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Original Research Article

Evaluation of systemic immune-inflammation index in young patients with coronary artery disease: association with glycaemic status

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ABSTRACT

Background: Coronary artery disease (CAD) in young adults is an important health concern, particularly in India. The Systemic Immune-Inflammation Index (SII) is a composite inflammatory marker derived from platelet, neutrophil and lymphocyte counts. However, limited information is available regarding its relationship with glycaemic status in young patients with CAD. To assess the association of Systemic Immune-Inflammation Index (SII) with glycaemic status and evaluate cardiovascular risk factors, comorbidities, clinical, laboratory, biochemical and angiographic characteristics in young patients with coronary artery disease.

Methods: A prospective observational study was conducted among 80 patients aged 18–45 years with CAD admitted to the Coronary Care Unit of Bangalore Baptist Hospital, Bangalore, during 2025. Demographic, clinical, laboratory, echocardiographic and angiographic data were collected. SII was calculated as platelet count × neutrophil count / lymphocyte count. Patients were grouped according to SII level and glycaemic status and the groups were compared using appropriate statistical tests.

Results: The mean age was 38.6±3.6 years, with males accounting for 87.5% of participants. Smoking (53.8%), diabetes (43.8%) and hypertension (36.3%) were the most common cardiovascular risk factors. The mean SII was 1049±881. Significant differences between the SII and glycaemic groups were observed for age ($p=0.039$), dyslipidaemia ($p=0.006$), HbA1c ($p<0.00001$), platelet count ($p=0.0003$), neutrophil count ($p<0.00001$) and lymphocyte count ($p<0.00001$). Angiographic disease extent did not differ significantly between the groups ($p=0.379$).

Conclusions: SII showed significant differences according to glycaemic status, particularly in relation to HbA1c and its cellular components. SII may provide additional information regarding systemic inflammation in young patients with CAD.

Keywords: Coronary artery disease, Glycaemic status, Systemic immune-inflammation index, Type 2 diabetes mellitus, Young adults

INTRODUCTION

CAD is a major cause of morbidity and mortality worldwide.¹ Young CAD, commonly defined as CAD occurring before 45 years of age, is an increasing concern in India.² Smoking, obesity, physical inactivity, diabetes, hypertension, dyslipidaemia and family history are

important risk factors.^{1,2} Early identification and prevention of these risk factors are essential to reduce the long-term health burden of CAD in young adults. India has a substantial burden of cardiovascular disease (CVD), with cardiovascular events occurring at a younger age compared with Western populations.³ The increasing prevalence of metabolic risk factors, including obesity, hypertension, diabetes and dyslipidaemia, has contributed

to the growing burden of premature CAD.⁴ These risk factors contribute to the development and progression of atherosclerosis, which may result in plaque formation, instability and clinical events such as angina and myocardial infarction.⁵

Premature CAD is particularly important in the Indian population because of its increasing occurrence among younger adults.^{6,7} A systematic review of young South Asian patients with CAD reported a high prevalence of modifiable cardiovascular risk factors, including smoking, dyslipidaemia, obesity and diabetes.⁸ Studies from India have also reported a high prevalence of cardiovascular risk factors among young patients with CAD, including smoking, diabetes, hypertension, dyslipidaemia, obesity and family history.⁹⁻¹² Therefore, identifying additional markers that may help to assess the inflammatory component of CAD is of clinical interest.

Inflammation plays an important role in the development and progression of atherosclerosis. Changes in inflammatory and immune responses may contribute to plaque formation and instability, thereby increasing the risk of coronary events.⁵ Systemic inflammatory markers may therefore provide additional information about the inflammatory state associated with CAD. Recent studies have reported associations between systemic inflammatory indices and cardiovascular outcomes in patients with CAD.^{13,14}

The systemic immune-inflammation index (SII) is a simple inflammatory marker derived from routinely available blood count parameters. It is calculated using the formula: $SII = \text{platelet count} \times \text{neutrophil count} / \text{lymphocyte count}$. SII combines information from platelets, neutrophils and lymphocytes and may reflect the balance between inflammatory and immune responses.^{15,16} Previous studies have reported associations between SII and coronary artery disease, coronary thrombus burden and cardiovascular outcomes.^{15,17,18} Recent systematic reviews and meta-analyses have also reported an association between elevated SII and adverse cardiovascular outcomes, including major adverse cardiovascular events, in patients with CAD and those undergoing percutaneous coronary intervention.^{19,20}

Diabetes mellitus is an important risk factor for premature CAD and is associated with inflammatory processes.^{21,22} The interaction between inflammation and abnormal glucose metabolism may therefore be relevant in young patients with CAD. Studies have reported an association between SII and type 2 diabetes mellitus, suggesting that SII may reflect inflammatory changes associated with altered glycaemic status.^{22,23} Additional cardiovascular risk factors are also frequently observed among young adults with type 2 diabetes mellitus.²¹

However, limited information is available on the relationship between SII and glycaemic status in young patients with CAD. Therefore, this study assessed the

association between SII and glycaemic status in young CAD patients.

METHODS

A prospective observational study was conducted for a period of 6 months in 2025 at the Coronary Care Unit (CCU) of Bangalore Baptist Hospital, Bangalore, India. The study included 80 patients aged 18–45 years who were admitted with coronary artery disease (CAD) and underwent coronary angiography. Patients aged below 18 years or above 45 years and those with congenital or valvular heart disease or pregnancy were excluded.

Patient demographic details, clinical findings, laboratory investigations, treatment details, echocardiography findings and angiographic findings were collected from case notes, treatment and medication charts, laboratory reports, angiogram profiles, ECHO reports and the data collection form. Information regarding major cardiovascular risk factors such as smoking, diabetes, hypertension, obesity, dyslipidaemia, family history and previous cardiovascular events was recorded.

The SII was calculated from the available laboratory parameters using the formula: $SII = \text{platelet count} \times \text{neutrophil count} / \text{lymphocyte count}$. The collected data were also assessed for clinical presentation, complications, left ventricular function and angiographic findings such as SVD, DVD, TVD, TIMI flow, lesion severity and presence of thrombus. The association between SII and diabetes mellitus among young patients with CAD was assessed.

The collected data were entered and analyzed statistically. Descriptive statistics were used to summarize the demographic, clinical, laboratory and angiographic findings. The results were expressed as frequencies, percentages, means and standard deviations, as appropriate. The findings were interpreted to assess the pattern of SII and its association with diabetes mellitus in young patients with CAD.

Statistical analysis

Descriptive statistics including mean, standard deviation and percentages were used and normality was assessed using the Shapiro–Wilk test. Mann–Whitney U test was used for comparison of two continuous variables, Chi-square or Fisher's exact test for categorical variables and one-way ANOVA for comparisons among more than two groups, as appropriate. A p value <0.05 was considered statistically significant and all analyses were performed using the Social Science Statistics online calculator.

RESULTS

As shown in table 1, the study included 80 participants with a mean age of 38.6 ± 3.6 years, with most aged 41–45 years (47.5%) and a male predominance (87.5%). Most

participants worked in the private sector (42.5%) or business (25%) and 65% reported low physical activity. Smoking was the most common risk factor (53.8%), followed by diabetes (43.8%), hypertension (36.3%), BMI $>25 \text{ kg/m}^2$ (30.0%) and dyslipidaemia (18.8%).

Mean lipid levels were total cholesterol $153.8 \pm 75.2 \text{ mg/dl}$, HDL $33.9 \pm 15.0 \text{ mg/dl}$, LDL $110.1 \pm 53.9 \text{ mg/dl}$ and triglycerides $142.0 \pm 101.0 \text{ mg/dl}$. Previous myocardial infarction and chronic kidney disease were reported in 18.0% and 8.0%, respectively, while cerebrovascular

accident was reported in 1.0% and no peripheral vascular disease was observed.

Table 2 shows that chest pain was the most common symptom (83.8%), followed by sweating (27.5%) and dyspnoea (21.3%). Most patients had preserved LVEF of 50–60% (73%) and normal chest X-rays (92.5%). STEMI was the predominant diagnosis, with anterior wall MI (33.75%) and inferior wall MI (21.25%) being the commonest types, followed by NSTEMI (16.25%) and unstable angina (13.75%).

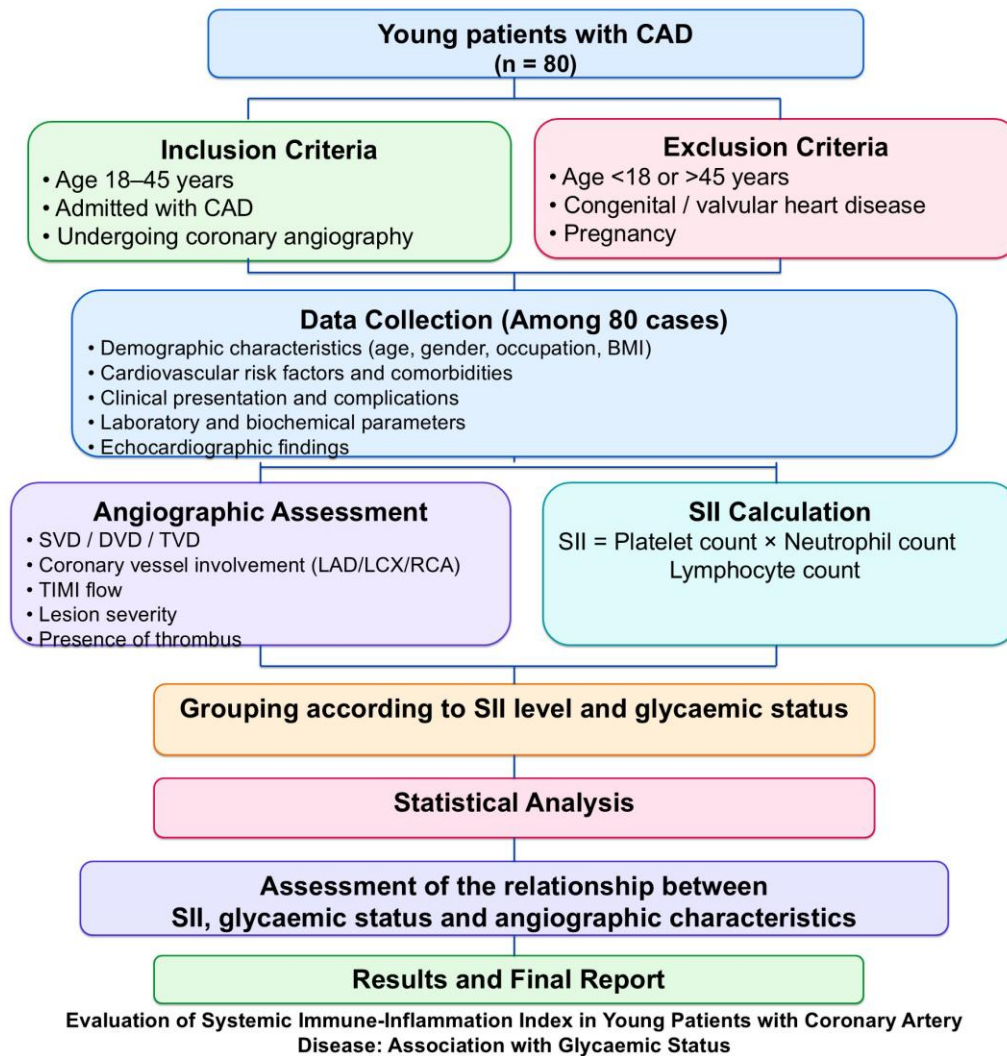


Figure 1: Flowchart of the study methodology.

Killip class distribution is presented in table 3, with most patients classified as Class I (90.0%), followed by Class III (7.5%) and Class IV (2.5%). No patients were classified as Class II.

Laboratory parameters are presented in Table 4. The mean SII was 1049 ± 881 , with mean neutrophil, lymphocyte and platelet counts of 64.67 ± 11.72 , 26.37 ± 13.01 and 2.94 ± 0.85 , respectively. Fatty liver was observed in 15%

of participants, including Grade 1 in 5% and Grade 2 in 10%.

Acute coronary syndrome was the most common complication (18.75%), followed by ventricular tachycardia and cardiogenic shock (5.0% each). Heart failure, stroke and peripheral arterial disease were reported in 1.25% each, while cardiac death occurred in 2.5% of participants (Table 5).

Table 6 shows that single-vessel disease was the most common angiographic pattern (41.25%), followed by normal/re canalized arteries (36.25%), double-vessel disease (17.5%) and triple-vessel disease (5.0%). Among patients with SVD, the LAD was most commonly involved (75.75%). In DVD, LAD+LCX and LCX+RCA were the most frequent combinations (35.71% each), while all patients with TVD had involvement of LAD, LCX and RCA.

Table 7 compares patients according to SII level and glycaemic status. Significant differences were observed in age ($p=0.039$), dyslipidaemia ($p=0.006$), HbA1c ($p<0.00001$), platelet count ($p=0.0003$), neutrophil count ($p<0.00001$) and lymphocyte count ($p<0.00001$). HbA1c, platelet and neutrophil counts were higher in the SII-high groups, while lymphocyte counts were lower. Gender, BMI, smoking, hypertension, HDL, LDL, creatinine, LVEF and angiographic extent did not show statistically significant differences between the groups.

Table 1: Demographic characteristics, cardiovascular risk factors and past medical history of study participants (n=80).

Characteristics	N (%) / Mean±SD
Age (in years)	38.65±3.61
Age groups (in years)	
21–25	1 (1.25)
26–30	5 (6.25)
31–35	16 (20.0)
36–40	20 (25.0)
41–45	38 (47.50)
Gender	
Male	70 (87.50)
Female	10 (12.50)
Cardiovascular risk factors	
Smoking	43 (53.80)
Family history	1 (1.30)
Hypertension	29 (36.30)
Diabetes	35 (43.80)
BMI >25 kg/m ²	24 (30.0)
Dyslipidaemia	15 (18.80)
Lipid profile	
Total cholesterol	153.76±75.23
HDL	33.85±15.04
LDL	110.10±53.86
Triglycerides	141.96±101.03
Past Medical History	
Myocardial infarction	14 (18.0)
Cerebrovascular accident	1 (1.0)
Peripheral vascular disease	0 (0)
Chronic kidney disease	6 (8.0)

Table 2: Clinical presentation, echocardiographic findings, diagnosis of study participants (n=80).

Characteristics	N (%)
Clinical presentation	
Chest pain	67 (83.75)
Sweating	22 (27.50)
Dyspnoea	17 (21.25)
Nausea/vomiting	10 (1.25)
Arrhythmia	7 (8.75)
Giddiness	12 (1.50)
Pulmonary oedema	6 (7.50)
ECHO–LVEF	
<30%	0 (0)
30–39%	1 (1.0)

Continued.

Characteristics	N (%)
40–49%	21 (26.0)
50–60%	58 (73.0)
>60%	0 (0)
CAD diagnosis	
STEMI	45 (56.25)
AWMI	27 (33.75)
IWMI	17 (21.25)
LWMI	0 (0)
PWMI	1 (1.25)
NSTEMI	13 (16.25)
Unstable angina	10 (12.75)
IHD	1 (1.25)
Unspecified	11 (13.75)
CXR findings	
Normal	74 (92.50)
Cardiomegaly	0 (0)
Pulmonary oedema	6 (7.50)

Table 3: Distribution of study participants according to killip class (n=80).

Killip class	N (%)
Class I	72 (90.0)
Class II	0 (0)
Class III	6 (7.50)
Class IV	2 (2.50)

Table 4: Laboratory, biochemical and clinical parameters of study participants (n=80).

Laboratory parameters	N (Mean±SD) / N (%)
Hb (g/dl)	80 (14.09±2.26)
Neutrophil count (10³/μl)	80 (64.67±11.72)
Lymphocyte count (10³/μl)	80 (26.37±13.01)
Monocyte count (10³/μl)	80 (6.81±1.94)
WBC count (10³/μl)	80 (8.20±3.72)
Platelet count (10⁹/l)	79 (2.94±0.85)
Systemic immune-inflammation index (SII)	80 (1049±881)
PT time (sec)	34 (12.23±3.07)
INR	22 (1.064±0.417)
Sodium (Na)	80 (137±2.39)
Potassium (K)	80 (4.27±0.497)
Creatinine (mg/dl)	79 (1.34±1.47)
Troponin T (ng/ml)	30 (713.75±1885.64)
HDL	70 (38.68±8.46)
LDL	70 (125.82±36.56)
Total cholesterol (mg/dl)	70 (175.72±51.07)
Triglycerides (mg/dl)	69 (164.59±90.05)
SGOT (U/l)	50 (80.94±88.48)
SGPT (U/l)	50 (46.38±45.55)
TSH	57 (4.44±7.73)
SBP (mmHg)	80 (126.62±22.99)
DBP (mmHg)	80 (79.15±16.26)
Heart rate (bpm)	80 (88.00±22.62)
SpO₂ (%)	80 (96.53±3.55)
ANA, N (%)	2 (2.5)
USG fatty liver, N (%)	12 (15.0)

Continued.

Laboratory parameters	N (Mean±SD) / N (%)
Grade 1	4 (5.0)
Grade 2	8 (10.0)

Table 5: Complications and clinical outcomes.

Complications/Outcomes	N (%)
Acute coronary syndrome	15 (18.75)
Ventricular tachycardia	4 (5.0)
Cardiogenic shock	4 (5.0)
Heart failure	1 (1.25)
Stroke	1 (1.25)
Peripheral arterial disease	1 (1.25)
Cardiac death	2 (2.5)

Table 6: Angiographic Pattern and Coronary Vessel Involvement Among Study Participants (n=80).

Angiographic characteristics	N (%)
Extent of coronary artery disease	
Single-vessel disease (SVD)	33 (41.25)
Double-vessel disease (DVD)	14 (17.50)
Triple-vessel disease (TVD)	4 (5.00)
Normal/recanalized arteries	29 (36.25)
Coronary territory involved	
SVD (n=33)	
LAD	25 (75.75)
LCX	4 (12.12)
RCA	4 (12.12)
DVD (n=14)	
LAD+LCX	5 (35.71)
LCX+RCA	5 (35.71)
LAD+RCA	4 (28.57)
TVD (n=4)	
LAD+LCX+RCA	4(100)

Table 7: Baseline characteristics for patients stratified by the level of SII and different glycaemic metabolism status.

Variables	SII-Low/T2DM	SII-Low/Non-T2DM	SII-High/T2DM	SII-High/Non-T2DM	P value
Baseline characteristics					
Age, years	40.09±4.63	39.86±4.62	40.41±4.30	36.73±5.87	0.039
Gender					
Male	8 (72.72%)	13 (86.66%)	20 (83.33%)	29 (96.60%)	0.180
Female	3 (27.27%)	2 (13.33%)	4 (16.66%)	1 (3.33%)	
BMI >25 kg/m ²	6 (54.54%)	4 (26.66%)	4 (16.66%)	10 (33.33%)	0.143
Dyslipidaemia	6 (54.54%)	3 (20.00%)	4 (16.66%)	2 (6.66%)	0.006
Smoking	5 (45.45%)	7 (46.66%)	10 (41.66%)	21 (70.00%)	0.157
Hypertension	4 (36.36%)	4 (26.66%)	12 (50.00%)	9 (30.00%)	0.381
HbA1c	7.57±2.00	5.87±0.84	8.35±2.90	5.65±0.63	<0.00001
Laboratory parameters					
Platelets	2.26±0.92	2.45±0.50	3.32±0.80	3.04±0.72	0.0003
Neutrophils	53.18±10.38	54.87±10.13	70.45±7.62	69.60±9.33	<0.00001
Lymphocytes	35.63±10.42	40.73±15.85	20.33±6.83	20.63±8.25	<0.00001
HDL	37.00±5.85	40.50±6.59	37.63±9.74	39.29±9.10	0.721
LDL	110.11±32.20	126.00±32.56	129.72±45.49	127.81±32.40	0.588
Creatinine	1.14±0.65	1.65±2.67	1.33±1.17	1.29±1.18	0.840

Continued.

LVEF	54.45±6.36	55.53±6.96	51.25±7.49	53.73±7.31	0.295
Angiographic data					
SVD	7 (63.63%)	6 (40.00%)	11 (45.83%)	9 (30.00%)	
DVD+TVD	1 (9.00%)	2 (13.33%)	8 (33.33%)	7 (23.33%)	0.379

DISCUSSION

Young-onset coronary artery disease remains an important clinical concern, particularly in India, where CAD may occur at a younger age and is often associated with multiple cardiovascular risk factors. The present study evaluated 80 young patients with CAD, with particular focus on the relationship between Systemic Immune-Inflammation Index (SII) and glycaemic status. The mean age of the study population was 38.6±3.6 years, with 47.5% of patients belonging to the 41–45 years age group. Previous Indian studies have also reported a considerable burden of CAD among younger adults, highlighting the increasing importance of premature CAD in the Indian population.^{1,2} Demographic analysis showed a marked male predominance, with males accounting for 87.5% of the study population. Similar findings have been reported in previous studies involving young patients with CAD and myocardial infarction.^{9–12} The higher proportion of males observed in these studies may be related to the greater prevalence of conventional cardiovascular risk factors among young men. In the present study, smoking was the most common cardiovascular risk factor (53.8%), followed by diabetes (43.8%), hypertension (36.3%), BMI >25 kg/m² (30.0%) and dyslipidaemia (18.8%). Similar patterns of risk factors have been reported in young Indian patients with CAD, where smoking, diabetes, hypertension, obesity and dyslipidaemia were commonly observed.^{7,8} These findings indicate that modifiable metabolic and lifestyle-related factors contribute substantially to the development of CAD at a younger age.

Clinical presentation showed that chest pain was the most common symptom (83.8%), followed by sweating (27.5%) and dyspnoea (21.3%). Most patients had preserved left ventricular function, with 73% having an LVEF of 50–60%. Previous studies of young CAD patients have also reported chest pain as the predominant presenting symptom.^{1,11} In the present study, 90% of patients were classified as Killip class I, indicating that most patients did not have clinical evidence of heart failure at presentation.

The mean SII in the present study was 1049±881. SII is a composite inflammatory marker derived from platelet, neutrophil and lymphocyte counts and has been investigated in patients with CAD and acute coronary syndrome. Previous studies have reported associations between SII and coronary disease and coronary thrombus burden.^{13,15} The elevated mean SII observed in the present study supports the presence of an inflammatory component among young patients with CAD.

The main finding of this study was the significant difference in SII-related parameters across the four groups

based on SII level and glycaemic status. HbA1c showed a highly significant difference between the groups ($p<0.00001$), with higher values observed among patients with diabetes. This finding is consistent with previous studies reporting an association between SII and diabetes mellitus or abnormal glucose metabolism.^{18,22,23} The findings suggest that glycaemic status may be an important factor to consider when interpreting SII in young patients with CAD.

The individual components of SII also showed significant differences between the groups. Platelet count ($p=0.0003$) and neutrophil count ($p<0.00001$) were higher in the SII-high groups, whereas lymphocyte count was significantly lower ($p<0.00001$). These findings are consistent with the components contributing to the calculation of SII and support its role as a composite marker reflecting inflammatory and immune status.^{13,15} Dyslipidaemia showed a statistically significant difference between the four groups ($p=0.006$). The highest proportion of dyslipidaemia was observed in the SII-low/T2DM group (54.54%), while the lowest was observed in the SII-high/non-T2DM group (6.66%). In contrast, HDL and LDL levels did not differ significantly between the groups. Previous studies have identified dyslipidaemia as an important risk factor for premature CAD, particularly among young South Asian patients.^{8,12} The present finding suggests that the distribution of dyslipidaemia may vary according to the combination of inflammatory and glycaemic status.

Age also showed a statistically significant difference between the four groups ($p=0.039$). However, gender, BMI, smoking and hypertension did not show significant differences. Similarly, creatinine and LVEF were not significantly different between the groups. These findings indicate that the differences between the SII and glycaemic groups were more evident for inflammatory and glycaemic parameters than for several conventional clinical characteristics. Angiographic assessment showed that single-vessel disease was the most common pattern (41.25%), followed by normal/recanalized arteries (36.25%), double-vessel disease (17.5%) and triple-vessel disease (5.0%). Among patients with single-vessel disease, the LAD was the most commonly involved vessel (75.75%). Similar predominance of single-vessel disease and LAD involvement has been reported in studies of young patients with CAD.^{8–12} However, angiographic extent did not differ significantly between the four SII and glycaemic groups ($p=0.379$). Therefore, the present study did not demonstrate a significant association between SII-glycaemic grouping and the extent of coronary artery disease. Previous research has mainly evaluated SII in relation to CAD, acute coronary syndrome, thrombotic burden and cardiovascular outcomes.^{13,15,19,20} Studies have

also examined the relationship between SII and diabetes and have reported associations with adverse outcomes in diabetic populations.^{17,22,23} However, these studies largely involved broader patient populations, whereas the present study specifically focused on young patients with CAD and assessed SII according to glycaemic status.

Limitations

A primary limitation of this study was the relatively small sample size of 80 participants and its single-centre design, which may limit the statistical power and generalizability of the findings. The observational design limits the ability to establish a causal relationship between SII and glycaemic status. The absence of long-term follow-up prevented assessment of the prognostic significance of SII and major adverse cardiovascular outcomes. Additionally, some laboratory parameters were unavailable for all participants, which may have affected certain comparisons and other factors influencing inflammatory status were not assessed.

CONCLUSION

The present study highlights a high burden of modifiable cardiovascular risk factors among young patients with CAD, with smoking being the most common risk factor (53.8%), followed by diabetes (43.8%) and hypertension (36.3%). Single-vessel disease was the predominant angiographic pattern, with the LAD being the most frequently involved vessel. The main finding was a significant association between SII and glycaemic status, with significant differences in HbA1c, platelet, neutrophil and lymphocyte counts across the SII-glycaemic groups. However, SII-glycaemic grouping was not significantly associated with angiographic disease extent. These findings suggest that SII may serve as a useful additional inflammatory marker in young patients with CAD, particularly in relation to glycaemic status.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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