Italian single-center study."	Throughout all enrollment seasons, we found that individuals with myocardial infarction had an extremely high frequency of vitamin D insufficiency.	Aleksova A et al [80]
17	"Serum vitamin D concentration status and its correlation with early biomarkers of remodeling following acute myocardial infarction. Clinical Research in Cardiology".	In this study, a low amount of vitamin D was linked to patient death. .	Khalili H et al [81]
18	"Independent association of severe vitamin D deficiency as a risk of acute myocardial infarction in Indians."	The results of the study show that vitamin D deficiency is more prevalent in both acute MI patients and the controls who were chosen from Delhi, India for the study. The levels of serum 25 (OH) vitamin D were significantly lower in the cases.	Roy A et al [82]
19	"Association between blood vitamin D and myocardial infarction: a meta-analysis including observational studies"	According to the current study, blood 25(OH)D levels were significantly lower in MI patients, particularly in America and Asia, and having enough blood vitamin D may help prevent MI from happening.	Huang J et al [83]

Si no	Area of research/ research title	Findings/outcomes	Reference
20	“Circulating Vitamin D Level and Risk of Sudden Cardiac Death and Cardiovascular Mortality: A Dose-Response Meta-Analysis of Prospective Studies”.	According to prospective cohort studies, there was a substantial increase in the risk of SCD and CVD mortality with decreased levels of circulating vitamin D.	Kong SY et al [84]
21	“The association between the serum level of vitamin D and ischemic heart disease: a study from Jordan”	failed to uncover any convincing evidence that vitamin D levels, or the existence of vitamin D insufficiency or deficiency, may be used as predictors of the likelihood of developing or recurrent coronary artery disease.	Jarrah MI et al [85]

3. OBJECTIVE OF THE STUDY

To review research articles published on the diagnostic and prognostic significances of various hematological parameters, serum ferritin and vitamin D level in patients with acute myocardial infarction.

4. METHODOLOGY

The proposed study reviews the relevant literature using the method of data collection. The information needed for the study was gathered from secondary sources, including journals, magazines, research papers, and publications.

5. DISCUSSION

A reliable, easily available, noninvasive haematological predictive marker for MI is desperately needed so that individuals at high cardiovascular risk can be identified for secondary prevention and their medication tailored to their needs.

The complex pathophysiology of MI is reflected in several of the markers that are discussed here. The development of atherosclerosis, the instability of atherosclerotic plaques, and the creation of clots on the surface of the plaque are all significantly influenced by inflammatory processes. As demonstrated above, numerous research have indicated the relevance of Total WBC count, Neutrophil Lymphocyte Ratio, Eosinophil leucocyte ratio, Platelet Lymphocyte Ratio, Platelet Distribution Width, Mean Platelet Volume, and Red cell Distribution Width in the prognosis of MI.A summary of the most important research on hematological indicators can be found in Table 1.

In patients with AMI, both low and high ferritin levels were linked to how long they spent in the hospital during their hospital stay and at longer follow-up. Ferritin assessment is a straightforward test that may be used to identify AMI patients at high risk who may benefit from more frequent follow-up and targeted treatment. These findings, which are outlined in Table 2, should be validated in sizable studies against the backdrop of heart failure and AMI treatments that are currently on availability.

The correlation between low vitamin D levels and obesity, diabetes mellitus, dyslipidemia, endothelial dysfunction, and hypertension has led to the suggestion that vitamin D deficiency may cause an increased risk of MI. However, the pathways via which a vitamin D shortage results in myocardial infarction from endothelial dysfunction remain unclear, despite the fact that vitamin D has been recognized as a potentially significant marker of cardiovascular disease. The majority of research points to low vitamin D levels in MI patients, which are compiled in Table 2.

6. CONCLUSION

Acute myocardial infarction (AMI) is a prominent global cause of mortality. AMI circumstances are associated with a number of haematological markers, which may be investigated for their potential to forecast in-hospital mortality. Patients with MI are more likely to see changes in their hematological markers. Faster and more accurate identification of high-risk patients can aid improve therapy and follow-up, which is especially beneficial in preventing the deterioration of circumstances for AMI patients. However, not much research has been done on how these haematological parameters relate to the risk of death for hospitalized short-term AMI patients. Along with theses hematological parameters vitamin D and ferritin levels shows significant changes in MI patients. Clinical investigations have shown that adverse outcomes in patients with AMI during their hospital stay and at longer follow-up assessments were related to both low and high ferritin concentrations. There is a link between acute MI and severe vitamin D insufficiency. However, because vitamin D status is strongly correlated with incidence AMI, a worse short-term prognosis, and recurrent major adverse cardiovascular events, it continues to be an independent risk factor even after controlling for key covariates. With regard to the current treatments for myocardial infarction and heart failure, these findings should be verified in sizable studies using modern patients.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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