



ACUTE CORONARY SYNDROME IN YOUNG ADULTS: CLINICAL PROFILE, CARDIOVASCULAR RISK FACTORS, AND SHORT-TERM IN-HOSPITAL OUTCOMES AT AYUB TEACHING HOSPITAL

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Abstract

Background: Acute coronary syndrome (ACS) is increasingly recognized among young adults and is associated with substantial morbidity and socioeconomic consequences. Data regarding the clinical profile, cardiovascular risk factors, and short-term outcomes of young ACS patients in northern Pakistan remain limited. This study aimed to describe the demographic characteristics, cardiovascular risk factors, clinical spectrum, and short-term in-hospital outcomes of young adults presenting with ACS at Ayub Teaching Hospital Abbottabad.

Methods: A descriptive cross-sectional hospital-based study was conducted in the Departments of Cardiology and General Medicine at Ayub Teaching Hospital Abbottabad from 1 April 2026 to 5 June 2026. A total of 100 consecutive patients aged 18–45 years admitted with ACS, including ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina (UA), were enrolled. Data regarding demographic characteristics, clinical presentation, cardiovascular risk factors, ACS subtype, investigations, management, complications, and short-term in-hospital outcomes were collected using a structured proforma and analyzed using SPSS version 26.

Results: Among 100 patients, the mean age was 38.2 ± 5.6 years, and 78.0% were male. The majority (66.0%) belonged to the 36–45-year age group, while 61.0% were from rural areas. Chest pain was the most common presenting symptom (94.0%), followed by sweating (71.0%) and shortness of breath (39.0%). The most prevalent cardiovascular risk factors were smoking/tobacco use (63.0%),

dyslipidemia (49.0%), sedentary lifestyle (46.0%), hypertension (42.0%), and diabetes mellitus (31.0%). STEMI was the predominant ACS subtype (64.0%), followed by NSTEMI (24.0%) and UA (12.0%). Elevated troponin-I was observed in 88.0% of patients, while regional wall motion abnormalities were present in 67.0%. The mean left ventricular ejection fraction was $45.8 \pm 8.7\%$. Coronary angiography was performed in 38.0% of patients, among whom single-vessel disease was identified in 50.0%. Arrhythmias (16.0%) and acute heart failure (13.0%) were the most common in-hospital complications. Overall, 90.0% of patients improved and were discharged, whereas 2.0% died during hospitalization.

Conclusion: ACS in young adults was characterized by a predominance of male patients, a high burden of modifiable cardiovascular risk factors, and frequent presentation as STEMI. Smoking, dyslipidemia, hypertension, diabetes mellitus, and sedentary lifestyle were common risk factors. Despite the occurrence of in-hospital complications, most patients experienced favorable short-term outcomes, highlighting the importance of early risk-factor modification and timely evidence-based management in this population.

Keywords: Acute Coronary Syndrome; Young Adults; ST-Segment Elevation Myocardial Infarction; Cardiovascular Risk Factors; Premature Coronary Artery Disease; Smoking; Dyslipidemia; In-Hospital Outcomes; Pakistan; Coronary Artery Disease.

Introduction

SAcute coronary syndrome (ACS) remains one of the leading causes of morbidity and mortality worldwide despite significant advances in preventive cardiology, pharmacotherapy, and interventional management¹. It encompasses a spectrum of clinical conditions resulting from acute myocardial ischemia, including ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina². Traditionally, ACS has been regarded as a disease predominantly affecting older individuals; however, increasing evidence suggests that the burden of ACS among younger adults is rising globally, particularly in low- and middle-income countries³. The occurrence of ACS at a younger age presents unique clinical, socioeconomic, and public health challenges because these patients are often in their most productive years of life. Young adults with ACS frequently demonstrate distinct demographic characteristics, clinical presentations, and cardiovascular risk-factor profiles compared with older patients⁴. While the exact age cutoff varies across studies, most literature defines young ACS patients as individuals younger than 45 years. Smoking has consistently emerged as the most prevalent and modifiable risk factor among young patients presenting with ACS⁵. Other important contributors include dyslipidemia, hypertension, diabetes mellitus, obesity, sedentary lifestyle, psychosocial stress, and a positive family history of premature coronary artery disease⁶. In recent years, the increasing prevalence of unhealthy dietary habits, physical inactivity, substance abuse, and metabolic disorders has further contributed to the growing incidence of premature coronary artery disease in younger populations⁷. The clinical significance of ACS in young adults extends beyond immediate cardiovascular morbidity. Premature coronary events are associated with substantial psychosocial and economic consequences, including long-term disability, reduced work productivity, financial burden on families, and impaired quality of life⁸. Younger patients often experience considerable emotional stress related to recurrent hospitalization, prolonged medication use, lifestyle modifications, and fear of future cardiac events. Furthermore, because coronary artery disease in younger individuals may initially be underestimated

due to their age, delayed recognition and late presentation can adversely affect outcomes⁹. Early identification of risk factors and clinical patterns in this population is therefore essential for timely intervention and preventive strategies. South Asian populations appear to have a disproportionately higher burden of premature coronary artery disease compared with Western populations¹⁰. Several studies have demonstrated that individuals from South Asia tend to develop coronary artery disease nearly a decade earlier than their Western counterparts and frequently exhibit more aggressive risk-factor profiles¹¹. Pakistan, in particular, faces an increasing prevalence of cardiovascular risk factors including tobacco use, diabetes mellitus, hypertension, obesity, and dyslipidemia due to rapid urbanization, lifestyle transitions, and limited implementation of preventive healthcare measures¹². Despite this growing burden, local data regarding ACS in young adults remain limited, especially from tertiary care centers in Khyber Pakhtunkhwa. Moreover, regional variations in socioeconomic conditions, healthcare access, dietary habits, and genetic predisposition may influence disease patterns and outcomes, making locally generated evidence clinically important. Ayub Teaching Hospital Abbottabad is a major tertiary care referral center catering to a large population from northern Khyber Pakhtunkhwa and adjoining regions. The hospital receives a substantial number of patients presenting with acute cardiovascular emergencies, including ACS, from both urban and rural backgrounds. Evaluating the clinical characteristics, cardiovascular risk factors, and short-term in-hospital outcomes among young adults presenting with ACS at this institution may provide valuable insights into the regional disease burden and help identify opportunities for early risk-factor modification and improved management strategies.

Given the increasing recognition of premature ACS and the scarcity of local data from this region, the present study was conducted to determine the clinical profile, cardiovascular risk factors, and short-term in-hospital outcomes of young adults presenting with acute coronary syndrome at Ayub Teaching Hospital Abbottabad.

Objectives

General Objective

To describe the clinical profile, cardiovascular risk factors, and short-term in-hospital outcomes of young adults presenting with acute coronary syndrome at Ayub Teaching Hospital Abbottabad.

Specific Objectives

1. To describe the demographic and clinical presentation patterns of young adults presenting with acute coronary syndrome.
2. To document the frequency of cardiovascular risk factors, including smoking, hypertension, diabetes mellitus, dyslipidemia, obesity, sedentary lifestyle, and family history of premature coronary artery disease, among young patients with acute coronary syndrome.
3. To describe the spectrum of acute coronary syndrome, including ST-segment elevation myocardial infarction, non-ST-segment elevation myocardial infarction, and unstable angina, in young adults admitted to the hospital.
4. To document short-term in-hospital outcomes, including recovery, complications, duration of hospital stay, referral to higher care, and in-hospital mortality among young adults admitted with acute coronary syndrome.

Methodology

Study Design and Setting

This descriptive cross-sectional hospital-based study was conducted in the Department of Cardiology and General Medicine wards at Ayub Teaching Hospital, Abbottabad, Pakistan. Ayub Teaching Hospital is a major tertiary care referral center serving patients from Abbottabad and surrounding districts of Hazara, Khyber Pakhtunkhwa.

Study Duration

The study was conducted over a period of approximately two months, from 1st April 2026 to 5th June 2026.

Sample Size Calculation

The sample size was calculated using the WHO sample size formula for descriptive studies:

$$n = Z^2 P(1-P) / d^2$$

Where:

n = required sample size

Z = 1.96 for 95% confidence interval

P = assumed prevalence of smoking (commonest risk factor) in acute coronary syndrome among young adults = 6%

d = margin of error = 5%

Using these values, the calculated sample size was 87 patients. To improve study reliability and account for incomplete records or missing data, a total sample size of 100 patients was included in the study. Non-probability consecutive sampling technique was used. Prospective consecutive enrollment was performed during the study period

Inclusion Criteria

All young adult patients aged 18–45 years admitted with a diagnosis of acute coronary syndrome, including ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina, during the study period were included.

Patients younger than 18 years were not included because acute coronary syndrome in the pediatric age group is uncommon and is usually associated with non-atherosclerotic etiologies and different clinical characteristics compared with adult patients.

Exclusion Criteria

- Patients older than 45 years, and younger than 18 years
- those with incomplete medical records,
- patients with congenital heart disease or cardiomyopathy
- Patients unwilling to participate in the study were excluded.

Data Collection Procedure

Patients fulfilling the inclusion criteria were enrolled consecutively after admission to the cardiology and medical wards. Diagnosis of acute coronary syndrome was established on the basis of clinical presentation, electrocardiographic findings, and cardiac biomarkers as assessed by the treating cardiology and General medicine team.

Relevant information was collected using a structured proforma designed for the study. Data were obtained through detailed history taking, physical examination, patient records, laboratory investigations, and hospital charts. All patients were followed during their hospital stay to document short-term in-hospital outcomes.

Variables Recorded

The study variables included DEMOGRAPHIC CHARACTERISTICS such as age and gender; clinical presentation including chest pain, dyspnea, sweating, palpitations, and hemodynamic status at presentation; CARDIOVASCULAR RISK FACTORS including smoking, hypertension, diabetes mellitus, dyslipidemia, obesity, sedentary lifestyle, and family history of premature coronary artery disease; and TYPE OF ACUTE CORONARY SYNDROME including STEMI, NSTEMI, and unstable angina.

Outcome Measures

Short-term in-hospital outcomes recorded during admission included clinical improvement, development of complications such as arrhythmias, heart failure or cardiogenic shock, duration of hospital stay, referral to intensive or higher care units, and in-hospital mortality.

Statistical Analysis

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26. Quantitative variables such as age and duration of hospital stay were presented as mean $\pm$ standard deviation. Qualitative variables including gender, clinical presentation, cardiovascular risk factors, type of ACS, and in-hospital outcomes were expressed as frequencies and percentages.

Ethical Considerations

Approval for the study was obtained from the Institutional Research and Ethical Review Committee of Ayub Teaching Hospital Abbottabad prior to commencement of data collection. Written informed consent was obtained from all participants or their attendants where applicable. Confidentiality of patient information was strictly maintained throughout the study, and all collected data were used solely for research purposes.

Operational definitions

Hypertension-previous diagnosis or antihypertensive treatment

Diabetes-previous diagnosis or ADA criteria

Dyslipidemia-documented diagnosis or lipid profile abnormalities

Obesity-BMI ≥ 30 kg/m²

Sedentary lifestyle-less than 150 min/week moderate physical activity.

Results

Table 1: Demographic Characteristics of Study Population (n=100)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
18–25	6	6.0
26–35	28	28.0

Variable	Frequency (n)	Percentage (%)
36–45	66	66.0
Gender		
Male	78	78.0
Female	22	22.0
Mean age (years)	38.2 ± 5.6	
Residence		
Rural	61	61.0
Urban	39	39.0

Table 2: Clinical Presentation of Patients (n=100)

Clinical Feature	Frequency (n)	Percentage (%)
Chest pain	94	94.0
Sweating	71	71.0
Shortness of breath	39	39.0
Nausea/Vomiting	26	26.0
Palpitations	18	18.0
Syncope	7	7.0
Cardiogenic shock at presentation	5	5.0

Table 3: Cardiovascular Risk Factors among Patients (n=100)

Risk Factor	Frequency (n)	Percentage (%)
Smoking/tobacco use	63	63.0
Dyslipidemia	49	49.0
Hypertension	42	42.0
Diabetes mellitus	31	31.0
Obesity (BMI ≥30 kg/m ²)	24	24.0

Risk Factor	Frequency (n)	Percentage (%)
Family history of premature CAD	19	19.0
Sedentary lifestyle	46	46.0

Table 4: Spectrum of Acute Coronary Syndrome (n=100)

Type of ACS	Frequency (n)	Percentage (%)
STEMI	64	64.0
NSTEMI	24	24.0
Unstable angina	12	12.0

Table 5: ECG Findings among Patients (n=100)

ECG Finding	Frequency (n)	Percentage (%)
Anterior wall STEMI	34	34.0
Inferior wall STEMI	21	21.0
Extensive anterior wall MI	7	7.0
Lateral wall STEMI	2	2.0
ST depression/T-wave inversion	26	26.0
Non-specific ECG changes	10	10.0

Table 6: Cardiac Biomarker Findings (n=100)

Biomarker Finding	Frequency (n)	Percentage (%)
Elevated Troponin-I	88	88.0
Elevated CK-MB	72	72.0
Both elevated	69	69.0

Table 7: Echocardiographic Findings (n=100)

Echocardiographic Variable	Frequency (n)	Percentage (%)
Regional wall motion abnormality	67	67.0
Preserved LV systolic function	39	39.0

Echocardiographic Variable	Frequency (n)	Percentage (%)
(EF >50%)		
Mild LV dysfunction (EF 40–49%)	37	37.0
Moderate LV dysfunction (EF 30–39%)	18	18.0
Severe LV dysfunction (EF <30%)	6	6.0
Mean ejection fraction	45.8 ± 8.7%	

Table 8: Management and Interventions (n=100)

Intervention	Frequency (n)	Percentage (%)
Dual antiplatelet therapy	100	100.0
Statin therapy	100	100.0
Anticoagulation	86	86.0
Thrombolysis	41	41.0
Coronary angiography	38	38.0
Percutaneous coronary intervention (PCI)	24	24.0
Managed conservatively	52	52.0

Table 9: In-Hospital Complications (n=100)

Complication	Frequency (n)	Percentage (%)
Arrhythmias	16	16.0
Acute heart failure	13	13.0
Cardiogenic shock	6	6.0
Recurrent ischemia/chest pain	9	9.0
Cardiac arrest	4	4.0
No major complication	58	58.0

Some patients developed more than one complication; therefore frequencies exceed 100%.

Table 10: Short-Term In-Hospital Outcomes (n=100)

Outcome	Frequency (n)	Percentage (%)
Improved and discharged	90	90.0
Shifted to critical care	7	7.0
Referred to higher cardiac center	1	1.0
In-hospital mortality	2	2.0

Table 11: Distribution of Major Risk Factors According to Gender

Variable	Male (n=78)	Female (n=22)
Smoking/tobacco use	58 (74.4%)	5 (22.7%)
Hypertension	29 (37.2%)	13 (59.1%)
Diabetes mellitus	21 (26.9%)	10 (45.5%)
Dyslipidemia	36 (46.2%)	13 (59.1%)
STEMI	54 (69.2%)	10 (45.5%)

Table 12: Comparison of Selected Clinical Characteristics According to ACS Type

Variable	STEMI (n=64)	NSTEMI (n=24)	UA (n=12)
Mean age (years)	37.9 ± 5.4	39.1 ± 5.8	38.5 ± 5.9
Smoking	46 (71.9%)	12 (50.0%)	5 (41.7%)
Diabetes mellitus	18 (28.1%)	9 (37.5%)	4 (33.3%)
LV dysfunction (EF <50%)	47 (73.4%)	11 (45.8%)	3 (25.0%)
In-hospital complications	24 (37.5%)	7 (29.2%)	1 (8.3%)
Mortality	2 (3.1%)	0	0

Table 13: Baseline Vital Signs and Laboratory Parameters at Presentation (n=100)

Variable	Mean ± SD
Heart rate (beats/min)	92.4 ± 16.8
Systolic blood pressure (mmHg)	128.6 ± 22.5

Variable	Mean $\pm$ SD
Diastolic blood pressure (mmHg)	81.2 $\pm$ 13.4
Random blood sugar (mg/dL)	168.3 $\pm$ 74.6
Total cholesterol (mg/dL)	212.7 $\pm$ 41.8
LDL cholesterol (mg/dL)	136.5 $\pm$ 32.7
HDL cholesterol (mg/dL)	38.9 $\pm$ 8.1
Triglycerides (mg/dL)	186.4 $\pm$ 58.3
Serum creatinine (mg/dL)	1.04 $\pm$ 0.36

Table 14: Time from Symptom Onset to Hospital Presentation (n=100)

Time Interval	Frequency (n)	Percentage (%)
<3 hours	31	31.0
3–6 hours	37	37.0
6–12 hours	22	22.0
>12 hours	10	10.0

Table 15: Coronary Angiographic Findings among Patients Undergoing Angiography (n=38)

Angiographic Finding	Frequency (n)	Percentage (%)
Single-vessel disease	19	50.0
Double-vessel disease	11	28.9
Triple-vessel disease	5	13.2
Non-obstructive/minimal disease	3	7.9

Major Vessel Involvement*

Vessel Involved	Frequency (n)	Percentage (%)
Left anterior descending artery (LAD)	24	63.2
Right coronary artery (RCA)	17	44.7
Left circumflex artery (LCX)	9	23.7

*Multiple vessel involvement was observed in some patients.

Table 16: Distribution of ACS According to Age Groups (n=100)

Age Group (years)	STEMI n (%)	NSTEMI n (%)	UA n (%)	Total
18–25	2 (33.3)	1 (16.7)	3 (50.0)	6
26–35	15 (53.6)	8 (28.6)	5 (17.8)	28
36–45	47 (71.2)	15 (22.7)	4 (6.1)	66

Table 17: Medications Administered During Hospital Stay (n=100)

Medication	Frequency (n)	Percentage (%)
Aspirin	100	100.0
Clopidogrel/Ticagrelor	100	100.0
High-intensity statins	100	100.0
Beta blockers	81	81.0
ACE inhibitors/ARBs	69	69.0
Nitrates	74	74.0
Low molecular weight heparin	86	86.0
Diuretics	21	21.0

FIGURE 1
CONSORT-style Study Flow Diagram — Participant Enrollment and Analysis

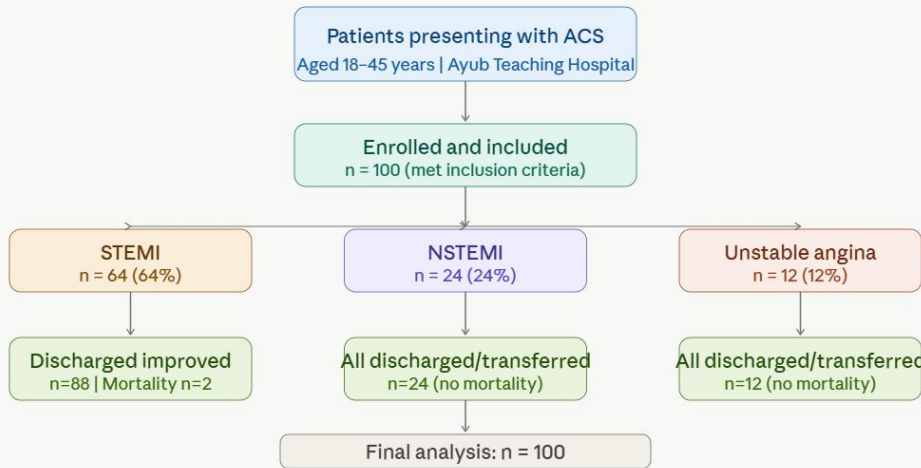


Figure 1. CONSORT-style participant flow diagram. A total of 100 young adult patients (18–45 years) presenting with acute coronary syndrome were enrolled. STEMI = ST-elevation myocardial infarction; NSTEMI = non-ST-elevation myocardial infarction; UA = unstable angina. In-hospital mortality occurred in 2 patients (both in the STEMI group).

FIGURE 2
Age Group Distribution

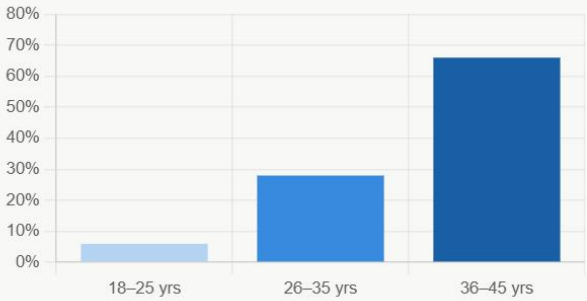


Figure 2. Distribution by age group (n=100). The majority (66%) were aged 36–45 years.

FIGURE 3
Gender & Residence Distribution

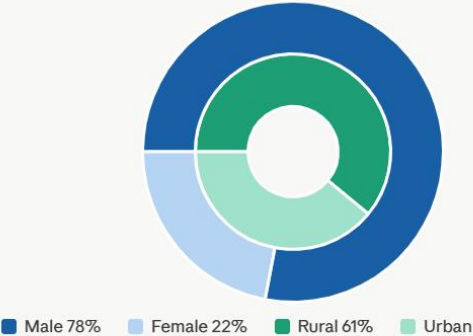


Figure 3. Gender (left) and residence (right) distribution.

FIGURE 4
Spectrum of Acute Coronary Syndrome Subtypes

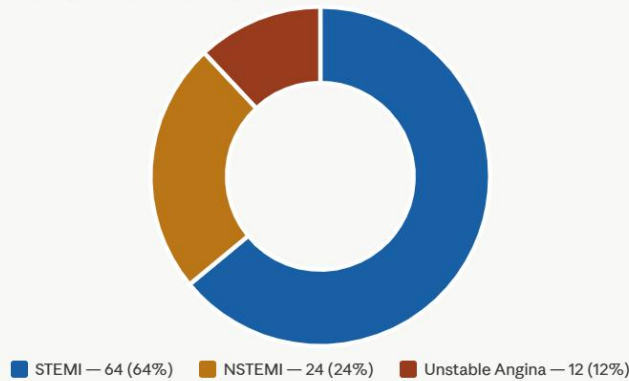


Figure 4. Distribution of acute coronary syndrome subtypes (n=100). STEMI was the predominant presentation, accounting for 64% of cases. STEMI = ST-elevation myocardial infarction; NSTEMI = non-ST-elevation myocardial infarction.

FIGURE 5
Frequency of Clinical Presenting Symptoms

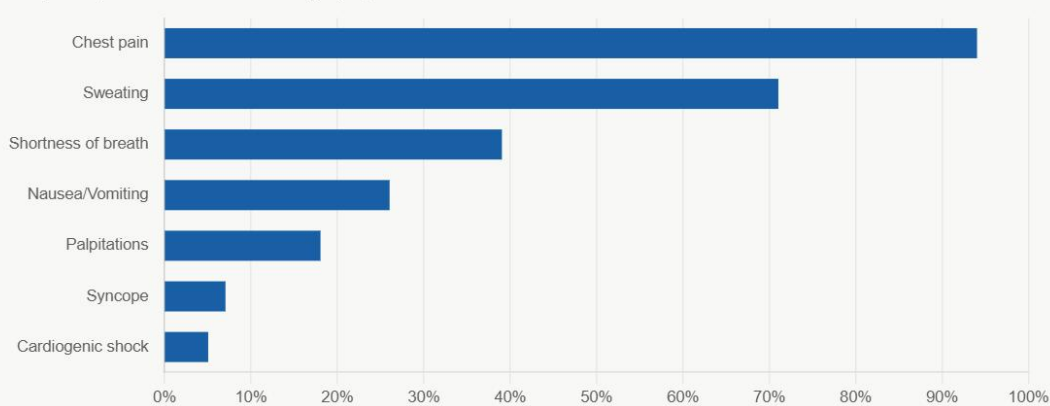


Figure 5. Prevalence of presenting clinical symptoms (n=100). Chest pain was the most frequent symptom (94%), followed by diaphoresis (71%).

FIGURE 6
Prevalence of Cardiovascular Risk Factors

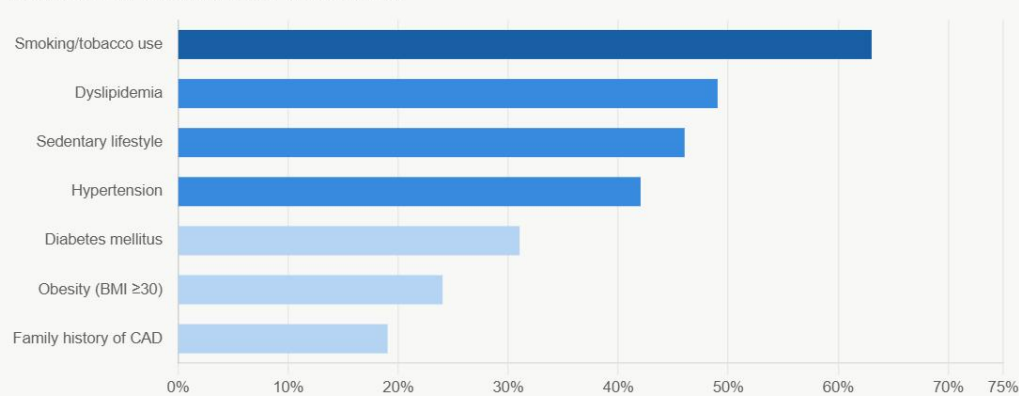


Figure 6. Prevalence of major cardiovascular risk factors (n=100). Smoking/tobacco use was the most prevalent modifiable risk factor (63%), followed by dyslipidemia (49%) and sedentary lifestyle (46%). CAD = coronary artery disease; BMI = body mass index.

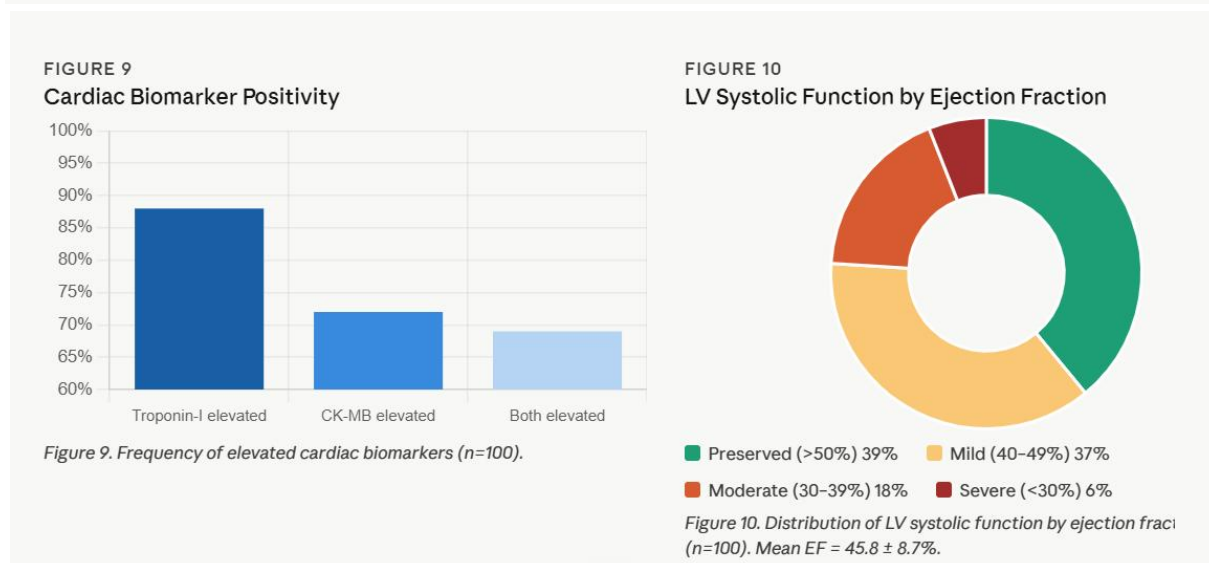
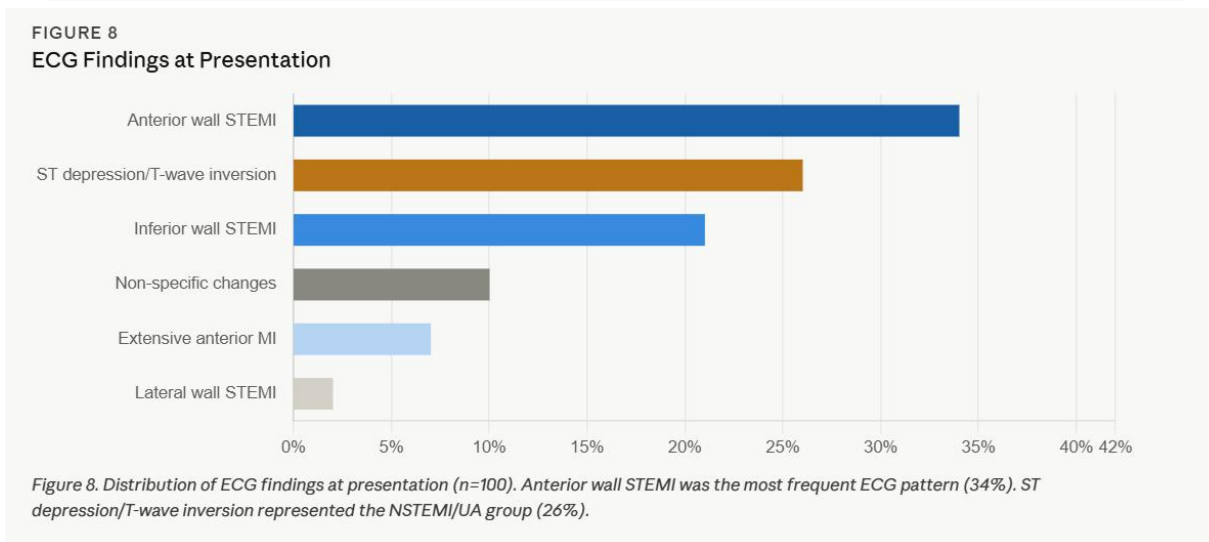
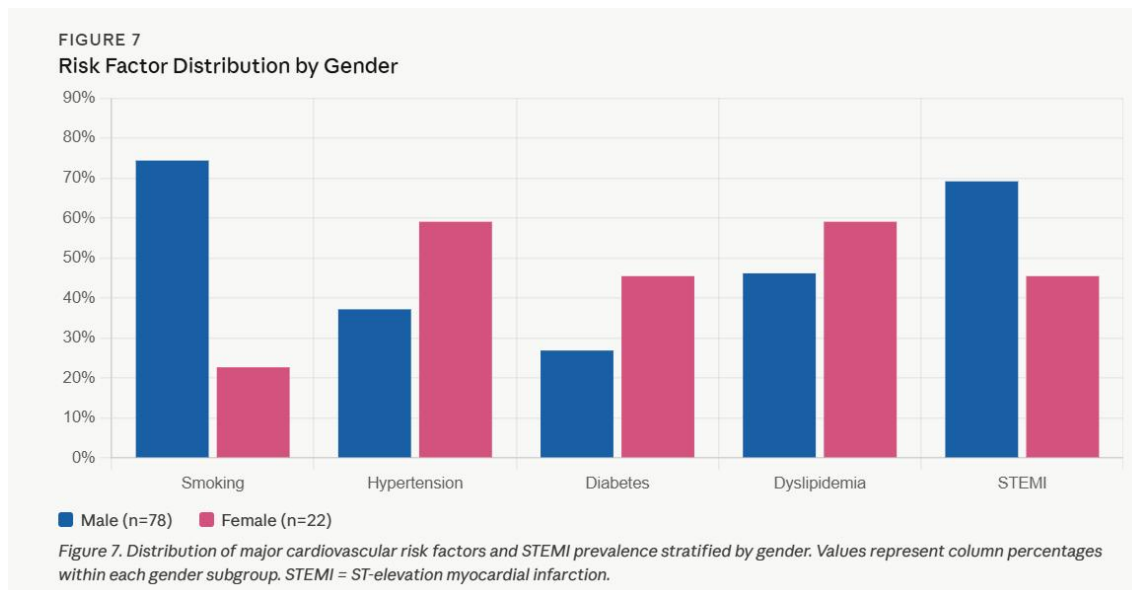


FIGURE 11

Time from Symptom Onset to Hospital Presentation

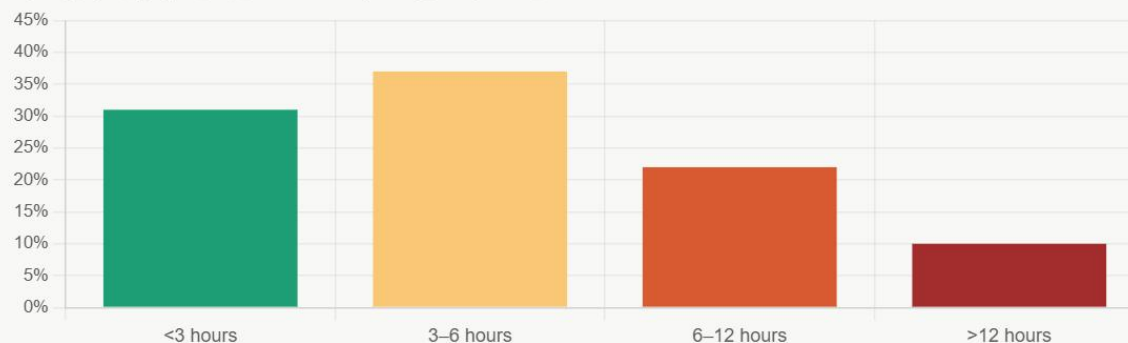


Figure 11. Distribution of symptom-to-hospital presentation intervals (n=100). Only 31% of patients presented within the optimal 3-hour window. The majority (69%) presented after 3 hours from symptom onset.

FIGURE 12

ACS Subtype Distribution Across Age Groups (100% Stacked)

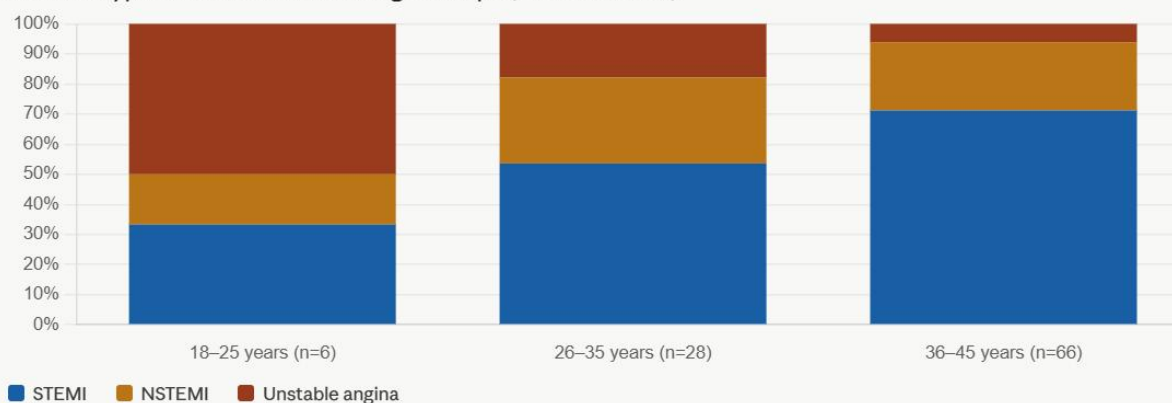


Figure 12. Proportional distribution of ACS subtypes across age groups (n=100). STEMI frequency increased progressively with advancing age, from 33.3% in the 18-25 year group to 71.2% in the 36-45 year group.

FIGURE 13

Clinical Outcomes by ACS Subtype

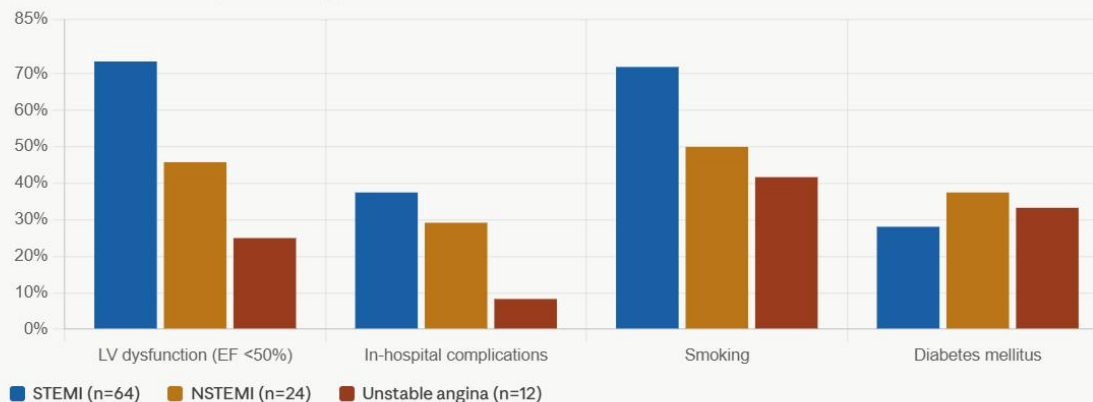


Figure 13. Comparison of selected clinical characteristics across ACS subtypes. LV dysfunction defined as ejection fraction <50%. STEMI patients had the highest rates of LV dysfunction (73.4%), in-hospital complications (37.5%), and in-hospital mortality (3.1%).

FIGURE 14
Management Strategies and Interventions

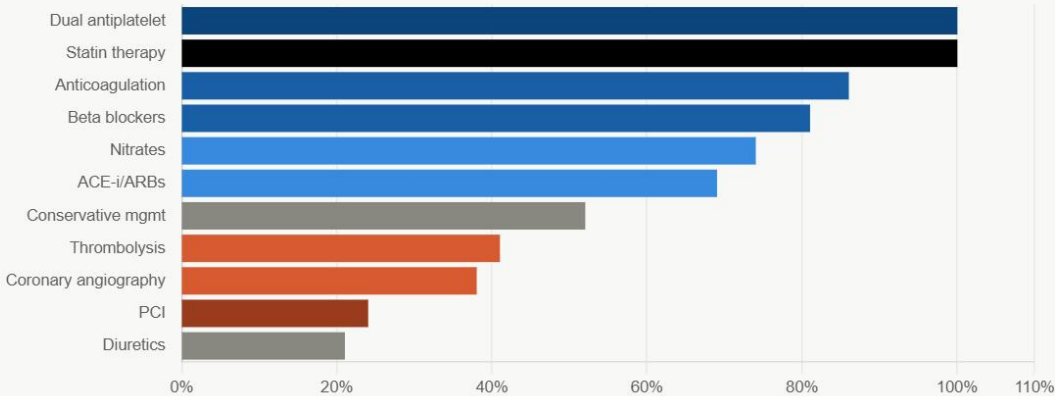


Figure 14. Frequency of pharmacological and interventional management strategies (n=100). Dual antiplatelet therapy and high-intensity statins were administered universally. PCI = percutaneous coronary intervention; DAPT = dual antiplatelet therapy; LMWH = low molecular weight heparin; ACE-i = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker.

FIGURE 15
Coronary Angiographic Findings

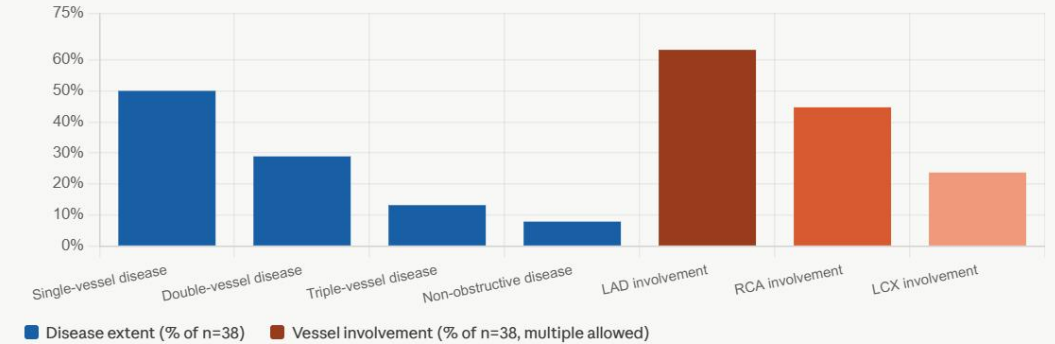
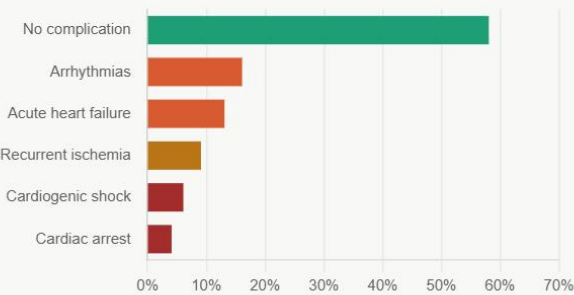


Figure 15. Coronary angiographic findings among patients undergoing angiography (n=38). Left panel: extent of obstructive coronary disease. Right panel: individual vessel involvement. Multiple vessel involvement was present in some patients; thus vessel involvement percentages do not sum to 100%. LAD = left anterior descending artery; RCA = right coronary artery; LCX = left circumflex artery.

FIGURE 16
In-Hospital Complications and Outcomes
16A. Complications



16B. Final outcomes

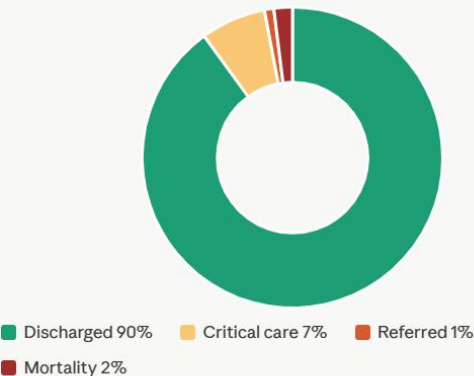


Figure 16. In-hospital complications (16A) and short-term outcomes (16B) (n=100). A majority of patients (58%) had no major in-hospital complication. The overall in-hospital mortality rate was 2%, occurring exclusively among STEMI patients. Mean length of stay was 4.9 ± 2.1 days.

Discussion

The present study evaluated the clinical profile, cardiovascular risk factors, and short-term in-hospital outcomes of young adults presenting with acute coronary syndrome at a tertiary care hospital in northern Pakistan. The findings demonstrate that ACS in young adults is not uncommon in our clinical setting and is predominantly seen in males with a high burden of modifiable cardiovascular risk factors, particularly smoking, dyslipidemia, hypertension, and sedentary lifestyle. STEMI was the most frequent presentation, and although most patients showed favorable short-term outcomes, a considerable proportion developed significant in-hospital complications.

The mean age of patients in the present study was 38.2 ± 5.6 years, with the majority belonging to the 36–45 years age group. These findings are comparable to several regional and international studies reporting that premature coronary artery disease is more frequently observed in the late third and fourth decades of life^{13,14}. Similar observations have been reported from South Asian populations, where coronary artery disease tends to occur nearly a decade earlier than in Western countries¹⁵. This earlier onset has been attributed to a combination of genetic susceptibility, high prevalence of metabolic risk factors, smoking, dietary habits, and limited implementation of preventive cardiovascular healthcare measures in developing countries¹⁶.

A marked male predominance was observed in our study, with males comprising 78% of the study population. This finding is consistent with previous Pakistani and international studies on young ACS patients^{17,18}. The higher frequency among males may partly be explained by greater tobacco exposure, occupational stress, sedentary behavior, and higher prevalence of conventional cardiovascular risk factors among men in South Asian societies. In contrast, the lower proportion of female patients may also reflect the relative protective effect of endogenous estrogen in premenopausal women¹⁹. However, females in our study demonstrated comparatively higher frequencies of hypertension, diabetes mellitus, and dyslipidemia, which is consistent with findings from previous literature suggesting that women presenting with premature ACS often have a greater burden of metabolic risk factors²⁰.

Smoking emerged as the most prevalent cardiovascular risk factor in the present study and was identified in 63% of patients. Similar high smoking rates have been documented in studies conducted in Pakistan, India, and other developing countries²¹. Tobacco use remains a major contributor to premature atherosclerosis through endothelial dysfunction, thrombogenesis, oxidative stress, and accelerated plaque formation²². The high prevalence of smoking among young adults in our study likely reflects increasing tobacco consumption, lack of awareness regarding cardiovascular risk, and inadequate smoking cessation interventions in the community. These findings emphasize the importance of aggressive tobacco-control strategies and preventive cardiology programs targeting younger populations.

Dyslipidemia, hypertension, and diabetes mellitus were also frequently observed in our cohort. Nearly half of the patients had dyslipidemia, while hypertension and diabetes were present in 42% and 31% of patients, respectively. These findings are comparable with those reported in the INTERHEART study and other South Asian registries demonstrating a substantial burden of modifiable metabolic risk factors among patients with premature coronary artery disease²³. The coexistence of obesity and sedentary lifestyle in a considerable proportion of patients further reflects ongoing epidemiological transition associated with urbanization, unhealthy dietary patterns, reduced physical activity, and increasing prevalence of metabolic syndrome in Pakistan²⁴. Collectively, these observations highlight

the need for earlier cardiovascular risk assessment and lifestyle modification strategies in younger individuals.

In the present study, STEMI was the most common subtype of ACS, accounting for 64% of cases. Similar predominance of STEMI among young ACS patients has been reported in local and regional studies^{25,26}. Younger patients often present with acute thrombotic occlusion in the setting of single-vessel disease and smoking-related plaque rupture, resulting in STEMI being more frequent than NSTEMI or unstable angina²⁵. Coronary angiographic findings in our study also demonstrated predominance of single-vessel disease, particularly involving the left anterior descending artery, which is in agreement with published literature on young myocardial infarction patients²⁷.

An important finding of our study was delayed presentation after symptom onset. Only 31% of patients presented within the first three hours, while a substantial proportion presented after six hours. Delayed hospital presentation remains a major challenge in Pakistan and other low- and middle-income countries due to poor symptom recognition, transportation difficulties, financial constraints, self-medication practices, and delayed referral from peripheral healthcare facilities²⁸. Late presentation adversely affects timely reperfusion therapy and may contribute to increased complications and myocardial damage. Strengthening public awareness regarding ACS symptoms and improving emergency cardiac referral systems may help reduce treatment delays.

Echocardiographic evaluation in our study revealed regional wall motion abnormalities in the majority of patients, while reduced left ventricular systolic function was observed particularly among STEMI patients. These findings are clinically expected because extensive myocardial ischemia and delayed reperfusion commonly result in impaired ventricular function²⁹. Despite this, the overall short-term outcomes in our cohort were relatively favorable, with 90% of patients improving and being discharged in stable condition. In-hospital mortality remained low at 2%, which is comparable to mortality figures reported in several studies involving younger ACS populations²⁹. Younger patients generally have fewer comorbidities, better physiological reserve, and less extensive coronary disease, contributing to improved short-term survival compared with older ACS patients³⁰.

Arrhythmias and acute heart failure were the most frequently encountered complications in the present study. Similar complication patterns have been documented in other studies evaluating ACS in young adults³¹. The relatively lower mortality despite the occurrence of complications may reflect early initiation of evidence-based medical therapy and availability of tertiary cardiac care services at our institution.

Strengths and Limitations

The present study has several strengths. It provides recent local data regarding ACS in young adults from a major tertiary care center in Khyber Pakhtunkhwa, a region where published data remain limited. The study also offers a comprehensive overview of demographic characteristics, cardiovascular risk factors, clinical spectrum, management patterns, and short-term outcomes in a relatively understudied population.

However, certain limitations should be acknowledged. The study was conducted at a single tertiary care center with a relatively small sample size and short study duration, which may limit generalizability of the findings. Long-term follow-up outcomes were not assessed. In addition, certain lifestyle-related variables such as dietary habits, psychosocial stress, and socioeconomic status could not be evaluated

in detail. Future multicenter studies with larger sample sizes and longer follow-up periods are recommended to better characterize premature ACS in Pakistani populations. Further research exploring genetic predisposition, psychosocial determinants, and long-term cardiovascular outcomes among young adults would also be valuable. Public health policies focusing on smoking cessation, early screening of cardiovascular risk factors, promotion of healthy lifestyle practices, and timely access to cardiac care are essential to reduce the growing burden of premature coronary artery disease in Pakistan.

Conclusion

Acute coronary syndrome among young adults in our setting was characterized by a predominance of male patients, a high burden of modifiable cardiovascular risk factors, and a predominance of ST-segment elevation myocardial infarction. Smoking, dyslipidemia, hypertension, diabetes mellitus, and sedentary lifestyle were frequently encountered, highlighting the substantial contribution of preventable risk factors to premature coronary artery disease in this population. Despite the occurrence of important in-hospital complications, most patients experienced favorable short-term outcomes with timely evidence-based management.

These findings underscore the changing profile of cardiovascular disease in Pakistan, where clinically significant coronary events are increasingly being encountered at a younger age. Greater emphasis on early cardiovascular risk assessment, risk-factor modification, and public awareness regarding prompt recognition of ACS symptoms may contribute to reducing the burden of premature coronary artery disease. Further multicenter studies with larger sample sizes and long-term follow-up are needed to better define the evolving pattern and outcomes of ACS among young adults in Pakistan.

Additional information

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References

1. World Health Organization. Cardiovascular diseases (CVDs). Geneva: WHO; 2023.

2. Collet JP, Thiele H, Barbato E, Barthélémy O, Bauersachs J, Bhatt DL, et al. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Eur Heart J*. 2021;42(14):1289-1367.
3. Gulati R, Behfar A, Narula J, Kanwar A, Lerman A, Cooper L, et al. Acute myocardial infarction in young individuals. *Mayo Clin Proc*. 2020;95(1):136-156.
4. Egred M, Viswanathan G, Davis GK. Myocardial infarction in young adults. *Postgrad Med J*. 2005;81(962):741-745.
5. Andersson C, Vasan RS. Epidemiology of cardiovascular disease in young individuals. *Nat Rev Cardiol*. 2018;15(4):230-240.
6. Yusuf S, Hawken S, Ôunpuu S, Dans T, Avezum A, Lanas F, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364(9438):937-952.
7. Virani SS, Alonso A, Aparicio HJ, Benjamin EJ, Bittencourt MS, Callaway CW, et al. Heart disease and stroke statistics—2021 update: a report from the American Heart Association. *Circulation*. 2021;143(8):e254-e743.
8. Tisminetzky M, Coukos JA, McManus DD. Psychological and social implications of premature coronary artery disease. *Curr Cardiol Rep*. 2020;22(10):1-8.
9. Arora S, Stouffer GA, Kucharska-Newton AM, Qamar A, Vaduganathan M, Pandey A, et al. Twenty year trends and sex differences in young adults hospitalized with acute myocardial infarction. *Circulation*. 2019;139(8):1047-1056.
10. Joshi P, Islam S, Pais P, Reddy S, Dorairaj P, Kazmi K, et al. Risk factors for early myocardial infarction in South Asians compared with individuals in other countries. *JAMA*. 2007;297(3):286-294.
11. Enas EA, Senthilkumar A, Chennikkara H, Bjurlin MA. Proneness of people of Indian origin to coronary artery disease. *J Am Coll Cardiol*. 2019;74(23):2985-3004.
12. Pakistan Bureau of Statistics. Pakistan demographic and health indicators related to non-communicable diseases. Islamabad: Government of Pakistan; 2022.
13. Gulati R, Behfar A, Narula J, Kanwar A, Lerman A, Cooper L, et al. Acute myocardial infarction in young individuals. *Mayo Clin Proc*. 2020;95(1):136-156.
14. Arora S, Stouffer GA, Kucharska-Newton AM, Qamar A, Vaduganathan M, Pandey A, et al. Twenty year trends and sex differences in young adults hospitalized with acute myocardial infarction. *Circulation*. 2019;139(8):1047-1056.
15. Joshi P, Islam S, Pais P, Reddy S, Dorairaj P, Kazmi K, et al. Risk factors for early myocardial infarction in South Asians compared with individuals in other countries. *JAMA*. 2007;297(3):286-294.
16. Prabhakaran D, Jeemon P, Roy A. Cardiovascular diseases in India: current epidemiology and future directions. *Circulation*. 2016;133(16):1605-1620.
17. Jafary FH, Aslam F, Mahmud H, Waheed A, Shakir T, Afzal A, et al. Cardiovascular health knowledge and behavior in patient attendants at four tertiary care hospitals in Pakistan. *BMC Public Health*. 2005;5:124.
18. Egred M, Viswanathan G, Davis GK. Myocardial infarction in young adults. *Postgrad Med J*. 2005;81(962):741-745.

19. Maas AHEM, Appelman YEA. Gender differences in coronary heart disease. *Neth Heart J*. 2010;18(12):598-603.
20. Gupta R, Gaur K, S Ram CV. Emerging trends in hypertension epidemiology in India. *J Hum Hypertens*. 2019;33(8):575-587.
21. Zaman KS, Jahan S, Tayyib M. Risk factors and angiographic profile in young patients with coronary artery disease. *J Pak Med Assoc*. 2010;60(3):193-197.
22. Ambrose JA, Barua RS. The pathophysiology of cigarette smoking and cardiovascular disease. *J Am Coll Cardiol*. 2004;43(10):1731-1737.
23. Yusuf S, Hawken S, Ôunpuu S, Dans T, Avezum A, Lanans F, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (INTERHEART study): case-control study. *Lancet*. 2004;364(9438):937-952.
24. Virani SS, Alonso A, Aparicio HJ, Benjamin EJ, Bittencourt MS, Callaway CW, et al. Heart disease and stroke statistics—2021 update. *Circulation*. 2021;143(8):e254-e743.
25. Kumar R, Singh MC, Ahlawat SK, Thakur JS, Srivastava A, Sharma D. Clinical profile and risk factors in acute coronary syndrome in young adults. *J Assoc Physicians India*. 2017;65(9):28-32.
26. Bhardwaj R, Kandoria A, Sharma R. Myocardial infarction in young adults: risk factors and pattern of coronary artery involvement. *N Am J Med Sci*. 2014;6(8):394-398.
27. Collet JP, Thiele H, Barbato E, Barthélémy O, Bauersachs J, Bhatt DL, et al. 2020 ESC Guidelines for acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Eur Heart J*. 2021;42(14):1289-1367.
28. Choudhury L, Marsh JD. Myocardial infarction in young patients. *Am J Med*. 1999;107(3):254-261.
29. Khan MS, Jafary FH, Faruqui AM, Rasool SI, Hatcher J, Chaturvedi N, et al. High prevalence of lack of knowledge of symptoms of acute myocardial infarction in Pakistan and its contribution to delayed presentation. *BMC Public Health*. 2007;7:284.
30. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. *Eur Heart J*. 2018;39(2):119-177.
31. Fournier JA, Sánchez A, Quero J, Fernández-Cortacero JA, González-Barrero A. Myocardial infarction in men aged 40 years or less: a prospective clinical-angiographic study. *Clin Cardiol*. 1996;19(8):631-636.