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Original Research Article

Metabolic Syndrome and Its Association with Cardiometabolic and Inflammatory Risk Factors in Patients with Acute Coronary Syndrome: A Cross-Sectional Study

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Abstract

Background: Metabolic syndrome (MS) comprises a cluster of interrelated cardiometabolic abnormalities that increase cardiovascular risk. Its coexistence with acute coronary syndrome (ACS) may contribute to an adverse metabolic and inflammatory profile. This study evaluated the prevalence of MS and its association with cardiometabolic and inflammatory risk factors in patients with ACS.

Methods: A descriptive cross-sectional observational study was conducted among 200 patients with ACS admitted to the Medicine Intensive Care Unit of Acharya Vinoba Bhave Rural Hospital, Wardha, over two years.

Results: MS was present in 103 (51.5%) patients. STEMI was the predominant ACS presentation, although ACS subtype was not significantly associated with MS (p=0.21). Diabetes mellitus was significantly more frequent in patients with MS than without MS (51.46% vs. 12.37%, p<0.0001), as was hypertension (66.02% vs. 26.80%, p<0.0001). BMI ≥23 kg/m² was significantly more common in the MS group (68.93% vs. 32.99%, p<0.0001). Central obesity, elevated fasting blood glucose, hypertriglyceridemia, and low HDL-C were significantly associated with MS (p<0.0001). CRP positivity was markedly higher among patients with MS than those without MS (66.9% vs. 15.5%, p<0.0001).

Conclusion: MS was highly prevalent among patients with ACS and was strongly associated with cardiometabolic abnormalities and systemic inflammation. Comprehensive assessment of metabolic and inflammatory risk factors may facilitate better identification and management of high-risk ACS patients. Metabolic abnormalities among patients with BMI <23 kg/m² further emphasize that BMI alone may not adequately reflect cardiometabolic risk.

Keywords: Acute Coronary Syndrome; Metabolic Syndrome; Cardiometabolic Risk; Cardiovascular Risk.

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Introduction

Acute coronary syndrome (ACS) is one of the most important clinical manifestations of coronary artery disease (CAD) and includes unstable angina (UA), ST-segment elevation myocardial infarction (STEMI), and non-ST-segment elevation myocardial infarction (NSTEMI). It usually results from acute disruption of an atherosclerotic coronary plaque followed by thrombus formation, leading to myocardial ischemia or infarction. ACS continues to be a major cause of morbidity and mortality worldwide. The burden of CAD is particularly important in India, where cardiovascular disease often occurs at a relatively younger age and is associated with a high prevalence of risk factors such as diabetes mellitus, hypertension, dyslipidemia, smoking, and obesity. Data from the CREATE registry have further highlighted the substantial burden of ACS and its clinical and outcome characteristics in the Indian population. [1,2] The development of CAD is complex and involves the interaction of genetic, environmental, lifestyle, metabolic, inflammatory, and vascular factors. Traditional cardiovascular risk factors such as diabetes mellitus, hypertension, smoking, dyslipidemia, and obesity play an important role in the development and progression of atherosclerosis. The INTERHEART study, conducted across 52 countries, demonstrated that potentially modifiable risk factors account for a large proportion of the risk of myocardial

infarction. These included diabetes, hypertension, smoking, abnormal lipid levels, abdominal obesity, physical inactivity, and psychosocial factors. The coexistence of several of these risk factors in the same individual may further increase cardiovascular risk. [3]

Metabolic syndrome (MetS) refers to the clustering of several interrelated metabolic abnormalities that together increase the risk of cardiovascular disease and type 2 diabetes mellitus. The major components include central obesity, elevated blood pressure, impaired glucose regulation, elevated triglycerides, and reduced high-density lipoprotein cholesterol (HDL-C). Although each component independently contributes to cardiovascular risk, their presence in combination may have an additive or synergistic effect. Metabolic syndrome is closely associated with insulin resistance, visceral adiposity, atherogenic dyslipidemia, endothelial dysfunction, and a chronic low-grade inflammatory state. [4,5]

Insulin resistance is considered one of the important underlying mechanisms in the development of metabolic syndrome. Increased visceral adiposity results in increased release of free fatty acids and various adipokines, which can adversely affect insulin signaling and glucose metabolism. This may lead to hyperglycemia, increased triglyceride levels, reduced HDL-C, endothelial dysfunction, and a prothrombotic state. These metabolic abnormalities contribute to endothelial injury and progression of atherosclerosis and may ultimately increase the susceptibility to acute coronary events. [5,6]

The relationship between metabolic syndrome and cardiovascular disease has been demonstrated in several epidemiological studies. A large systematic review and meta-analysis involving more than 950,000 individuals reported that metabolic syndrome was associated with approximately a two-fold increase in the risk of cardiovascular disease and myocardial infarction, along with increased cardiovascular and all-cause mortality. Importantly, cardiovascular risk remained elevated even in individuals with metabolic syndrome who did not have diabetes mellitus. This finding highlights the importance of the overall clustering of metabolic abnormalities rather than focusing on hyperglycemia alone. [7]

Metabolic syndrome is particularly relevant among patients presenting with ACS because of its high prevalence in this population. Previous studies have reported a substantial burden of metabolic syndrome among patients with ACS. Dhakhada et al. reported a prevalence of approximately 59% among ACS patients, with a slightly higher prevalence among males. Similarly, Sowdagar et al. reported that 60% of patients with ACS had metabolic syndrome, while 40% did not. [8,9] The individual components of metabolic syndrome are also important determinants of cardiovascular risk. Central obesity, assessed by waist circumference, is a useful marker of visceral adiposity and may provide additional information beyond body mass index (BMI). Increased abdominal adiposity is closely associated with insulin resistance, dyslipidemia, hypertension, and inflammation. Similarly, increased BMI, elevated fasting blood glucose, hypertriglyceridemia, and low HDL-C are frequently observed in individuals with metabolic syndrome. Therefore, assessment of these parameters provides a more comprehensive understanding of the metabolic abnormalities associated with ACS. [10]

C-reactive protein (CRP) is one of the most commonly studied markers of systemic inflammation. It is an acute-phase protein produced mainly by the liver in response to inflammatory cytokines. Increased CRP levels have been associated with cardiovascular risk in both apparently healthy individuals and patients with established cardiovascular disease. Several large epidemiological studies and meta-analyses have demonstrated an association between elevated CRP levels and the risk of coronary heart disease, stroke, and cardiovascular mortality. [11,12] The Emerging Risk Factors Collaboration also demonstrated an association between CRP concentration and the risk of coronary heart disease, stroke, and mortality, supporting its role as a marker of systemic inflammatory burden.

Despite the well-established relationship between metabolic syndrome and cardiovascular disease, evaluation of the combined cardiometabolic and inflammatory profile of patients presenting with ACS remains clinically relevant, particularly in the Indian population.

Therefore, the present study, “Metabolic Syndrome and Its Association with Cardiometabolic and Inflammatory Risk Factors in Patients with Acute Coronary Syndrome,” was undertaken to assess the prevalence of metabolic syndrome among patients with ACS and to evaluate its association with BMI, waist circumference, diabetes mellitus, hypertension, fasting blood glucose, triglycerides, HDL-C, smoking, and serum CRP.

The study aims to provide a comprehensive assessment of the cardiometabolic and inflammatory characteristics associated with metabolic syndrome in patients presenting with ACS and to highlight the importance of early identification and management of modifiable cardiovascular risk factors.

Material and Methods

Study Setting: The present study entitled **"**Metabolic Syndrome and Its Association with Cardiometabolic and Inflammatory Risk Factors in Patients with Acute Coronary Syndrome" was conducted in the Department of Medicine, Acharya Vinoba Bhave Rural Hospital, Jawaharlal Nehru Medical College, Sawangi (Meghe), Wardha.

Ethical Approval: The study was initiated only after obtaining permission from the Institutional Ethics Committee, Datta Meghe Institute of Medical Sciences (Deemed to be University), Sawangi (Meghe), Wardha. Patients willing to participate in the study were evaluated after obtaining informed consent.

Study Design: A descriptive cross-sectional observational study was conducted to assess the prevalence of metabolic syndrome among patients with acute coronary syndrome and to evaluate its association with selected cardiometabolic and inflammatory risk factors.

Study Duration: The study was conducted over a period of two years.

Study Population and Sample Size: The study included 200 diagnosed patients with acute coronary syndrome admitted to the Medicine Intensive Care Unit. All eligible patients who fulfilled the study criteria and consented to participate were included.

Inclusion Criteria:

1. Patients diagnosed cases of acute coronary syndrome.
2. Patients admitted to the Medicine Intensive Care Unit.
3. Patients willing to participate in the study and provide informed consent.

Exclusion Criteria

Patients with the following conditions were excluded:

1. Pericardial disease.
2. Wolff–Parkinson–White syndrome.
3. Valvular heart disease.
4. Patients receiving digoxin or amiodarone, as these drugs may produce ST–T wave changes and interfere with ECG interpretation.

Definition and Diagnosis of Acute Coronary Syndrome: The diagnosis of ACS was based on the European Society of Cardiology/American College of Cardiology criteria (2000). Acute myocardial infarction was diagnosed on the basis of a typical rise and gradual fall in troponin or a more rapid rise and fall in CK-MB, together with at least one of the following:

- Symptoms suggestive of myocardial ischemia;
- Development of pathological Q waves on ECG;
- ECG changes indicative of myocardial ischemia, including ST-segment elevation or depression; or
- Evidence of coronary artery intervention, including coronary angioplasty.

Definition and Diagnosis of Metabolic Syndrome: Metabolic syndrome was diagnosed according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria. The presence of at least three of the following five components was required for diagnosis:

1. **Elevated fasting blood glucose:** >100 mg/dL or current treatment with insulin or oral hypoglycemic agents.
2. **Elevated triglycerides:** >150 mg/dL.
3. **Reduced HDL cholesterol:** <40 mg/dL in males and <50 mg/dL in females.
4. **Increased waist circumference:** >90 cm in males and >80 cm in females.

Based on these criteria, the study participants were divided into:

- Metabolic Syndrome (MS) group
- Non-Metabolic Syndrome (NMS) group

Assessment of Serum C - reactive protein:

Serum C-reactive protein (CRP) was assessed using a latex agglutination slide test. The test was based on the principle of agglutination between CRP present in the patient's serum and CRP-specific latex particles. One drop of serum was placed on the test slide and mixed with one drop of CRP latex reagent. The slide was gently rocked and examined macroscopically after approximately two minutes.

The results were interpreted as:

- **CRP positive:** visible agglutination, corresponding to a CRP concentration >0.6 mg/dL.
- **CRP negative:** absence of visible agglutination, corresponding to a CRP concentration <0.6 mg/dL.

Statistical Analysis: Data were entered and analyzed using Epi Info software, version 3.5.3. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were expressed as frequencies and percentages. The Chi-square (χ^2) test was used to determine associations between categorical variables. Where appropriate, a corrected Chi-square test was applied. A p-value <0.05 was considered statistically significant.

Observation and Results

Table 1: Distribution of patients according to type of ACS in subjects with metabolic syndrome and without metabolic syndrome

Type of ACS	Metabolic Syndrome (n=103)	Non-Metabolic Syndrome (97)	Total (200)	χ^2 -value	p-value
NSTEMI	11(10.68%)	12(12.37%)	23(11.50%)	3.11	0.21 NS
STEMI	76(73.79%)	61(62.89%)	137(68.50%)		
UA	16(15.53%)	24(24.74%)	40(20.00%)		
Total	103(100%)	97(100%)	200(100%)		

NS-Not Significant

Among the 200 patients with acute coronary syndrome, 103 (51.5%) had metabolic syndrome, while 97 (48.5%) did not. STEMI was the most common presentation in both groups, occurring in 73.79% of patients with metabolic syndrome and 62.89% of those without metabolic syndrome. NSTEMI was observed in 10.68% and 12.37%, respectively, whereas unstable angina accounted for 15.53% and 24.74% of cases. Although STEMI was numerically more frequent among patients with metabolic syndrome and unstable angina was more frequent among those without metabolic syndrome, the difference in the distribution of ACS types between the Metabolic Syndrome and Non-Metabolic Syndrome groups was not statistically significant ($\chi^2 = 3.11$, $p = 0.21$).

Table 2: Age- and Sex-wise Distribution of Patients with Acute Coronary Syndrome According to the Presence or Absence of Metabolic Syndrome

		Metabolic Syndrome (n=103)	Non-Metabolic Syndrome (97)	Total (200)	χ^2 -value	p-value
Age (Years)	≤40 yrs	9(8.74%)	14(14.43%)	23(11.50%)	3.27	0.19 NS
	41-60 yrs	60(58.25%)	45(46.39%)	105(52.50%)		
	>60 yrs	34(33.01%)	38(39.18%)	72(36%)		
	Total	103(100%)	97(100%)	200(100%)		
	Mean ±SD	56.31±11.79	57.13±14.50	56.71±13.155		
Gender	Male	68(66.02%)	74(76.29%)	142(71%)	2.55	0.11 NS
	Female	35(33.98%)	23(23.71%)	58(29%)		

NS-Not Significant

Among the 200 patients with acute coronary syndrome, 103 (51.5%) had metabolic syndrome, while 97 (48.5%) did not.

In the metabolic syndrome group, the majority of patients (58.25%) were aged 41–60 years, followed by those aged >60 years (33.01%) and ≤40 years (8.74%). Similarly, among patients without metabolic syndrome, 46.39% were aged 41–60 years, 39.18% were >60 years, and 14.43% were ≤40 years. The difference in age-group distribution between the two groups was not statistically significant ($\chi^2 = 3.27$, $p = 0.19$). The mean age of patients with metabolic syndrome was 56.31 ± 11.79 years, compared with 57.13 ± 14.50 years among those without metabolic syndrome. Overall, the mean age of the study population was 56.71 ± 13.16 years.

Regarding sex distribution, males predominated in both groups. Males constituted 66.02% of patients with metabolic syndrome and 76.29% of those without metabolic syndrome, while females accounted for 33.98% and 23.71%, respectively. The difference in sex distribution was not statistically significant ($\chi^2 = 2.55$, $p = 0.11$).

Table 3: Distribution of Conventional Cardiovascular Risk Factors among Patients with and Without Metabolic Syndrome

Risk Factors	Metabolic Syndrome (n=103)	Non-Metabolic Syndrome (97)	Total (200)	χ^2 -value	p-value
DM	53(51.46%)	12(12.37%)	65(32.50%)	5.89	P<0.0001 S
HTN	68(66.02%)	26(26.80%)	94(47.0%)	5.55	P<0.0001 S
Smoking	30(29.13%)	27(27.84%)	57(28.5%)	0.20	P=0.84 NS
Alcohol	26(25.24%)	15(15.46%)	41(20.5%)	1.71	P=0.087 NS
Tobacco	32(31.07%)	29(29.90%)	61(30.5%)	0.17	P=0.857 NS

S: Significant, NS-Not Significant

Among the 200 patients with acute coronary syndrome, diabetes mellitus (DM) and hypertension (HTN) were significantly more prevalent among patients with metabolic syndrome compared with those without metabolic syndrome. Diabetes mellitus was present in 53 (51.46%)

patients with metabolic syndrome compared with 12 (12.37%) patients without metabolic syndrome, representing a statistically significant difference ($\chi^2 = 5.89$, $p < 0.0001$). Similarly, hypertension was observed in 68 (66.02%) patients with metabolic syndrome and 26 (26.80%) patients without metabolic syndrome, with the difference being statistically significant ($\chi^2 = 5.55$, $p < 0.0001$).

Smoking was reported in 30 (29.13%) patients with metabolic syndrome and 27 (27.84%) patients without metabolic syndrome. The difference was not statistically significant ($\chi^2 = 0.20$, $p = 0.84$). Alcohol consumption was reported in 26 (25.24%) patients with metabolic syndrome compared with 15 (15.46%) patients without metabolic syndrome; however, this difference did not reach statistical significance ($\chi^2 = 1.71$, $p = 0.087$). Similarly, tobacco use was present in 32 (31.07%) patients with metabolic syndrome and 29 (29.90%) patients without metabolic syndrome, with no statistically significant difference between the groups ($\chi^2 = 0.17$, $p = 0.857$). Overall, diabetes mellitus and hypertension were significantly associated with the presence of metabolic syndrome, whereas smoking, alcohol consumption, and tobacco use did not differ significantly between the two groups.

Table 4: Distribution of Patients According to Body Mass Index among Those With and Without Metabolic Syndrome

	BMI(kg/m^2)	Metabolic Syndrome (n=103)	Non-Metabolic Syndrome (97)	Total (200)	χ^2 - value	p-value
BMI (kg/m2)	<23 kg/m^2	32(31.07%)	65(67.01%)	97(48.50%)	25.83	P<0.0001 S
	≥ 23 kg/m^2	71(68.93%)	32(32.99%)	103(51.50%)		

S-Significant

Among the 200 patients with acute coronary syndrome, 103 (51.50%) had a BMI ≥23 kg/m², while 97 (48.50%) had a BMI <23 kg/m². In the metabolic syndrome group, 71 (68.93%) patients had a BMI ≥23 kg/m², compared with 32 (32.99%) patients in the non-metabolic syndrome group. Conversely, a BMI <23 kg/m² was observed in 32 (31.07%) patients with metabolic syndrome and 65 (67.01%) patients without metabolic syndrome. The distribution of BMI categories differed significantly between the two groups ($\chi^2 = 25.83$, $p < 0.0001$). Patients with metabolic syndrome were significantly more likely to have a BMI ≥23 kg/m² than patients without metabolic syndrome.

Table 5: Sex-Specific Distribution of Waist Circumference According to the Presence or Absence of Metabolic Syndrome

		Metabolic Syndrome (n=68)		**Without Metabolic Syndrome (74)**		**Total (200)**	**χ^2 - value**	**p-value**
		Non-Obese	**Overweight/ Obese**	**Non-Obese**	**Overweight/ Obese**			
WC (in cm) in Male	<90	15(22.06%)	0(0%)	43(58.11%)	8(10.81%)	66	28.01	P<0.0001 S
	≥90	1(1.47%)	52(76.47%)	2(2.70%)	21(23.38%)	76		
	Total	16(23.53%)	52(76.47%)	45(60.81%)	29(39.19%)	142		
WC(in cm) in Female	<80	10(28.57%)	0(0%)	13(56.52%)	0(0%)	23	37.73	P<0.0001 S
	≥80	6(17.14%)	19(54.29%)	7(30.43%)	3(13.04%)	35		
	Total	16(45.71%)	19(54.29%)	20(86.96%)	3(13.04%)	58		

S-Significant

Among the 142 male patients, the distribution of waist circumference differed significantly between patients with and without metabolic syndrome.

In the metabolic syndrome group, 52 (76.47%) male patients had a waist circumference ≥90 cm, whereas only 1 (1.47%) had a waist circumference <90 cm.

In contrast, among male patients without metabolic syndrome, 21 (23.38%) had a waist circumference ≥90 cm and 43 (58.11%) had a waist circumference <90 cm. The association between waist circumference and metabolic syndrome among male patients was statistically significant ($\chi^2 = 28.01$, $p < 0.0001$). Among the 58 female patients, 19 (54.29%) patients with metabolic syndrome had a waist circumference ≥80 cm, compared with 3 (13.04%) patients without metabolic syndrome.

A waist circumference <80 cm was observed in 10 (28.57%) women with metabolic syndrome and 13 (56.52%) women without metabolic syndrome.

The association between waist circumference and metabolic syndrome among female patients was also statistically significant ($\chi^2 = 37.73$, $p < 0.0001$).

Overall, central obesity, as indicated by sex-specific elevated waist circumference, was significantly associated with the presence of metabolic syndrome in both male and female

patients. The prevalence of metabolic syndrome was substantially higher among patients with waist circumference ≥90 cm in males and ≥80 cm in females.

Table 6: Distribution of Glycemic and Lipid Parameters According to the Presence or Absence of Metabolic Syndrome

		Metabolic Syndrome (n=103)		Non-Metabolic Syndrome (97)		Total (200)	χ^2-value	p-value
		Non-Obese	Overweight/ Obese	Non-Obese	Overweight/ Obese			
FBS (mg%)	<100	5(4.85%)	8(7.77%)	50(51.55%)	23(23.71%)	86	25.93	P<0.0001 S
	≥ 100	27(26.24%)	63(61.17%)	15(15.46%)	9(9.29%)	114		
	Total	32(31.07%)	71(68.93%)	65(67.01%)	32(32.99%)	200		
Triglyceride levels (TG)	<150	14(13.59%)	30(29.13%)	60(61.86%)	31(31.96%)	135	24.94	P<0.0001 S
	≥ 150	18(17.48%)	41(39.81%)	5(5.15%)	1(1.03%)	65		
	Total	32(31.07%)	71(68.93%)	65(67.01%)	32(32.99%)	200		
HDL for males	<40	15(22.06%)	44(64.71%)	12(16.22%)	4(5.41%)	75	28.01	P<0.0001 S
	≥ 40	1(1.47%)	8(11.76%)	33(44.59%)	25(33.78%)	67		
	Total	16(23.53%)	52(76.47%)	45(60.81%)	29(39.19%)	142		
HDL for Females	<50	16(45.71%)	18(51.43%)	11(47.83%)	0(0%)	45	37.73	P<0.0001 S
	≥ 50	0(0%)	1(2.86%)	9(39.13%)	3(13.04%)	13		
	Total	16(45.71%)	19(54.29%)	20(86.96%)	3(13.04%)	58		

S-Significant

Fasting blood glucose (FBS), triglyceride levels, and HDL cholesterol showed significant differences between patients with and without metabolic syndrome.

Regarding FBS, among patients with metabolic syndrome, 63 (61.17%) overweight/obese patients and 27 (26.24%) non-obese patients had FBS ≥100 mg/dL. In comparison, among patients without metabolic syndrome, FBS ≥100 mg/dL was observed in 9 (9.29%) overweight/obese patients and 15 (15.46%) non-obese patients. Overall, 114 (57.0%) patients had FBS ≥100 mg/dL, while 86 (43.0%) had FBS <100 mg/dL. The association between FBS category and metabolic syndrome was statistically significant ($\chi^2 = 25.93$, $p < 0.0001$).

For triglycerides, elevated TG levels (≥150 mg/dL) were observed in 59 (57.29%) patients with metabolic syndrome compared with only 6 (6.18%) patients without metabolic syndrome. Conversely, TG <150 mg/dL was more frequent among patients without metabolic syndrome (91 [93.82%]) than among those with metabolic syndrome (44 [42.72%]). This difference was statistically significant ($\chi^2 = 24.94$, $p < 0.0001$).

Among male patients, HDL cholesterol <40 mg/dL was observed in 59 (86.77%) patients with metabolic syndrome compared with 16 (21.63%) patients without metabolic syndrome. HDL ≥40 mg/dL was observed in 9 (13.23%) and 58 (78.38%), respectively. The difference was statistically significant ($\chi^2 = 28.01$, $p < 0.0001$). Among female patients, HDL cholesterol <50 mg/dL was observed in 34 (97.14%) patients with metabolic syndrome compared with 11 (47.83%) patients without metabolic syndrome. HDL ≥50 mg/dL was present in 1 (2.86%) patient with metabolic syndrome and 12 (52.17%) patients without metabolic syndrome. This difference was statistically significant ($\chi^2 = 37.73$, $p < 0.0001$).

Overall, abnormal glycemic and lipid parameters—particularly elevated fasting blood glucose, hypertriglyceridemia, and low HDL cholesterol—were significantly more frequent among patients with metabolic syndrome than among those without metabolic syndrome ($p < 0.0001$).

Table 7: Distribution of Serum C - reactive protein Status among Patients With and Without Metabolic Syndrome

Serum CRP	Metabolic Syndrome (n=103)	Non-Metabolic Syndrome (97)	Total (200)	χ^2-value	p-value
Positive	69(66.9%)	15(15.5%)	84(42%)	54.44	P<0.0001 S
Negative	34(33.1%)	82(84.5%)	116(58%)		
Total	103(100%)	97(100%)	200(100%)		

Serum C-reactive protein (CRP) positivity was substantially more frequent among patients with metabolic syndrome than among those without metabolic syndrome. Among the 103 patients with metabolic syndrome, 69 (66.9%) had a positive serum CRP, whereas only 15 (15.5%) of the 97

patients without metabolic syndrome had a positive CRP result. Conversely, a negative CRP result was observed in 34 (33.1%) patients with metabolic syndrome compared with 82 (84.5%) patients without metabolic syndrome. Overall, 84 (42.0%) patients had positive serum CRP, while 116 (58.0%) had negative CRP. The difference in CRP status between patients with and without metabolic syndrome was highly statistically significant (χ^2 = 54.44, $p < 0.0001$).

Thus, serum CRP positivity was significantly more prevalent among patients with metabolic syndrome, suggesting a strong association between metabolic syndrome and systemic inflammatory status in the study population.

Discussion

In the present study, 51.5% (103/200) of patients with acute coronary syndrome (ACS) had metabolic syndrome (MS). STEMI was the most common presentation in both groups; however, the distribution of STEMI, NSTEMI, and unstable angina did not differ significantly between patients with and without MS ($p = 0.21$). This suggests that MS was common across the clinical spectrum of ACS rather than being specifically associated with one ACS subtype.

Patients with MS had significantly higher frequencies of diabetes mellitus (51.46% vs. 12.37%) and hypertension (66.02% vs. 26.80%), both with $p <0.0001$. These findings are consistent with the established clustering of insulin resistance, hyperglycemia, and hypertension in metabolic syndrome. Similar associations have been reported by Dhakhada et al. [14] and Sowdagar et al. [15] in patients with ACS.

BMI was significantly associated with MS ($p <0.0001$), with 68.93% of MS patients having BMI ≥23 kg/m², compared with 32.99% of patients without MS. However, 31.07% of patients with MS had BMI <23 kg/m², indicating that normal BMI does not exclude significant metabolic risk. This observation is particularly relevant in Asian Indian populations, where metabolic abnormalities may occur at comparatively lower BMI.

Central obesity showed a strong association with MS. Among males, 76.47% of patients with MS had waist circumference ≥90 cm, compared with 23.38% without MS ($p <0.0001$). Similarly, among females, waist circumference ≥80 cm was present in 54.29% of patients with MS compared with 13.04% without MS ($p <0.0001$). These findings support the importance of waist circumference as an indicator of visceral adiposity and cardiometabolic risk. Significant differences were also observed in fasting blood glucose, triglycerides, and HDL-C. FBS ≥100 mg/dL was considerably more frequent among patients with MS ($p <0.0001$). Similarly, TG ≥150 mg/dL occurred in 57.29% of patients with MS compared with only 6.18% without MS. Low HDL-C was also significantly more common in both males and females with MS ($p <0.0001$). These findings are comparable with previous observations by Olijhoek et al. [16], Dhakhada et al. [14], and Sowdagar et al. [15], who reported clustering of hyperglycemia, hypertriglyceridemia, and low HDL-C among patients with MS.

A particularly important finding was the strong association between MS and systemic inflammation. Serum CRP was positive in 66.9% of patients with MS, compared with only 15.5% of patients without MS ($p <0.0001$). This supports the concept that metabolic syndrome is associated not only with metabolic abnormalities but also with a pro-inflammatory state. Similar findings have been reported by Sattar et al. [17], who demonstrated higher CRP levels among individuals with MS.

Conclusion

In this study patients with acute coronary syndrome (ACS), metabolic syndrome (MS) was present in 51.5% of patients. Metabolic syndrome was strongly associated with important cardiometabolic abnormalities, including diabetes mellitus, hypertension, higher BMI, central obesity, elevated fasting blood glucose, hypertriglyceridemia, and low HDL cholesterol. These associations were statistically significant for the major metabolic parameters. A particularly important finding was the strong association between metabolic syndrome and inflammation. CRP positivity was present in 66.9% of patients with metabolic syndrome compared with 15.5% without metabolic syndrome ($p < 0.0001$), demonstrating a significant inflammatory component of the metabolic syndrome phenotype in acute coronary syndrome. Although STEMI was more frequent among patients with metabolic syndrome, the type of acute coronary syndrome was not significantly associated with metabolic syndrome. Importantly, metabolic abnormalities were also observed among patients with BMI <23 kg/m², highlighting that BMI alone may not adequately identify cardiometabolic risk.

Ethical Approval: The study was conducted after obtaining approval from the Institutional Ethics Committee of Acharya Vinoba Bhave Rural Hospital, Wardha,. Written informed consent was obtained from all participants prior to enrollment. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki

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