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Research Article

The Young Heart Crisis: Exploring the Rising Burden of Acute Coronary Syndrome in the Young Population

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Abstract

Background: Coronary artery disease (CAD) remains a leading cause of morbidity and mortality worldwide, influenced by multiple risk factors, demographic variations, and lifestyle factors. Early identification and management of CAD are essential to reducing adverse cardiovascular events. This study aims to analyse CAD prevalence, clinical presentation, risk factor burden, electrocardiographic (ECG) findings, and coronary involvement patterns in a hospital-based population, with an emphasis on gender-specific differences.

Materials and Methods: This retrospective study was conducted from January 2023 to August 2024 at a tertiary care hospital in South India, involving a cohort of 298 patients from a low socioeconomic background. The inclusion criteria encompassed all patients aged between 18-45 years admitted to the hospital with a diagnosis of ACS. Demographic data, clinical symptoms, ECG findings, and coronary angiographic patterns were assessed. Major cardiovascular risk factors, including smoking, hypertension, diabetes mellitus, dyslipidaemia, obesity, and family history, were evaluated. The severity of coronary artery involvement was classified into single-vessel disease (SVD), double-vessel disease (DVD), and triple-vessel disease (TVD). Data were stratified by gender to assess differences in disease presentation and severity.

Results: Males comprised 77.8% of cases, with the majority aged >41 years (57.4%). Chest pain (90%) was the most common symptom, while women frequently presented with atypical symptoms such as dyspnoea and epigastric pain. STEMI (35.5%), NSTEMI (28.5%), and unstable angina (35.9%) were the predominant ECG findings. The left anterior descending artery (LAD) was the most affected vessel (48%), and single-vessel disease (SVD) was most common (48.6%). Key risk factors included smoking (81.2%), hypertension (56.3%), dyslipidaemia (46.9%), diabetes (38.6%), and obesity (51.6%). Women had a lower incidence of multivessel disease but presented with more risk factors. Notably, smoking was significantly higher in males, reinforcing its role as a primary risk factor for CAD. Hypertension and diabetes were more frequent in patients with multivessel disease, suggesting their role in disease progression.

Conclusion: This study highlights the high prevalence of CAD in males, with LAD involvement and SVD being the most common findings. The significant burden of modifiable risk factors emphasizes the importance of early screening, lifestyle modifications, and aggressive medical management. Women often present with atypical symptoms, which may contribute to underdiagnosis and delays in treatment, necessitating gender-specific diagnostic approaches. The predominance of STEMI indicates late disease presentation, emphasizing the need for public awareness programs on early symptom recognition. Future multicentre, prospective studies with long-term follow-up and broader risk factor assessment are required to further investigate CAD progression and optimize prevention and treatment strategies.

Keywords: Young Heart; Acute Coronary Syndrome; Young Population

Background

Coronary artery disease (CAD) has become the leading cause of morbidity and mortality among South Asian populations [1]. The increasing prevalence of acute coronary syndrome (ACS) in young adults presents a significant public health challenge, particularly in developing nations like India. Rapid urbanization, lifestyle modifications, and the adoption of Westernized diets have contributed to a rising burden of cardiovascular diseases [2]. Over the past few decades, conventional CAD risk factors, including smoking, alcohol consumption, physical inactivity, obesity, hypertension, and diabetes, have been exacerbated by socio-economic transitions, increasing the risk of premature CAD among younger populations compared to other ethnic groups [3].

The rising incidence of ACS in young adults is particularly concerning, as this demographic is generally perceived as low-risk for cardiovascular disease. The Global Burden of Disease Study has highlighted an increasing trend in cardiovascular disease (CVD) prevalence among young populations, particularly in low- and middle-income countries such as India [4]. Traditionally, ACS incidence has been higher in older individuals due to the cumulative effects of aging and prolonged exposure to risk factors. However, young adults with ACS exhibit distinct clinical characteristics, risk factor profiles, and angiographic findings. Studies suggest that modifiable lifestyle risk factors, such as smoking and substance abuse, are more prevalent among young adults with ACS [5,6]. Unlike older patients, who typically present with multi-vessel CAD, younger individuals often demonstrate single-vessel disease (SVD) and have comparatively better long-term prognoses [7,8].

Despite the growing attention to ACS in young adults in India, available data remain limited, with only a few hospital-based studies specifically addressing this demographic [9]. Consequently, young adults with ACS constitute an underreported and underrecognized group within the medical community. Early identification of risk factors, a deeper understanding of the pathophysiology, and targeted prevention strategies are crucial to improving patient outcomes. Therefore, this study aims to assess the clinical characteristics, associated risk factors, and angiographic profiles of young adults presenting with ACS at a tertiary care hospital in South India.

Materials and Methods

Study design and population

This retrospective observational study was conducted at a tertiary care hospital in South India over 18 months (January 2023 to August 2024). During this period, a total of 3,118 coronary interventions were performed. Among these, 298 patients aged 18 to 45 years who underwent coronary angiography (CAG) for ACS were included in the study. The hospital primarily serves patients from low- and middle-income backgrounds, offering a unique opportunity to evaluate the burden of ACS in a resource-limited setting.

The study population represented a diverse socioeconomic spectrum, providing real-world insights into the burden of cardiovascular disease among India's working population. The study was approved by the institutional ethical committee.

Inclusion criteria

- Patients aged 18 to 45 years who underwent CAG for ACS.
- Diagnosis confirmed by electrocardiographic changes, elevated cardiac biomarkers (troponins), and the presence of both modifiable (smoking, alcohol consumption, dyslipidaemia) and non-modifiable risk factors (family history, genetic predisposition).
- Patients who provided informed consent for study participation.

Exclusion criteria

- Patients younger than 18 years or older than 45 years.
- Individuals with congenital heart diseases, valvular heart disease, or known structural heart abnormalities.
- Patients with non-ischemic causes of myocardial injury (e.g., myocarditis, stress-induced cardiomyopathy).
- Patients with incomplete medical records or insufficient data for analysis.

Data collection and analysis

Data were retrospectively collected from the hospital's electronic medical records, including demographic details, clinical presentation, medical history, risk factors, laboratory findings, angiographic results, and treatment interventions. Key variables included:

- **Demographics**: Age, gender, socioeconomic status.
- **Symptoms**: Chest pain, dyspnoea, palpitations, etc.
- **Medical History**: Hypertension, diabetes, smoking, alcohol use.
- **Cardiovascular Risk Factors**: Dyslipidaemia, obesity, family history.
- **Electrocardiographic Diagnosis**: Unstable angina, non ST elevation MI (NSTEMI), ST elevation MI (STEMI).
- **Angiographic Findings**: Extent of coronary involvement, vessel disease pattern.
- **Management Strategies**: Medications, revascularization procedures.

Primary outcome measures

- Prevalence and distribution of conventional and modifiable risk factors.
- Extent of coronary artery involvement.
- Associations between risk factors and angiographic profiles.

Risk factor analysis

- **Hypertension (HTN):** Defined as an average blood pressure ≥ 130/80 mmHg or use of antihypertensive medication [10].
- **Diabetes Mellitus (DM):** Defined by a random blood glucose ≥ 200 mg/dL with symptoms, HbA1c ≥ 6.5%, or use of antidiabetic medication [11].
- **Smoking:** Defined as daily tobacco use or any smoking within one month of the index event [12].
- **Obesity**: Categorized based on South Asian BMI cut-offs: <18.5 kg/m^2 (underweight), 18.5–22.9 kg/m^2 (normal), 23.0–24.9 kg/m^2 (overweight), ≥ 25.0 kg/m^2 (obese) [13].
- **Family History:** Considered positive for premature CAD if a primary male or female relative was diagnosed with CAD before the age of 55 or 65 years, respectively [14].

Statistical analysis

Data analysis was performed using SPSS software (version 25). Continuous variables were expressed as means and standard deviations, while categorical variables were presented as percentages. Chi-square tests and independent t-tests were used to examine associations between categorical and continuous variables, respectively. A p-value < 0.05 was considered statistically significant.

Results

Demographics and age distribution

The study population consisted of 298 males (77.8%) and 66 females (22.2%), with the majority aged 41-45 years (57.4%), indicating a higher prevalence of coronary artery disease (CAD) in older adults. The mean age of the study population was 39.9 ± 4.98 years. Age distribution revealed a progressive increase in cases with advancing age, particularly among males, which is consistent with global trends showing a higher incidence of ACS in men. However, a notable subset (17.5%) were aged 18 to 34 years, underscoring the increasing incidence of early-onset ischemic heart disease.

Clinical presentation and ECG findings

Chest pain (90%) was the predominant symptom, followed by shortness of breath (40%) and dyspnoea (35%). Males reported more severe symptoms, whereas females exhibited a relatively lower frequency across all categories. NSTEMI (28.5%), STEMI (35.5%), and unstable angina (35.9%) were the primary ECG diagnoses. Table 1 summarises the patient characteristics of this demographic population.

Risk factors and disease burden

A significant proportion of patients had modifiable risk factors. Smoking (81.2%) and alcohol consumption (66.4%) were highly prevalent. Hypertension (56.3%), diabetes (38.6%), and dyslipidaemia (46.9%) contributed substantially to CAD progression. Obesity (51.6%) and a family history of CAD (6.7%) were also notable. Risk stratification showed that 43.6% had one risk factor, while 18.8% had no identifiable risks, underscoring the role of non-traditional and genetic factors. Table 2 summaries the major risk factors of the patients.

These findings underscore the significant role of lifestyle-related factors in the development of ACS at a young age. The high rates of smoking and alcohol consumption are particularly concerning and point to the need for public health interventions aimed at reducing these behaviours.

Pattern of coronary artery disease

Single-vessel disease (48.6%) was the most common, with LAD involvement in 30.5% of the SVD cases. Double-vessel disease (13.7%) and triple-vessel disease (7%) showed a decreasing trend. Normal coronary arteries were observed in 30.5% of patients, more

S. No	Patient characteristic	Observation	Male	Female
1	Age	39.9 ± 4.98 years		
2	Sex		232 (77.8%)	66 (22.2%)
3	Age groups	298	234 (78.5%)	64 (21.5%)
	• 18-25 years	• 5(1.6%)	• 4 (1.3%)	• 1(0.3%)
	• 26-30 years	• 11 (3.6%)	• 10 (3%)	• 1(0.3%)
	• 31-35 years	• 36 (12%)	• 31(10.4%)	• 5 (1.6%)
	• 36-40 years	• 75 (25.1%)	• 61(20.4%)	• 14 (4.7%)
	• 41-45 years	• 171 (57.4%)	• 128 (42.9%)	• 43 (14.4%)
4	Symptoms			
	• Chest pain	• 268 (90%)	• 220 (73.8%)	• 48 (16.1%)
	• Dyspnoea	• 104 (35%)	• 74 (24.8%)	• 30 (10%)
	• Palpitations	• 59 (20%)	• 39 (13%)	• 20 (6.7%)
	• Syncope	• 24 (8%)	• 14 (4.7%)	• 10 (3.3%)
	• SOB	• 119 (40%)	• 80 (26.8%)	• 39 (13%)
	• Epigastric pain	• 11 (3.6%)	• 5 (1.6%)	• 6 (2%)
5	ECG diagnosis			
	• NSTEMI	• 85 (28.5%)	• 65 (21.8%)	• 20 (6.7%)
	• STEMI	• 106 (35.5%)	• 90 (30.2%)	• 16 (5.3%)
	• Unstable angina	• 107 (35.9%)	• 77 (25.8%)	• 30 (10%)

Table 1: Patient characteristics of the population.

S. No	Angiographic profile	Observation (n, %)	Male (n, %)	Female (n, %)
1	Smoking	242 (81.2%)	236 (79.2%)	6 (2%)
2	Alcohol consumption	198 (66.4%)	178 (59.7%)	20 (6.7%)
3	Dyslipidaemia	140 (46.9%)	104 (34.9%)	36 (12%)
4	Diabetes mellitus	115 (38.6%)	84 (28.1%)	31 (10.4%)
5	Hypertension	168 (56.3%)	110 (36.9%)	58 (19.4%)
6	Obesity	154 (51.6%)	102 (34.2%)	52 (17.4%)
7	Family history of coronary artery disease (CAD)	20 (6.7%)	14 (4.7%)	6 (2%)
8	Number of risk factors			
	• None	• 56 (18.8%)	• 45 (15.1%)	• 11 (3.7%)
	• One	• 130 (43.6%)	• 95 (31.8%)	• 35 (11.7%)
	• Two	• 59 (19.8%)	• 40 (13.4%)	• 19 (6.3%)
	• Three	• 34 (11.4%)	• 20 (6.7%)	• 14 (4.7%)
	• Four	• 13 (4.3%)	• 10 (3.3%)	• 3 (1%)
	• Five	• 6 (2%)	• 4 (1.3%)	• 2 (0.6%)

Table 2: The distribution of the cardiovascular risk factors.

frequently in females, suggesting that alternative aetiologies such as coronary vasospasm, microvascular dysfunction, spontaneous recanalization of the artery or other non-atherosclerotic conditions could play a role in the pathophysiology of ACS in this group.

The left anterior descending (LAD) artery was the most frequently involved vessel (48%), followed by the right coronary artery (RCA) in 28.8% and the left circumflex artery (LCX) in 20.4%), with a higher incidence in males. These findings align with previous studies, which report that the LAD is the most commonly affected artery in ACS, due to its larger size and more extensive perfusion territory. Table 3 summaries the coronary angiographic profile of the study participants.

S. No	Angiographic profile	Observation (n, %)	Male (n, %)	Female (n, %)
1	Coronary artery involved • LAD • RCA • LCX	 • 143 (48%) • 86 (28.8%) • 61 (20.4%)	 • 126(42.3%) • 71 (23.8%) • 50 (16.7%)	 • 17(5.7%) • 15 (5%) • 11(3.6%)
2	Single vessel disease (SVD) • RCA only • LAD only • LCX only	145 (48.6%) • 39 (13%) • 91 (30.5%) • 15 (5%)	127 (42.9%) • 31 (10.4%) • 83 (27.8%) • 13 (4.3%)	18 (5.7%) • 08 (2.6%) • 08 (2.6%) • 02 (0.6%)
3	Double vessel disease (DVD) • RCA, LAD • LAD, LCX • RCA, LCX	41 (13.7%) • 16 (5.3%) • 15 (5%) • 10 (3.3%)	30 (10%) • 13 (4.3%) • 10 (3%) • 7 (2.3%)	11(3.6%) • 3 (1%) • 5 (1.6%) • 3 (1%)
4	Triple vessel disease (TVD)	21 (7%)	20 (6.6%)	1 (0.3%)
5	Normal coronaries	91 (30.5%)	56 (18.8%)	35 (11.7%)

Table 3: The coronary angiographic profile of the study participants.

Age and gender distribution

The 41-45 years age group (57.4%) had the highest representation, reflecting a higher prevalence of CAD with increasing age. Males consistently outnumbered females across all age groups. Notably, single-vessel disease was the most common finding, with multi-vessel disease being relatively rare, especially in younger individuals. Table 4 summarise age group wise distribution of coronary artery disease among the study population.

Management and outcomes

Management of ACS in this cohort primarily involved revascularization procedures. In total, 51% of patients underwent revascularization. The majority (43%) received percutaneous coronary intervention (PCI), while 8% underwent coronary artery bypass grafting (CABG). In terms of pharmacological management, dual antiplatelet therapy (DAPT) was initiated in all patients, alongside statins, beta-blockers, and angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin receptor blockers (ARBs), following current guideline recommendations for ACS management.

Table 4: Age group wise distribution of the coronary artery disease among the participants.

S. No	Age group (n, %)	Single vessel disease (n, %)	Double vessel disease (n,%)	Triple Vessel disease (n,%)	Normal coronaries (n,%)
1	18-25 years (5, 1.6%)	3 (1%)	0	0	2 (0.6%)
2	26-30 years (11, 3.6%)	5 (1.6%)	1 (0.3%)	0	5 (1.6%)
3	31-35 years (36, 12%)	14 (4.6%)	4 (1.3%)	0	18 (6%)
4	36-40 years (75, 25.1%)	44 (14.7%)	8 (2.6%)	5 (1.6%)	18 (6%)
5	41-45 years (171, 57.4%)	79 (26.4%)	28 (9.3%)	16 (5.3%)	48 (15.4%)

Discussion

Coronary artery disease continues to be the leading cause of morbidity and mortality worldwide, with its pathogenesis intricately linked to a complex interplay of established and emerging risk factors even in the younger populations. In India, the prevalence of CAD is notably higher among the younger demographic, driven by changing lifestyle factors. Compared to Western populations, CAD in India manifests earlier, with the INTERHEART study indicating a 10-year earlier onset in South Asians [15]. Our study corroborates these findings, with the majority of cases presenting in individuals aged over 41 years. This trend highlights the critical need for early prevention strategies in this age group.

A male predominance in CAD was observed in our cohort (77.8% vs. 22.2%), consistent with existing literature that reports a higher incidence of CAD among males (99.2%) [5]. This is attributed to various factors, including hormonal differences, such as testosterone-related effects on endothelial function, lipid metabolism, and lifestyle influences. The protective role of oestrogen in premenopausal women, including its effects on lipid regulation and vascular inflammation, explains the lower incidence of CAD in women during their reproductive years [16]. However, postmenopausal women experience a marked increase in CAD risk, underscoring the necessity for more vigilant monitoring and aggressive risk management strategies in this population.

Classic chest pain, found in 90% of patients, was the most common presenting symptom, as expected. However, there was a notable incidence of atypical symptoms, such as dyspnoea (35%), shortness of breath (40%), and palpitations (20%), revealing the diverse clinical spectrum of CAD. Notably, women exhibited a lower incidence of typical chest pain and had a higher frequency of atypical symptoms, including epigastric discomfort and dyspnoea, which are often overlooked. This gender-specific symptomatology emphasizes the importance of heightened clinical vigilance and awareness, as delayed diagnosis due to atypical presentations could worsen outcomes. Among the clinical syndromes, unstable angina was the most common diagnosis (35.9%), followed by STEMI (35.5%) and NSTEMI (28.5%). This distribution indicates that a significant proportion of patients presenting late in the disease course with STEMI, often necessitating emergent intervention.

Our study highlights the significant burden of modifiable risk factors in younger adults with CAD. The most prevalent risk factors identified included smoking (81.2%), hypertension (56.3%), dyslipidaemia (46.9%), and diabetes mellitus (DM) (38.6%). These findings align with other Indian cohorts, such as the study by Sinha., *et al*. which reported high rates of smoking, obesity, family history of early CAD, and physical inactivity among young CAD patients [6]. Similarly Aggarwal., *et al*. documented high rates of dyslipidaemia, smoking, and central obesity as key contributors to CAD risk [17].

Risk stratification in our cohort revealed that 43.6% of patients had at least one identified risk factor, 19.8% had two, 11.4% had three traditional risk factors. Interestingly, 18.8% of patients had no identifiable conventional risk factors, suggesting the involvement of non-traditional risk factors such as psychological stress, dietary factors, genetic predispositions, drug use, autoimmune disorders and emerging biomarkers (e.g., lipoprotein(a) levels, homocysteine) [3,18-20]. This finding suggests that current risk factor profiles may still be incomplete and highlights the need for more comprehensive evaluations in clinical practice. Gender differences were evident, with women exhibiting a higher prevalence of hypertension and obesity, while smoking and alcohol consumption were more prevalent among men. These differences suggest divergent risk factor profiles between genders, necessitating tailored

approaches to prevention and management in both populations. Moreover, the clustering of multiple risk factors in over half of our cohort hihglights the multifactorial nature of CAD and the need for personalized risk management strategies, consistent with findings by Sekhri., *et al.* [21].

Coronary angiography revealed left anterior descending artery (LAD) involvement in 48% of patients, followed by the right coronary artery (RCA) (28.8%) and left circumflex artery (LCx) (20.4%). The LAD's central role in supplying a large portion of the myocardium contributes to its involvement in more severe and extensive disease. In terms of angiographic findings, single-vessel disease (SVD) was the most common (48.6%), followed by double-vessel disease (DVD) (13.7%) and triple-vessel disease (TVD) (7%). The high prevalence of SVD suggests that early interventions, such as percutaneous coronary intervention (PCI) or aggressive medical management, may help prevent progression to more complex multivessel disease.

These findings align with those of Kumbhalkar., *et al*. [22] and Suri P., *et al*. [9], who also reported high LAD involvement (82.5% and 77%) and a prevalence of SVD (57.1% and 69.5%) in their cohorts. Additionally, they found associations between obesity, diabetes, and alcohol consumption with higher rates of TVD, highlighting the impact of lifestyle factors on disease severity. This supports the established literature that identifies diabetes, increased BMI, and low ejection fraction (EF) as independent predictors of mortality in multivessel disease [23].

Implications for clinical practice and public health

Our findings have several important clinical and public health implications:

- **Early Risk Stratification**: Targeted screening initiatives for early identification of high-risk individuals are critical, particularly in younger populations.
- **Gender-Specific Interventions:** The atypical presentation in women, along with their higher likelihood of presenting with late-stage disease, calls for gender-sensitive diagnostic and therapeutic protocols.
- **Aggressive Smoking Cessation:** Given the high prevalence of smoking in our cohort, tobacco cessation programs should be prioritized, with integrated pharmacologic and behavioral interventions.
- **Optimized Medical Therapy:** For patients with SVD and high-risk profiles, aggressive medical management, particularly with guideline-directed therapies, is essential to mitigate the risk of disease progression.

Conclusion

This study highlights a significant male predominance in CAD, with LAD involvement being the most frequent angiographic finding, and single-vessel disease the predominant pattern. The study underscores the high prevalence of modifiable risk factors, such as smoking, hypertension, and diabetes, and emphasizes the urgent need for proactive preventive measures. Additionally, the observation of atypical symptoms in women and the frequent late presentation of STEMI further stress the importance of early diagnosis and gender-specific management strategies. These findings reinforce the need for a comprehensive, multifactorial approach to CAD prevention and management, especially in younger populations. Tailored interventions, timely detection, and effective management of risk factors are essential for optimal outcomes.

Limitations

This single-center, retrospective study may limit generalizability and is susceptible to selection bias. The underrepresentation of females may affect gender-specific insights, and the absence of long-term follow-up restricts the ability to assess long-term outcomes. Furthermore, the lack of advanced biomarkers and lifestyle data reduces the precision of risk assessment. Variations in diagnostic and management protocols may also influence the findings.

Future Directions

- Implementation of public health policies aimed at reducing smoking and other modifiable risk factors.
- Further multicentric studies to provide a more comprehensive understanding of the epidemiology of ACS in younger populations across India.
- Development of region-specific guidelines addressing the unique risk factors of the South Asian population.

Ethical Approval and Consent to Participate

Approved by the institute ethical committee.

Consent to Publish

Written and informed consent for publication of this case report was obtained from the parents of the patient.

Availability of Data and Material

Not applicable.

Competing Interests

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Author Contribution

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