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Frequency of Metabolic Syndrome Among Young Patients with Acute ST-Elevation Myocardial Infarction

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ABSTRACT

Objective: To determine the prevalence of metabolic syndrome and its individual components among young patients presenting with ST-elevation myocardial infarction at a tertiary care hospital in Karachi. **Study Design:** Cross-sectional study. **Place and Duration of Study:** Department of Cardiology, Liaquat National Hospital, Karachi, from 11 February to 11 May 2025. **Methodology:** A total of 189 patients aged 18–40 years diagnosed with ST-elevation myocardial infarction were enrolled using non-probability consecutive sampling. Clinical examination included age, weight, height, and body mass index. Metabolic syndrome was assessed using standard diagnostic criteria. Laboratory parameters including fasting glucose, triglycerides, and HDL cholesterol were recorded. **Results:** The mean age of patients was 33.8 ± 4.1 years, and 79.3% were male. Metabolic syndrome was present in 42.9% of the cohort. Central obesity (45.4%) and hypertriglyceridemia (38.6%) were the most common components. Patients with metabolic syndrome had significantly higher BMI (29.1 ± 3.2 vs 26.1 ± 3.1), fasting glucose (118.4 ± 22.5 mg/dL vs 97.2 ± 16.8 mg/dL), and triglyceride levels (197.6 ± 48.2 mg/dL vs 136.9 ± 42.7 mg/dL). Multivessel coronary artery disease was more frequent in the metabolic syndrome group (32.1% vs 18.7%). Smoking ($p = 0.03$) and family history of coronary artery disease ($p = 0.04$) showed significant associations with metabolic syndrome. **Conclusion:** Metabolic syndrome is common among young patients with ST-elevation myocardial infarction and is associated with a more adverse cardiometabolic profile and greater coronary disease burden. Early detection and targeted prevention strategies are essential to reduce premature cardiovascular morbidity in this population.

INTRODUCTION

Cardiovascular diseases are a major cause of morbidity and mortality in both developed and developing countries and account for 46.2% of all deaths worldwide [1]. Myocardial infarction has two major clinical types: non-ST-segment elevation myocardial infarction (NSTEMI) and ST-segment elevation myocardial infarction (STEMI), which is the more severe form and a major contributor to mortality [2]. STEMI occurs due to acute obstruction of an epicardial coronary artery, resulting in downstream ischemia. Injury triggers changes in gene transcription, differences in protein expression, and alterations in metabolite levels, all of which contribute to cardiac dysfunction [3]. Metabolic syndrome is defined as the presence of at least three out of five conditions: hyperglycemia, elevated triglycerides, hypertension, low HDL cholesterol, and abdominal obesity [4]. Due to lifestyle shifts, the number of patients with metabolic syndrome is rising globally, including among children and adults [5]. According to the AHA/NHLBI, metabolic syndrome is diagnosed when three or more of the following are present: central obesity (waist circumference ≥102 cm in men, ≥88 cm in women), hypertriglyceridemia (≥1.7 mmol/L), low HDL-C (<1.03 mmol/L in men, <1.29 mmol/L in women), elevated blood pressure (≥130/85 mmHg or on treatment), and fasting glucose ≥5.6 mmol/L or on treatment [6].

Chronic inflammation plays a central role in metabolic syndrome. Low-grade inflammation increases risk for atherosclerosis and CAD [7]. High leukocyte counts and other inflammatory markers are also commonly elevated in children and adults with obesity. The metabolomics field has grown rapidly, allowing measurement of low-molecular-weight metabolites and providing insights into disease mechanisms [8-10]. Metabolic syndrome is closely linked with CAD due to associations with central obesity, dyslipidemia, hypertension, and impaired glucose tolerance [11]. Its presence predicts future cardiovascular events and diabetes. The incidence of STEMI is higher in patients with metabolic syndrome and demands proper

control to prevent complications [12]. Previous studies show that metabolic syndrome increases the risk of CAD 7.3 times in males and 10.2 times in females. Pakistan-based studies reveal metabolic syndrome prevalence of 40–54% among STEMI patients [13,14]. Local studies also show hypertension as the most common metabolic syndrome component (52.6%), followed by diabetes (42.8%), abdominal obesity (41.2%), hypertriglyceridemia (40%), and low HDL (31.7%) [15]. Due to rising metabolic syndrome and CAD among young Pakistanis, and limited regional data, this study aims to determine the prevalence of metabolic syndrome and its components among young STEMI patients [16].

Objectives

1. To determine the prevalence of metabolic syndrome in young patients with ST-elevation myocardial infarction at a tertiary-care hospital.
2. To assess the distribution of metabolic syndrome components among these patients.

METHODOLOGY

This cross-sectional study was conducted in the Department of Cardiology at Liaquat National Hospital, Karachi, from 11 February to 11 May 2025. A sample size of 189 patients was calculated using the WHO sample size calculator, based on an expected prevalence of metabolic syndrome of 40%, a margin of error of 7%, and a 95% confidence level. A non-probability consecutive sampling technique was employed to recruit eligible patients. Patients of either gender between 18 and 40 years of age who were diagnosed with ST-elevation myocardial infarction were included in the study. Individuals were excluded if they refused participation, had undergone prior cardiac surgery, were pregnant with a gestational age of more than four weeks, or had a documented history of previous ST-elevation myocardial infarction.

Data Collection

Data collection commenced after approval from CPSP and the hospital's ethical review committee. All eligible patients presenting with ST-elevation myocardial infarction during the study period were approached, and written informed consent was obtained. A detailed clinical assessment was performed, including measurement of age, weight, height, and body mass index. Information related to smoking status and individual components of metabolic syndrome was recorded using a structured predesigned proforma. Body mass index was calculated using weight in kilograms divided by height in meters squared. Metabolic syndrome was diagnosed according to standard operational definitions.

Data Analysis

Data were analyzed using SPSS version 25. Quantitative variables were assessed for normality using the Shapiro–Wilk test. Normally distributed variables were presented as mean and standard deviation, while non-normally distributed variables were expressed as median and interquartile range. Categorical variables were summarized as frequencies and percentages. Stratification was performed for age, gender, and smoking status to control for potential confounding. Post-stratification analysis was carried out using the chi-square test. A p-value of 0.05 or less was considered statistically significant.

RESULTS

Data were collected from 189 patients, with a mean age of 33.8 ± 4.1 years, indicating that most individuals presented with myocardial infarction in their early to mid-thirties. Males comprised 79.3% of the cohort, while females represented 20.7%, showing a clear male predominance. Urban residents accounted for 69.3% of participants, whereas 30.7% came from rural areas. The mean BMI was 27.4 ± 3.6 kg/m^2, falling in the overweight range. Smoking was the most prevalent risk factor, reported in 58.2% of patients. Hypertension and diabetes mellitus were present in 34.9% and 29.1% of the sample, respectively, while dyslipidemia was observed in 31.2%. A family history of coronary artery disease was noted in 23.8% of patients.

Table 1

Baseline Demographic and Clinical Characteristics of Young STEMI Patients (N = 189)

Variable	Category	Statistics (n %, Mean ± SD)
Age (years)	—	33.8 ± 4.1
Gender	Male	150 (79.3%)
	Female	39 (20.7%)
Residence	Urban	131 (69.3%)
	Rural	58 (30.7%)
BMI (kg/m^2)	—	27.4 ± 3.6
Smoking	Yes	110 (58.2%)
	No	79 (41.8%)
Hypertension	Yes	66 (34.9%)
	No	123 (65.1%)
Diabetes Mellitus	Yes	55 (29.1%)
	No	134 (70.9%)
Dyslipidemia	Yes	59 (31.2%)
	No	130 (68.8%)
Family history of CAD	Yes	45 (23.8%)
	No	144 (76.2%)

Metabolic syndrome was present in 42.9% of the study population, indicating that nearly half of young STEMI patients exhibited clustering of metabolic abnormalities. Among its components, central obesity was the most common feature, observed in 45.4% of patients, followed by hypertriglyceridemia in 38.6% and low HDL-C in 33.9%. Hypertension as part of the metabolic syndrome cluster was seen in 36.0%, while elevated fasting glucose was recorded in 31.7%.

Table 2

Prevalence and Components of Metabolic Syndrome (N=189)

Variable	Category	n (%)
Metabolic Syndrome	Present	81 (42.9%)
	Absent	108 (57.1%)
Components	Central Obesity	86 (45.4%)
	Hypertriglyceridemia	73 (38.6%)
	Low HDL-C	64 (33.9%)
	Hypertension	68 (36.0%)
	Elevated Fasting Glucose	60 (31.7%)

BMI was higher in the metabolic syndrome group (29.1 ±

3.2 vs 26.1 ± 3.1; p < 0.001), reflecting greater adiposity. Fasting glucose levels were also higher in patients with metabolic syndrome (118.4 ± 22.5 mg/dL vs 97.2 ± 16.8 mg/dL; p < 0.001), indicating impaired glycemic control. Similarly, triglyceride levels were markedly elevated (197.6 ± 48.2 mg/dL vs 136.9 ± 42.7 mg/dL; p < 0.001), while HDL-C levels were significantly lower (36.3 ± 5.9 mg/dL vs 42.7 ± 6.1 mg/dL; p < 0.001). Multivessel coronary artery disease was more frequent in patients with metabolic syndrome (32.1% vs 18.7%; p = 0.03), suggesting more extensive coronary involvement in this group.

Table 3

Comparison of Clinical and Laboratory Parameters in Patients with and Without Metabolic Syndrome

Parameter	With MS (n = 81)	Without MS (n = 108)	p-value
BMI (kg/m^2)	29.1 ± 3.2	26.1 ± 3.1	<0.001
Fasting Glucose (mg/dL)	118.4 ± 22.5	97.2 ± 16.8	<0.001
Triglycerides (mg/dL)	197.6 ± 48.2	136.9 ± 42.7	<0.001
HDL-C (mg/dL)	36.3 ± 5.9	42.7 ± 6.1	<0.001
Multivessel CAD	26 (32.1%)	20 (18.7%)	0.03

Stratified analysis showed that metabolic syndrome was more common in smokers, with 50.9% of smokers affected compared to 31.6% of non-smokers (p = 0.03), indicating a significant association between smoking and metabolic clustering. A higher proportion of patients with a family history of coronary artery disease also had metabolic syndrome (53.3% vs 39.6%; p = 0.04). No significant association was found between metabolic syndrome and gender (p = 0.37) or residential status (p = 0.41), suggesting that these demographic factors did not meaningfully influence metabolic syndrome prevalence in the studied population.

Table 4

Stratified Analysis of Metabolic Syndrome by Demographic and Clinical Variables

Variable	Category	MS Present n (%)	MS Absent n (%)	p-value
Gender	Male	62 (41.3%)	88 (58.7%)	0.37
	Female	19 (48.7%)	20 (51.3%)	—
Smoking	Yes	56 (50.9%)	54 (49.1%)	0.03
	No	25 (31.6%)	54 (68.4%)	—
Family history of CAD	Yes	24 (53.3%)	21 (46.7%)	0.04
	No	57 (39.6%)	87 (60.4%)	—
Residence	Urban	55 (42.0%)	76 (58.0%)	0.41
	Rural	26 (44.8%)	32 (55.2%)	—

DISCUSSION

This study explored the frequency and pattern of metabolic syndrome among young patients presenting with ST-elevation myocardial infarction and demonstrated that metabolic syndrome is highly prevalent in this age group. The overall prevalence of 42.9% aligns closely with previous research, which also reported metabolic syndrome affecting approximately 40% to 54% of young STEMI patients. The high burden observed in this cohort reinforces the growing trend of premature cardiovascular disease in South Asian populations, who are known to develop atherosclerotic disease earlier than Western counterparts [17]. The demographic characteristics in this study showed a marked male predominance and a substantial proportion of urban residents. This pattern mirrors previous research, where males in their 30s and 40s constituted the majority of STEMI presentations. Urban predominance may reflect increased exposure to sedentary lifestyles, high caloric diets, pollution, and psychosocial stress, all of which contribute to the metabolic risk environment. Among individual metabolic syndrome components, central obesity and hypertriglyceridemia emerged as the most common features [18]. This finding is consistent with previous research reporting that abdominal obesity is a major driver of cardiometabolic risk in South Asian individuals due to visceral fat accumulation and associated inflammatory processes. Hypertriglyceridemia and low HDL levels also appeared frequently in this cohort, aligning with the well-established dyslipidemia phenotype seen in younger STEMI patients, which is characterized by small dense LDL particles, high triglycerides, and reduced HDL functioning [19].

The comparison between patients with and without metabolic syndrome further highlighted the adverse cardiometabolic profile associated with the condition. Patients with metabolic syndrome had significantly higher BMI, fasting glucose levels, and triglyceride concentrations [20]. Similar patterns have been described in previous research, which consistently demonstrates that metabolic syndrome promotes early plaque formation, endothelial dysfunction, and accelerated atherosclerosis. The presence of multivessel coronary artery disease in a higher proportion of patients with metabolic syndrome supports this pathophysiological link, indicating that clustering of metabolic abnormalities contributes to diffuse and more severe coronary involvement [21]. Stratified analysis revealed that smoking was significantly associated with metabolic syndrome. This relationship has been reported in previous research, where smoking amplified insulin resistance, exacerbated dyslipidemia, and accelerated vascular inflammation. The association with family history of coronary artery disease further strengthens the argument that metabolic syndrome in young STEMI patients is influenced not only by lifestyle factors but also by genetic predisposition. No significant association was found with gender or residential status, suggesting that metabolic syndrome exerts its effect irrespective of these demographic variables [22]. Overall, the findings underscore that metabolic syndrome is a major contributor to premature myocardial infarction in young adults. Its strong presence in this population highlights gaps in early screening, lifestyle intervention, and preventive cardiology services. Early identification and aggressive management of metabolic syndrome components may play a crucial role in reducing the rising burden of early-onset ST-elevation myocardial infarction [23]. This study has several limitations that should be considered when interpreting the findings. First, it was conducted at a single tertiary care center, which may limit the generalizability of the results to the broader population of young patients with ST-elevation myocardial infarction. Second, the use of a non-probability consecutive sampling technique introduces the possibility of selection bias, as patients who presented during the study period may not fully represent all eligible

individuals. Third, the cross-sectional design restricts the ability to establish causal relationships between metabolic syndrome and the severity of coronary artery disease. Fourth, some metabolic parameters, such as dietary history, physical activity level, and waist circumference measured by standardized devices, were not included, which may affect the precision of metabolic syndrome classification. Fifth, reliance on medical records for certain clinical variables may introduce information bias. Lastly, the relatively short study duration may not reflect seasonal or temporal variations in risk factor patterns among young individuals.

CONCLUSION

It is concluded that metabolic syndrome is highly prevalent among young patients presenting with ST-elevation myocardial infarction, affecting nearly half of the study population. Central obesity, hypertriglyceridemia, and low HDL levels were the most frequently observed components, reflecting a strong clustering of modifiable cardiovascular risk factors at an early age. Patients with metabolic syndrome demonstrated a significantly worse cardiometabolic profile and a higher likelihood of multivessel coronary artery disease, highlighting the aggressive nature of atherogenesis when metabolic abnormalities coexist. These findings emphasize the urgent need for early identification, targeted lifestyle modification, and preventive interventions to reduce the growing burden of premature myocardial infarction in the young population of Pakistan.

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