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Role of NLR and CK-MB as predictive biomarkers for PCI in suspected CAD patients at PAAMCC

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ABSTRACT

Early identification of coronary artery disease (CAD) is important for reducing mortality and improving patient outcomes. This study aimed to evaluate the usefulness of neutrophil-to-lymphocyte ratio (NLR) and creatine kinase-MB (CK-MB) as predictive biomarkers of CAD in patients suspected of requiring percutaneous coronary intervention (PCI). This hospital-based retrospective cross-sectional study included patients admitted to Prince Abdullah Bin Abdulaziz Bin Musaed Cardiac Centre (PAAMCC) between 1 July and 30 November 2023. Clinical, hematological, and biochemical data were collected from electronic medical records. Patients were divided into two groups according to NLR level: normal (≤ 3.0) and high (> 3.0). A total of 276 patients were included, comprising 256 males (92.8%) and 20 females (7.2%), with a mean age of 48.09 ± 7.97 years. Among them, 157 patients (56.9%) underwent PCI and were classified as having CAD. NLR was significantly associated with PCI ($P < 0.001$), and 143 of the 157 patients who underwent PCI (91.1%) had a high NLR level. Significant differences were also observed between the normal and high NLR groups in serum levels of CK, CK-MB, troponin I, and LDL ($P < 0.001$). Multivariate analysis showed that both NLR and CK-MB were significant predictors of PCI, with adjusted odds ratios (AORs) of 3.08 ($P < 0.001$) and 1.10 ($P = 0.001$), respectively. In conclusion, NLR and CK-MB were independently associated with PCI among patients from the Northern Border Region of Saudi Arabia. However, further studies are needed to confirm the clinical value of NLR as an effective diagnostic biomarker for CAD.

1. Introduction

Coronary artery disease (CAD) is one of the most common and severe cardiovascular disorders, accounting for a significant number of deaths and disabilities. In recent years, the disease burden has increased dramatically in both developed and developing countries (Bauersachs et al., 2019). The introduction of percutaneous coronary intervention (PCI) has significantly transformed the treatment options, and it continues to be the focus of intensive research and development. The PCI is now recognized as an effective treatment option for patients with coronary artery disease, and is the most frequent cardiac intervention to improve myocardial perfusion in these patients (Grech, 2003). The main advantage of PCI is that it is a non-surgical procedure to relieve the narrowing or blockage of the coronary artery, thereby increasing blood flow to the heart muscle (Bhatt, 2018).

Indeed, the precise and appropriate diagnosis of CAD is imperative to prevent the patient from further damage. Initially, various traditional diagnostic techniques such as blood tests, electrocardiogram (ECG), echocardiography, stress tests, coronary angiography, cardiac CT or MRI, and coronary artery bypass were used to identify CAD patients. However, most of them were found to be very complex (Khawaja et al., 2024). In addition, due to the lack of medical diagnostic tools and experts, particularly in developing countries, the diagnosis and treatment of heart disorders continue to be a real challenge.

This highlighted the need for a more affordable, simple, rapid, and relatively accurate diagnostic approach. As of now, cardiac and blood biomarkers

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have been substantially considered as complements or alternatives to traditional techniques. Cardiac biomarkers are extremely important in the timely, accurate diagnosis and clinical management of acute coronary syndrome (Jacob and Khan, 2018). On the other hand, the role of blood biomarkers, particularly inflammatory markers, in CAD has been extensively investigated, and a consistent correlation between various inflammatory markers and CAD has been established.

In this regard, the effectiveness of blood biomarkers in CAD diagnosis and prognosis has been reported in several studies; nevertheless, additional investigations are required to determine the predictive value of many of these biomarkers in CAD prediction (Hsu et al., 2023). Among the blood biomarkers, the neutrophil to lymphocyte ratio (NLR) has recently been identified as an additional inflammatory marker that can be used to predict mortality risk in cardiovascular disease patients (Ha et al., 2024).

Unlike other diagnostic parameters, obtaining NLR results requires a simple blood count test, which is available even in limited-resource settings, providing an easily accessible and inexpensive laboratory investigation. The biological basis of NLR as an inflammatory index is primarily based on systemic inflammatory cascades initiated by the innate immune system in patients with sepsis, pneumonia, cancer, pregnancy complications, multiple organ damage, and various cardiovascular diseases (Zahorec, 2021). In this regard, accumulated evidence suggests that NLR could be identified as a novel inflammatory marker, shedding light on its pivotal diagnostic and prognostic role in infections. This could be attributed to the fact that systemic inflammation has been found to be associated with prognosis in various diseases (Buonacera et al., 2022).

As a predictive factor of morbidity and mortality in several diseases, the normal cut-off value of NLR is still under debate. However, it has been reported that the normal NLR values in an adult are between 1-2, while values ranging from 2.3 to 3.0 indicate a gray zone in which NLR serves as an early warning sign of a pathological state or process. NLR values higher than 3.0 and less than 0.7 indicate a pathological condition (Mirna et al., 2021; Zahorec, 2021). Despite no consensus on predictive cutoff values, NLR remains a cost-effective and readily available biomarker when compared to other inflammatory biomarkers, and thus could be considered as an alternative method for detecting cardiovascular diseases. However, the utilization of NLR as an early predictive marker for PCI has not been sufficiently explored. In addition, there is a significant lack of relevant evidence that is customized to the demographic and clinical characteristics of the Northern Border Region of Saudi Arabia. Thus, this study speculated that NLR combined with other cardiac enzymes, such as CK-MB and troponin, might be a promising method for improving the clinical decisions for PCI.

2. Methods

This was a hospital-based, retrospective cross-sectional study conducted among individuals suspected of having cardiovascular complications at the Prince Abdullah Bin Abdulaziz Bin Musaed Cardiac Centre (PAAMCC) from 1st July to 30th November 2023. The PAAMCC is a prestigious cardiac center located in Arar, a northern border region, that provides cutting-edge care for the treatment of cardiac conditions.

Study participants were randomly selected from adult patients attending the PAAMCC at the time of recruitment. The sampling frame included all patients with cardiovascular complications symptoms who underwent cardiac catheterization to confirm or rule out coronary artery disease as a prerequisite clinical investigation for PCI. Overall, 276 patients fulfilled the inclusion criteria and were subsequently enrolled in this study.

Patients were eligible for inclusion in this study if they were: (1) aged 18 years and above and visited PAAMCC during the study period; (2) suspected of having clinically stable coronary artery disease and expected to undergo PCI; (3) subjected to cardiac catheterization; and (4) had available data on NLR, CKMB, and other relevant information in their medical records. Meanwhile, patients with incomplete medical records, particularly for NLR and CKMB, as well as those suffering from severe pulmonary disease, neoplasm, corticosteroid therapy within the previous year, chronic inflammatory disease, and active infection, were excluded.

The relevant information from each eligible patient was collected from the electronic medical record using a predesigned spreadsheet created in Microsoft Excel. The sheet captured key information regarding socio-demographic characteristics (gender, age, and nationality), clinical manifestation (fever, fatigue, and chest pain), comorbidities (hypertension, diabetes, haemoglobinopathies, smoking, kidney disease, allergy, pregnancy, thyroid illness), haematological parameters (white blood cell (WBC) count, red blood cell (RBC) count, hemoglobin (Hb), platelet count (PLT), hematocrit (HCT), mean cell hemoglobin (MCH), mean cell hemoglobin concentration (MCHC) and NLR) and biochemical parameters (CK, CKMB, TROPONIN I and LDL).

The Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS, IBM, and Chicago, USA) version 22.0. Initially, all variables were tested for normality using the Shapiro-Wilk test. Accordingly, normally distributed continuous variables were presented as mean ± SD, while skewed variables were reported as median with interquartile range (IQR). In contrast, categorical variables were statistically described as frequency (n) and percentages (%). The association between continuous data was assessed using an independent-sample t-test or Mann-Whitney U test. While Categorical variables were compared using either Pearson's Chi-square or Fisher's exact tests. Regression analysis was performed to assess the

association of the NLR, CK, CK-MB, and LDL biomarkers with PCI. Patients were categorized into two groups based on their NLR level between 0.75 and 3.0 as group one and the other group having values ≤ 3.0. Receiver operating characteristic (ROC) curve analysis was used to evaluate the predictive performance of the NLR. A p-value of less than 0.05 indicated statistical significance.

3. Results

3.1. Baseline characteristics of included patients

A total of 276 patients who were suspected of having CAD and visited PAAMCC between July 1st and November 30th, 2023, were enrolled in the study. Of them, 256 (92.8%) were males, and 20 (7.2%) were females. Their mean age was 48.09 ± 7.97 years. Saudi Arabia accounts for most study participants (87.3%), with RCA being the most common diagnosis (19.9%). Regarding PCI, approximately half of the participants (56.9%) underwent the procedure and were thus classified as having CAD. The NLR was significantly associated with PCI (P < 0.001) and diagnosis (P < 0.001). While there was no significant association between NLR and age or nationality. Interestingly, among the 157 patients who underwent PCI, 143 (91.1%) had a high NLR level, compared to 14 (8.9%) with a low NLR level.

3.2. The prevalence of clinical manifestations, comorbidities, and risk factors in patients with normal and high NLR levels

As shown in Table 1, NLR was significantly associated with fever (P = 0.029), hypertension (P < 0.001), diabetes (P = 0.017), smoking (P < 0.001), and kidney disease (P = 0.039). A high NLR was more common among patients with high fever (mean = 36.65), hypertension (64.8%), diabetes (61.4%), smoking history (67.0%), and kidney disease (100%).

Table 1: Comparative table of clinical manifestations and comorbidities based on NLR level

Variable		Normal NLR (N = 118)	High NLR (N = 158)	p-value
Fever		36.47±0.46	36.65±0.62	0.029
Chest pain	No	7 (50.0)	7 (50.0)	0.574
	Yes	111 (42.4)	151 (57.6)	
Hypertension	No	54 (57.4)	40 (42.6)	< 0.001
	Yes	64 (35.2)	118 (64.8)	
Diabetes	No	38 (55.1)	31 (44.9)	0.017
	Yes	80 (38.6)	127 (61.4)	
Smoking	No	59 (60.8)	38 (39.2)	< 0.001
	Yes	59 (33.0)	120 (67.0)	
Kidney disease	No	118 (43.7)	152 (56.3)	0.039
	Yes	0 (0)	6 (100)	
Thyroid	No	115 (44.1)	146 (55.9)	0.067
	Yes	3 (20.0)	12 (80.0)	

N: Number; N (%); Mean±SD

3.3. Comparison of hematological parameters and cardiac biomarkers

The comparison between patients with normal NLR and those with high NLR showed several significant differences in hematological parameters, as presented in Table 2. Significant mean differences were observed in WBCs, RBCs, Hb, HCT, LYM, and NEUT levels between the two groups (P < 0.001). Patients with high NLR had significantly higher mean values of WBCs (13.51 ± 9.51), RBCs (4.83 ± 4.36), Hb (14.48 ± 13.42), HCT (42.56 ± 41.27), and NEUT (9.16 ± 4.35). In contrast, the high NLR group had significantly lower LYM counts, with a mean of 1.85 ± 0.71, compared to 2.34 ± 0.67 in the normal NLR group.

Regarding cardiac biomarkers, significant mean differences were also found in serum levels of CK, CK-MB, troponin I, and LDL between the normal and high NLR groups (P < 0.001). Patients with high NLR showed significantly higher mean levels of CK (421.16 ± 90.99), CK-MB (80.20 ± 17.81), troponin I (0.30 ± 0.02), and LDL (6.04 ± 4.02) compared with patients in the normal NLR group.

3.4. Correlation of NLR with cardiac biomarkers

Table 3 displays the independent predictors of increasing NLR. NLR had a significant and positive relationship with CK-MB (B = 0.432, P < 0.001), and LDL (B = 0.120, P < 0.001).

3.5. Correlation of NLR, CK, CK-MB, and LDL with PCI

The strength of association between NLR, CK, CK-MB, and LDL with PCI was evaluated using multivariate regression analysis (Table 4). PCI showed a significant positive association with both NLR (AOR = 3.08, P < 0.001) and CK-MB (AOR = 1.10, P = 0.001). Specifically, each one-unit increase in NLR was associated with a 3.08-fold increase in the odds of undergoing PCI, corresponding to a 208% increase in odds. In comparison, each one-unit increase in CK-MB was associated with a 10% increase in the odds of PCI. These findings indicate that, within this study population, NLR demonstrated a stronger association with PCI than CK-MB.

Table 2: Comparative table of haematological parameters based on NLR level

Parameters	Normal NLR (N = 118)	High NLR (N = 158)	p-value
WBCs (×10³/µL)	9.51±2.06	13.51±3.01	< 0.001[a]
RBCs (×10⁹/µL)	4.36±0.62	4.83±0.72	< 0.001[b]
Hb (g/dL)	13.42±1.44	14.48±1.98	< 0.001[a]
HCT (%)	41.27±3.73	42.56±5.82	< 0.001[a]
MCV (fL)	84.02±3.70	84.05±3.98	0.677[a]
MCH (pg)	29.33±1.72	29.58±4.32	0.714[a]
MCHC (g/dL)	33.81±1.10	33.66±1.78	0.588[a]
PLT (×10³/µL)	278.71±77.12	293.82±80.31	0.095[a]
LYM (×10³/µL)	2.34±0.67	1.85±0.71	< 0.001[a]
NEUT (×10³/µL)	4.35±1.41	9.16±2.70	< 0.001[a]
NLR	1.93±0.47	5.33±1.83	< 0.001[a]
RDW-SD (fL)	42.94±5.30	43.12±3.09	0.050[a]
CK (U/L)	90.99±78.15	421.16±351.43	< 0.001[a]
CK-MB (U/L)	17.81±13.45	80.20±64.43	< 0.001[a]
Troponin I (ng/ml)	0.02±0.04	0.30±1.96	< 0.001[a]
LDL (U/L)	4.02±5.82	6.04±1.58	< 0.001[a]

a: Mann-Whiteney test; b: Independent t-test

Table 3: Linear regression analysis of NLR

Variable	Univariate			Multivariate		
	Unstandardized coefficients B	Standardized coefficients B	p-value	Unstandardized coefficients B	Standardized coefficients B	p-value
CK (U/L)	0.003	0.490	< 0.001	0.001	0.048	0.640
CK-MB (U/L)	0.020	0.535	< 0.001	0.016	0.432	< 0.001
Troponin I (ng/ml)	0.085	0.057	0.346	-	-	-
LDL (U/L)	0.128	0.238	< 0.001	0.065	0.120	0.019

Table 4: Logistic regression analysis of PCI

Variable	COR (95% CI)	p-value	AOR (95% CI)	p-value
NLR	5.62 (3.80, 8.31)	< 0.001	3.08 (1.98, 4.80)	< 0.001
CK	1.02 (1.01, 1.03)	< 0.001	1.01 (0.99, 1.01)	0.116
CK-MB	1.18 (1.13, 1.24)	< 0.001	1.10 (1.04, 1.16)	0.001
LDL	1.57 (1.36, 1.81)	< 0.001	0.95 (0.84, 1.09)	0.485

CI: confidence interval; COR: crude odds ratio; AOR: adjusted odds ratio

3.6. The diagnostic accuracy of NLR as an early predictive marker for PCI

The diagnostic accuracy of the NLR as a potential predictive marker for PCI among patients with CAD was investigated using receiver operating characteristic (ROC) curve analysis. According to the ROC curve (Fig. 1), NLR exhibited a high area under the curve (AUC) for predicting PCI (97.6%), with a sensitivity of 94.1% and specificity of 89.4%. The positive predictive value (PPV), negative predictive value (NPV), and accuracy were estimated to be 91.7%, 92.4%, and 92.0%, respectively.

4. Discussion

As far as we know, this is the first study that evaluates the role of NLR and CKMB as effective diagnostic and predictive inflammatory biomarkers for PCI among CAD patients in Saudi Arabia. This study demonstrated a significant association (P < 0.001) between NLR and PCI, with patients in the high NLR group having significantly higher numbers of PCI operations. Overall, 143 out of 157 patients (91.1%) who underwent PCI had a high NLR level, while only 14 (8.9%) had a low NLR. In this regard, there is growing interest in the role of NLR in CAD patients, and numerous studies have evaluated the role of NLR in the onset and progression of CAD in recent years. Recent evidence suggests that a high NLR is associated with poor clinical outcomes and myocardial damage in patients with CAD (Chen et al., 2018). A similar study conducted by Ha et al. suggested that an increasing NLR level could be considered a useful prognostic marker for worse outcomes in CAD patients. The study also found that a high NLR value may indicate a state of CAD-associated inflammation, which is an effective indicator of increased mortality in patients with CAD undergoing PCI (Ha et al., 2024). Moreover, many studies have reported that CAD patients with high NLR have an increased likelihood of left ventricular systolic dysfunction, as well as left main and/or three-vessel disease (Bekler et al., 2015). Similarly, NLR was independently correlated with the clinical outcome and severity of CAD in patients undergoing angiography (Arbel et al., 2012).

To improve the understanding of coronary artery disease (CAD), many observational and epidemiological studies, as well as genome-wide association studies, have been conducted on CAD. Proper management of cardiovascular diseases largely depends on early diagnosis, adoption of a healthy lifestyle, and identification of associated risk factors. Genome-wide association studies have suggested that chromosome 9p21.3 may be associated with the early onset of CAD. Major risk factors for CAD include hypertension, diabetes,

smoking, physical inactivity, unhealthy diet, obesity, air pollution, and harmful alcohol consumption.

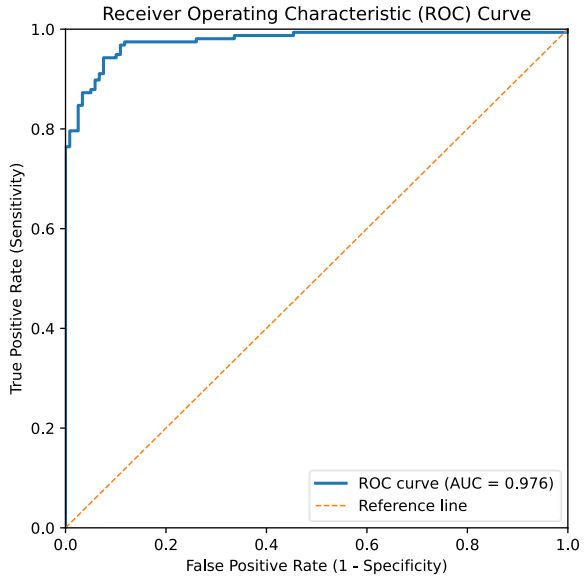

Fig. 1: ROC Curve analysis of PCI prediction model

Consistent with previous studies, our findings showed significant associations between CAD and several comorbidities and risk factors. In this study, hypertension ($P < 0.001$), diabetes ($P = 0.017$), smoking ($P < 0.001$), and kidney disease ($P = 0.039$) were significantly associated with CAD. In addition, the prevalence of high NLR was significantly greater among patients with high fever (mean = 36.65), hypertension (64.8%), diabetes (61.4%), smoking history (67.0%), and kidney disease (100%).

The association between inflammatory pathways and cardiovascular complications has been well explored in previous studies. Growing evidence suggests that CAD is an inflammatory condition that involves vascular inflammation. Given that the importance of inflammation in CAD patients has been highlighted in many studies, it is critical to use easily accessible inflammation markers to identify patients who are at risk. Complete blood cell counts are commonly used as an indicator of the patient's inflammatory status. In this study, elevated levels of total WBCs and neutrophil count were observed in patients from the high NRL group as compared to the normal NLR group. However, the lymphocyte count was significantly lower in the high NLR group (1.85±0.71) than in the normal NLR group (2.34±0.67). A similar pattern of increasing WBC and neutrophil counts while decreasing in lymphocyte counts in ACS patients has been previously reported (Shumilah et al., 2021).

Previous research efforts have thoroughly investigated whether a high NLR value can be clinically useful in predicting the onset and progression of various illnesses. The NLR was found to be an independent risk factor for cerebral hemorrhage, as well as positively correlated with lower extremity arterial disease and carotid atherosclerotic plaque in T2DM patients (Luo et al., 2017). The NLR was also reported as an independent risk factor for myocardial injury in COVID-19 patients, with 82.8% sensitivity and 69.5% specificity. In contrast, NLR has poor diagnostic value in the hyperglycemic Saudi population (Alfhili et al., 2022). An independent correlation between the development of myocardial injury and elevated NLR level was observed in patients following non-cardiac surgery (Durmuş et al., 2018). With regards to cardiovascular diseases, high NLR values were prospectively and significantly associated with incident atrial fibrillation (Berkovitch et al., 2019), mortality, and heart failure (Kim et al., 2018).

In various studies, NLR has consistently been identified as a reliable biomarker for predicting the risk in CAD patients both in the short and long term. However, it sounds like NLR is best suited for follow-up rather than screening or diagnosing cardiovascular diseases, though further investigation is certainly warranted. Zazula et al. (2008) investigated the diagnostic utility of NLR at admission for patients with chest pain. Patients with noncardiac chest pain had the lowest admission NLR, followed by unstable angina, non-ST-elevation MI, and ST-elevation MI with NLR values of (3 ± 1.6), (3.6 ± 2.9), (4.8 ± 3.7), and (6.9 ± 5.7), respectively (Zazula et al., 2008). Similarly, a high NLR in atherosclerosis indicates a higher risk of severe stenosis and plaque vulnerability. This is in line with findings observed in CCS, which demonstrated that elevated NLRs may indicate long-term MACEs. High NLR levels are linked to worse long-term outcomes and increased infarct sizes in ACS patients. This could be caused by ischemia-reperfusion damage, in-stent restenosis, and fibrinolysis failure, all of which are linked to elevated NLR levels. Yet, more research is needed to determine whether adding NLR to existing risk-stratification models improves the identification of patients at high risk for CAD (Agarwal et al., 2022).

In this study, we report an exceptionally high area under the curve (AUC) of 97.6% for the neutrophil-to-lymphocyte ratio (NLR) in predicting percutaneous coronary intervention (PCI) in patients with coronary artery disease (CAD). This value is notably higher than those reported in many previous studies, which typically range from 0.6 to 0.8 for NLR as a predictive biomarker for cardiovascular events. A study by Arbel et al. (2012) found that the NLR had an AUC of 0.68 for predicting the severity of coronary artery disease, while a study by Bekler et al. (2015) reported an AUC of 0.72 for predicting left ventricular systolic dysfunction in non-ST-elevation acute coronary syndrome. The discrepancy between the current study's findings and those of previous research could be attributed to several factors. Firstly, the current study's population may have unique characteristics, such as a higher prevalence of certain comorbidities or a distinct genetic background, that influence the relationship between NLR and PCI. Additionally, the study's retrospective design and single-center setting may have introduced selection biases that could explain the observed differences. Furthermore,

the current study used a cutoff value of 3.0 for NLR, which may differ from the cutoff values used in other studies, potentially affecting the diagnostic accuracy. Lastly, the current study's use of more comprehensive and sensitive diagnostic criteria for PCI may have contributed to the higher AUC value. The clinical actionability of NLR in this setting is significant. Given its high sensitivity (94.1%) and specificity (89.4%), NLR could serve as a valuable tool for risk stratification rather than a definitive rule-in test. Clinicians could use NLR to identify patients at higher risk of requiring PCI, allowing for earlier intervention and potentially improving patient outcomes.

Indeed, cardiac biomarkers have been extensively used as complements or alternatives to traditional techniques for the clinical diagnosis of cardiac injury. It is considered extremely important in the timely, accurate diagnosis and clinical management of acute coronary syndrome. Certain biomarker levels are routinely measured in clinical practice and clinical trials following a myocardial infarction to determine the extent of myocardial necrosis (Jacob and Khan, 2018). Of them, cardiac troponin and CK-MB are key biomarkers used for the identification of CAD. The troponin, in particular troponin I, has become the preferred cardiac biomarker for myocardial damage. While CK-MB is used in clinical medicine as a potential adjunct biomarker to identify CAD patients (Aldous 2013; Jacob and Khan, 2018). The current study found a significant mean difference ($P < 0.001$) in troponin I and CK-MB levels between normal and high NRL. Individuals with high NRL have significantly higher mean troponin I (0.30 ± 0.02) and CK-MB (80.20 ± 17.81). Indeed, troponin I is a very sensitive and accurate biomarker for cardiac damage that indicates myocardial injury. It is thus recommended as the primary diagnostic choice and a key reference for the identification of myocardial infarction. Numerous investigations revealed that troponin I can be found in the blood samples 3 to 4 hours following the myocardial infarction, peaks 16–18 hours later, and remains in the blood for up to two weeks. In addition to its role in the diagnosis of cardiovascular diseases, cardiac troponin levels are additionally utilized in clinical medicine to assess the prognosis and severity of myocardial damage.

On the other hand, CK-MB was considered a second-line biomarker for the identification of cardiovascular diseases. It is extensively utilized in clinical medicine for the routine diagnosis of coronary artery disease. Following the patient's experience of chest pain, their CK-MB concentration starts to rise in about 4~6 hours, peaks in 17 hours (±1 hour), and has a half-life of 11 hours (±1 hour) in plasma. It then starts to decrease at 48 hours and reaches the normal level in 48~72 hours (Xu et al., 2020). This study found that CK-MB and LDL were positively correlated with increasing NLR levels, suggesting that these markers could be used synergistically to identify ACS-associated inflammation. Although the role of troponin I in cardiovascular diseases, including CAD, has been well documented, the linear regression analysis revealed that NLR has no significant relationship with troponin I. The statistically insignificant but clinically significant association between NLR and troponin I could be attributed to SPSS's limitations when comparing very small values. However, further research is needed to elaborate on the correlation between the two biomarkers. Overall, our findings indicate a strong correlation between CK-MB and NLR, both of which were shown to be independent variables of PCI.

One of the key strengths of the current study is that it is the first to evaluate the role of NLR and CKMB as effective diagnostic and predictive inflammatory biomarkers for PCI among CAD patients in Saudi Arabia. Nevertheless, its findings should be interpreted in light of several significant limitations. One important limitation of this study is the marked predominance of male participants, which reflects the patient population at the study center but limits the generalizability of the findings. Sex-related differences in inflammatory responses, cardiovascular risk profiles, and clinical presentation of coronary artery disease are well established. Therefore, the strong association observed between NLR, CK-MB, and PCI in this cohort may not fully represent the predictive value of these biomarkers in female patients. The underrepresentation of women restricts sex-specific analysis and reduces the ability to draw conclusions applicable to the broader population. In addition, the single-center, retrospective design introduces inherent methodological constraints. Because biomarker measurements were limited to a single time point, temporal relationships and dynamic changes in NLR could not be assessed.

5. Conclusion

This study showed that elevated NLR and CK-MB levels are independently associated with the likelihood of undergoing PCI in patients suspected of coronary artery disease. NLR, in particular, demonstrated strong predictive performance and may serve as a simple, inexpensive adjunct marker for early risk stratification in routine clinical practice.

However, given the single-center design and limited female representation, these findings require further validation. Prospective multi-center studies with larger and more diverse populations, including serial NLR measurements, are needed to confirm the clinical value of NLR and clarify its role in improving risk prediction and decision-making in CAD patients.

List of abbreviations

ACS	Acute coronary syndrome
AOR	Adjusted odds ratio
AUC	Area under the curve
CAD	Coronary artery disease
CI	Confidence interval

CK	Creatine kinase
CK-MB	Creatine kinase-MB
COR	Crude odds ratio
CT	Computed tomography
CVD	Cardiovascular diseases
ECG	Electrocardiogram
Hb	Hemoglobin
HCT	Hematocrit
IQR	Interquartile range
LDL	Low-density lipoprotein
LYM	Lymphocyte count
MACEs	Major adverse cardiovascular events
MCH	Mean cell hemoglobin
MCHC	Mean cell hemoglobin concentration
MCV	Mean corpuscular volume
MI	Myocardial infarction
MRI	Magnetic resonance imaging
NEUT	Neutrophil count
NLR	Neutrophil-to-lymphocyte ratio
NPV	Negative predictive value
PAAMCC	Prince Abdullah Bin Abdulaziz Bin Musaed Cardiac Centre
PCI	Percutaneous coronary intervention
PLT	Platelet count
PPV	Positive predictive value
RBC	Red blood cell
RCA	Right coronary artery
ROC	Receiver operating characteristic
SD	Standard deviation
T2DM	Type 2 diabetes mellitus
U/L	Units per liter
WBC	White blood cell

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Compliance with ethical standards

Ethical considerations

The study protocol was approved by the Institutional Review Board (IRB) in Arar, Saudi Arabia (IRB Log No. NIC-IRB-024-05-10). Permission to access patients' medical records and clinical data was also obtained from the Director of Prince Abdullah Bin Abdulaziz Bin Musaed Cardiac Center (PAAMCC). The requirement for informed consent was waived by the IRB because the study was retrospective and used anonymized data collected from medical records.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Agarwal R, Aurora RG, Siswanto BB, and Muliawan HS (2022). The prognostic value of neutrophil-to-lymphocyte ratio across all stages of coronary artery disease. Coronary Artery Disease, 33(2): 137-143. https://doi.org/10.1097/MCA.0000000000001040 **PMid:33826535**

Aldous SJ (2013). Cardiac biomarkers in acute myocardial infarction. International Journal of Cardiology, 164(3): 282-294. https://doi.org/10.1016/j.ijcard.2012.01.081 **PMid:22341694**

Alfhili MA, Alsughayyir J, Basudan A et al. (2022). Isolated and combined effect of age and gender on neutrophil–lymphocyte ratio in the hyperglycemic Saudi population. Medicina, 58(8): 1040. https://doi.org/10.3390/medicina58081040 **PMid:36013507 PMCid:PMC9412958**

Arbel Y, Finkelstein A, Halkin A et al. (2012). Neutrophil/lymphocyte ratio is related to the severity of coronary artery disease and clinical outcome in patients undergoing angiography. Atherosclerosis, 225(2): 456-460. https://doi.org/10.1016/j.atherosclerosis.2012.09.009 **PMid:23040448**

Bauersachs R, Zeymer U, Briere JB, Marre C, Bowrin K, and Huelsebeck M (2019). Burden of coronary artery disease and peripheral artery disease: A literature review. Cardiovascular Therapeutics, 2019: 8295054. https://doi.org/10.1155/2019/8295054 **PMid:32099582 PMCid:PMC7024142**

Bekler A, Erbag G, Sen H, Gazi E, and Ozcan S (2015). Predictive value of elevated neutrophil-lymphocyte ratio for left ventricular systolic dysfunction in patients with non ST-elevated acute coronary syndrome. Pakistan Journal of Medical Sciences, 31(1): 159-163. https://doi.org/10.12669/pjms.311.5967 **PMid:25878635 PMCid:PMC4386178**

Berkovitch A, Younis A, Grossman Y, Segev S, Kivity S, Sidi Y, Beinart R, Goldenberg I, and Maor E (2019). Relation of neutrophil to lymphocyte ratio to risk of incident atrial fibrillation. The American Journal of Cardiology, 123(3): 396-401. https://doi.org/10.1016/j.amjcard.2018.10.036 **PMid:30502048**

Bhatt DL (2018). Percutaneous coronary intervention in 2018. JAMA, 319(20): 2127-2128. https://doi.org/10.1001/jama.2018.5281 **PMid:29800163**

Buonacera A, Stancanelli B, Colaci M, and Malatino L (2022). Neutrophil to lymphocyte ratio: An emerging marker of the relationships between the immune system and diseases. International Journal of Molecular Sciences, 23(7): 3636. https://doi.org/10.3390/ijms23073636 **PMid:35408994 PMCid:PMC8998851**

Chen C, Cong BL, Wang M, Abdullah M, Wang XL, Zhang YH, Xu SJ, and Cui L (2018). Neutrophil to lymphocyte ratio as a predictor of myocardial damage and cardiac dysfunction in acute coronary syndrome patients. Integrative Medicine Research, 7(2): 192-199. https://doi.org/10.1016/j.imr.2018.02.006 **PMid:29984180 PMCid:PMC6026362**

Durmuş G, Belen E, and Can MM (2018). Increased neutrophil to lymphocyte ratio predicts myocardial injury in patients undergoing non-cardiac surgery. Heart & Lung, 47(3): 243-247. https://doi.org/10.1016/j.hrtlng.2018.01.005 **PMid:29500104**

Grech ED (2003). Percutaneous coronary intervention. I: History and development. BMJ, 326: 1080. https://doi.org/10.1136/bmj.326.7398.1080 **PMid:12750213 PMCid:PMC1125993**

Ha ET, Yee A, Peterson SJ, Kobayashi Y, Sacchi T, Parikh M, and Brener SJ (2024). Neutrophil-to-lymphocyte ratio and prognosis in patients undergoing percutaneous coronary intervention for acute coronary syndrome. Cardiovascular

Revascularization Medicine, 60: 29-34.
https://doi.org/10.1016/j.carrev.2023.09.003
PMid:37714727

Hsu PS, Chen JL, Sung SY, Tsai YT, Lin CY, Wu YF, and Tsai CS (2023). Inflammatory biomarkers and blood physical property transformations following on-pump coronary artery bypass graft surgery. Journal of Personalized Medicine, 13(10): 1434.
https://doi.org/10.3390/jpm13101434
PMid:37888046 PMCid:PMC10607935

Jacob R and Khan M (2018). Cardiac biomarkers: What is and what can be. Indian Journal of Cardiovascular Disease in Women, 3(4): 240-244.
https://doi.org/10.1055/s-0039-1679104
PMid:31934672 PMCid:PMC6957084

Khawaja M, Britt M, Khan MA, Munaf U, Arshad H, Siddiqui R, Virk HU, Alam M, and Krittanawong C (2024). Left main coronary artery disease: A contemporary review of diagnosis and management. Reviews in Cardiovascular Medicine, 25(2): 66.
https://doi.org/10.31083/j.rcm2502066
PMid:39077332 PMCid:PMC11263144

Kim S, Eliot M, Koestler DC, Wu WC, and Kelsey KT (2018). Association of neutrophil-to-lymphocyte ratio with mortality and cardiovascular disease in the Jackson Heart Study and modification by the Duffy antigen variant. JAMA Cardiology, 3(6): 455-462.
https://doi.org/10.1001/jamacardio.2018.1042
PMid:29801037 PMCid:PMC6128503

Luo P, Li R, Yu S, Xu T, Yue S, Ji Y, Chen X, and Xie H (2017). The relationship between neutrophil-to-lymphocyte ratio and intracerebral hemorrhage in type 2 diabetes mellitus. Journal of Stroke and Cerebrovascular Diseases, 26(5): 930-937.
https://doi.org/10.1016/j.jstrokecerebrovasdis.2016.10.041
PMid:27908556

Mirna M, Schmutzler L, Topf A, Hoppe UC, and Lichtenauer M (2021). Neutrophil-to-lymphocyte ratio and monocyte-to-lymphocyte ratio predict length of hospital stay in myocarditis. Scientific Reports, 11: 18101.
https://doi.org/10.1038/s41598-021-97678-6
PMid:34518607 PMCid:PMC8438016

Shumilah AM, Othman AM, and Al-Madhagi AK (2021). Accuracy of neutrophil to lymphocyte and monocyte to lymphocyte ratios as new inflammatory markers in acute coronary syndrome. BMC Cardiovascular Disorders, 21: 422.
https://doi.org/10.1186/s12872-021-02236-7
PMid:34493205 PMCid:PMC8424963

Xu C, Zhang T, Zhu B, and Cao Z (2020). Diagnostic role of postmortem CK-MB in cardiac death: A systematic review and meta-analysis. Forensic Science, Medicine and Pathology, 16: 287-294.
https://doi.org/10.1007/s12024-020-00232-5
PMid:32193705

Zahorec R (2021). Neutrophil-to-lymphocyte ratio, past, present and future perspectives. Bratisl Lek Listy, 122(7): 474-488.
https://doi.org/10.4149/BLL_2021_078
PMid:34161115 PMCid:PMC9714399

Zazula AD, Précoma-Neto D, Gomes AM, Kruklis H, Barbieri GF, Forte RY, Langowiski AR, Facin G, Souza LC, and Faria Neto JR (2008). An assessment of neutrophils/lymphocytes ratio in patients suspected of acute coronary syndrome. Arquivos Brasileiros de Cardiologia, 90: 31-36.
https://doi.org/10.1590/S0066-782X2008000100006
PMid:18317638