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Dyslipidemia Patterns and In-Hospital Outcomes in Young Adults with Acute Coronary Syndrome: A Central Indian Study

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ABSTRACT

Background: Early coronary artery disease (CAD) is an emerging public health problem in India, where young individuals are frequently admitted with acute coronary syndrome (ACS). Although dyslipidemia is a major modifiable risk factor, its pattern and clinical implications remain understudied in young patients with CAD-ACS in Central India.
Subject and Methods: This cross-sectional observational study was conducted at a tertiary care hospital in Indore, India, from January to December 2024. Patients aged 18–45 years with a definite diagnosis of CAD-ACS were consecutively enrolled after obtaining informed consent. A total of 120 patients underwent detailed clinical evaluation and fasting lipid profiling. Dyslipidemia was classified according to National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria. Patients were followed for in-hospital outcomes, including arrhythmias, intensive care unit (ICU) stay, and mortality. Data were analysed using JAMOVI, with $p<0.05$ considered statistically significant.
Results: The mean age of the 120 patients was 37.46 ± 5.72 years, and 73.3% were male. Combined dyslipidemia was the predominant pattern (74.2%). Low HDL was the most prevalent lipid abnormality (76.7%), followed by elevated LDL (55%) and hypertriglyceridemia (50%). STEMI was the most common ACS presentation (60.8%), and dyslipidemia pattern was significantly associated with ACS type ($p=0.005$). Arrhythmias occurred in 15% of patients and were associated with significantly higher total cholesterol ($p=0.029$), LDL ($p=0.002$), and triglyceride levels ($p=0.036$). Triglycerides ($\rho=0.240$, $p=0.008$) and total cholesterol ($\rho=0.193$, $p=0.035$) showed significant positive correlations with ICU-stay duration. In-hospital mortality was 4.2%, and dyslipidemia pattern was significantly associated with mortality ($p=0.043$).
Conclusion: Young adults with CAD-ACS demonstrated a high burden of dyslipidemia, predominantly combined dyslipidemia, with low HDL as the most frequent abnormality followed by elevated LDL and hypertriglyceridemia. Lipid abnormalities showed differential associations with arrhythmias, ICU-stay duration, and in-hospital mortality. These findings highlight the importance of comprehensive lipid profiling in young patients with CAD-ACS rather than focusing on a single lipid abnormality.

Keywords: Acute coronary syndrome, dyslipidemia, low HDL, elevated LDL, hypertriglyceridemia, young adults, India, in-hospital outcomes.

INTRODUCTION

Coronary artery disease (CAD) remains a major cause of morbidity and mortality worldwide, and its occurrence at a young age is of particular concern because it results in a longer lifetime burden of recurrent cardiovascular events, disability, and treatment. South Asians develop myocardial infarction at younger ages than many other populations, with conventional modifiable risk factors accounting for much of this excess burden [1–4]. Indian registries and hospital-based studies have similarly documented premature CAD and acute coronary syndrome (ACS) in young adults, frequently with a marked male predominance and substantial exposure to smoking and other cardiometabolic risk factors [5,6]. These observations make early identification of modifiable abnormalities especially relevant in Indian patients aged 45 years or younger [1,2].

Dyslipidemia is one of the principal modifiable determinants of atherosclerotic cardiovascular disease. Among the lipid fractions, low-density lipoprotein cholesterol (LDL-C) has a well-established causal relationship with atherosclerosis, supported by convergent genetic, epidemiological, and clinical evidence; both the magnitude and duration of LDL-C exposure influence subsequent cardiovascular risk [7–10]. However, cardiovascular risk in South Asian populations cannot be described by LDL-C alone. Studies from India and the INTERHEART programme have highlighted a broader atherogenic lipid phenotype that may include low high-density lipoprotein cholesterol (HDL-C), elevated triglycerides, adverse apolipoprotein profiles, and clustering of multiple lipid abnormalities [11–14]. Accordingly, evaluation of the complete lipid profile is important when characterizing premature CAD rather than focusing on a single lipid component [11–14].

The lipid phenotype of young patients with CAD or ACS has shown considerable variation across Indian and South Asian cohorts. Studies of young ACS patients have reported a high prevalence of dyslipidemia alongside smoking or tobacco use, diabetes, hypertension, obesity, and family history of premature CAD [15–19]. Indian studies examining premature CAD have also described low HDL-C, elevated LDL-C, hypertriglyceridemia, and mixed or combined dyslipidemic patterns in differing proportions [20–22]. This variation may reflect differences in geography, diet, lifestyle, metabolic risk, age definitions, referral patterns, and the criteria used to define dyslipidemia. Therefore, findings from one region cannot necessarily be assumed to represent young CAD-ACS patients throughout India, and region-specific characterization remains clinically relevant [11,20–22].

Although the association between dyslipidemia and the development of coronary atherosclerosis is well recognized, comparatively less information is available on how individual lipid parameters and categorical dyslipidemia patterns relate to the immediate hospital course of young patients presenting with ACS. Previous studies in young South Asian ACS populations have largely emphasized the prevalence of risk factors, angiographic patterns, or overall lipid profiles [15,18,23]. Whether low HDL-C, elevated LDL-C, hypertriglyceridemia, or combined dyslipidemia show different relationships with short-term outcomes such as arrhythmias, critical-care requirement, and in-hospital mortality remains less clearly defined. Importantly, these relationships should be examined without assuming that the most prevalent lipid abnormality will necessarily be the lipid parameter most strongly associated with an acute clinical outcome.

Central India has relatively limited published data specifically describing the spectrum of dyslipidemia in young adults with CAD-ACS together with its relationship to in-hospital outcomes. A clearer understanding of this profile may help define the local burden of potentially modifiable lipid abnormalities and generate evidence for future risk-stratification and longitudinal

studies. Therefore, the primary aim of the present study was to evaluate the lipid profile in young patients (≤45 years) diagnosed with CAD-ACS. The secondary objectives were to assess the pattern of dyslipidemia, including isolated and combined abnormalities, and to correlate dyslipidemia severity and lipid parameters with in-hospital mortality, development of arrhythmias, and duration of ICU stay.

MATERIALS AND METHODS

Study Design & Setting: This cross-sectional observational study was carried out in the general medicine department of M.G.M. Medical College and M.Y. Hospital, Indore, a Central Indian tertiary care facility. After the Institutional Ethics Committee granted clearance, this trial was conducted for a full year.

Study Population and Sample Size: The study population comprised patients between the age group of 18 to 45 years admitted with a confirmed diagnosis of CAD-ACS (STEMI, NSTEMI or unstable angina). We excluded patients with known secondary causes of dyslipidemia (e.g. nephrotic syndrome, hypothyroidism) or patients on prior statin therapy. Sample size was computed using Cochran's formula with an estimated prevalence of young CAD of 7%, based on published registry data summarized by Revaiah et al. **[15]**, a 95% confidence level and a 5% margin of error. Considering a 20% non-response rate, the final sample size was 120.

Data collection and definitions: Data were collected on a structured proforma after written informed consent. A detailed history was taken (demographics, lifestyle risk factors, comorbidities and family history) and a physical examination and systemic review were performed. A fasting lipid profile was obtained within 24 hours of admission. Dyslipidemia was classified according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) guidelines **[24]**. A master chart of all patient data was maintained in de-identified fashion.

Operational Definitions:

Combined Dyslipidemia: The coexistence of two or more lipid abnormalities (elevated LDL-C, hypertriglyceridemia, or low HDL-C).

Isolated Hypertriglyceridemia: Triglycerides ≥150 mg/dL with normal levels of other lipid parameters (total cholesterol, LDL-C, HDL-C).

Coronary Artery Disease - Acute Coronary Syndrome (CAD-ACS): Diagnosis was based on the clinical presentation, electrocardiographic findings, and cardiac biomarkers, as appropriate to the ACS subtype.

Statistical Analysis

The Shapiro-Wilk test was used to determine the normality of continuous variables, which are then displayed as mean ± standard deviation or median (IQR), depending on the situation. Frequencies and percentages are used to display categorical variables. To find correlations between categorical variables, the Chi-square test or Fisher's exact test were employed, depending on the situation. Continuous variables were compared between groups using the Mann-Whitney U test. Correlations were evaluated using Spearman's rank correlation coefficient. For statistical significance, the p-value was set at less than 0.05, and when appropriate, 95% confidence intervals were given.

Ethical Considerations: The MGM Medical College Indore Institutional Ethics Committee (IEC) gave its approval to the study protocol. The study methods adhered to the Helsinki Declaration of 1975 (updated 2013) and the ethical standards of the responsible human experimentation committee. Written informed consent was provided by each subject. All information was collected solely for research purposes and handled with confidentiality.

RESULTS

A total of 120 young patients (≤45 years) with confirmed CAD-ACS were included in the analysis.

Baseline Demographics and Clinical Profile

The mean age was 37.46 ± 5.72 years, with the majority (54.1%) in the 36-45-year age group; 73.3% were male (Table 1). Smoking was reported in 45% and alcohol use in 24.2%. Diabetes mellitus was present in 25%, hypertension in 15%, and 10% had a positive family history of coronary artery disease (Table 2). STEMI was the predominant clinical presentation (60.8%), followed by NSTEMI (35.8%) and unstable angina (3.4%). Regarding critical care requirement, 25.8% had no ICU stay, 54.2% stayed for 1-2 days, 17.5% for 3-5 days and 2.5% for >5 days; the mean ICU stay was 1.74 ± 1.96 days. In-hospital arrhythmias occurred in 15% and overall, in-hospital mortality was 4.2%.

Table 1: Demographic and Clinical Characteristics of Study Participants (n=120)

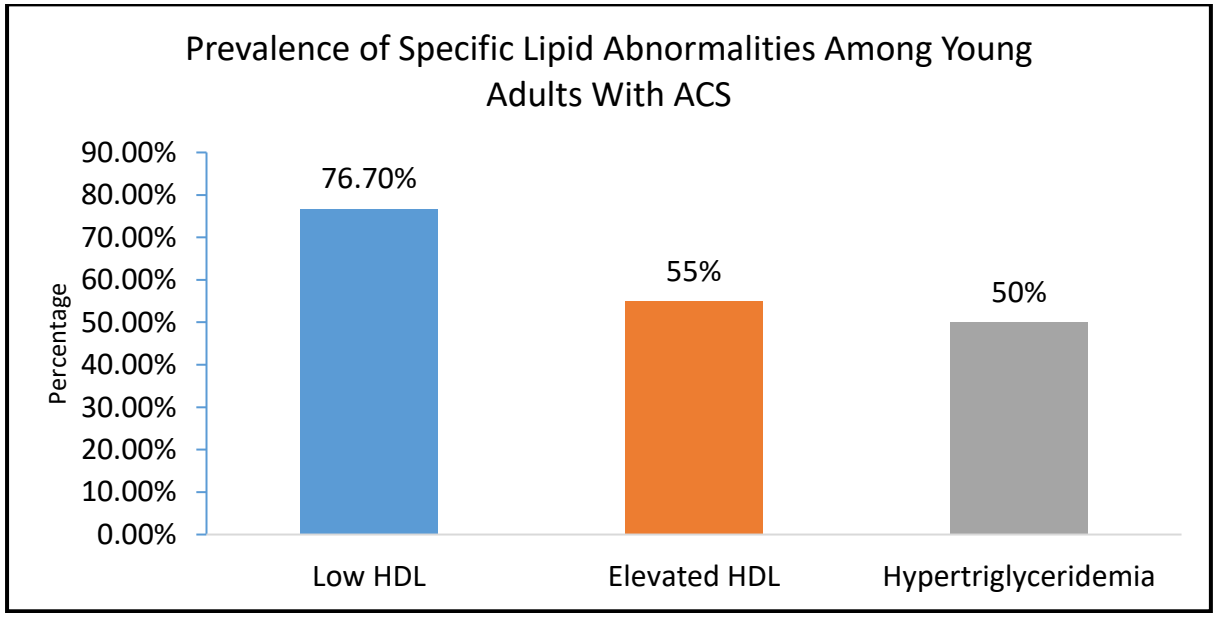
Characteristic	Category	n (%)	95% CI
Age Group	18–25 years	5 (4.2%)	(1.4-9.5%)
	26–35 years	50 (41.7%)	(32.8-51.0%)
	36–45 years	65 (54.1%)	(44.8-63.3%)
Gender	Male	88 (73.3%)	(64.4-81.0%)
	Female	32 (26.7%)	(19.0-35.6%)
Type of ACS	STEMI	73 (60.8%)	(51.5-69.6%)
	NSTEMI	43 (35.8%)	(27.3-45.0%)
	Unstable Angina	4 (3.4%)	(0.9-8.5%)

Table 2: Prevalence of Risk Factors (n=120)

Risk Factor	n (%)	95% CI
Smoking (Ever)	54 (45.0%)	(35.9-54.3%)
Alcohol (Ever)	29 (24.2%)	(16.8-32.9%)
Diabetes Mellitus	30 (25.0%)	(17.5-33.7%)
Hypertension	18 (15.0%)	(9.1-22.6%)
Family History of CAD	12 (10.0%)	(5.3-16.9%)

Lipid Profile and Patterns of Dyslipidemia

The median lipid levels were: total cholesterol 192.5 (IQR: 151-233) mg/dL, LDL 134 (IQR: 101-155) mg/dL, HDL 32 (IQR: 28-39) mg/dL, and triglycerides 154.5 (IQR: 111-205) mg/dL. Low HDL was the most prevalent abnormality (76.7%), followed by elevated LDL (55%) and hypertriglyceridemia (50%) (Figure 1A). The most common type of dyslipidemia was the combined type (74.2%) (Figure 1B).



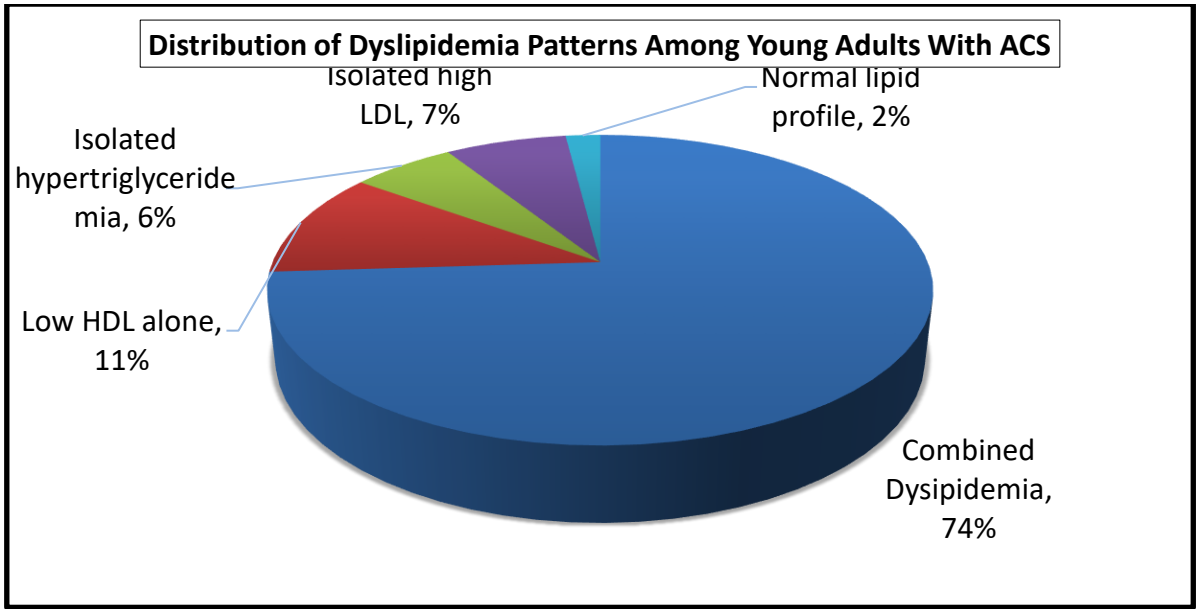


Figure 1: (A) Bar chart showing the percentage of patients with specific lipid abnormalities as per NCEP-ATP III criteria. (B) Pie chart illustrating the distribution of different patterns of dyslipidemia.

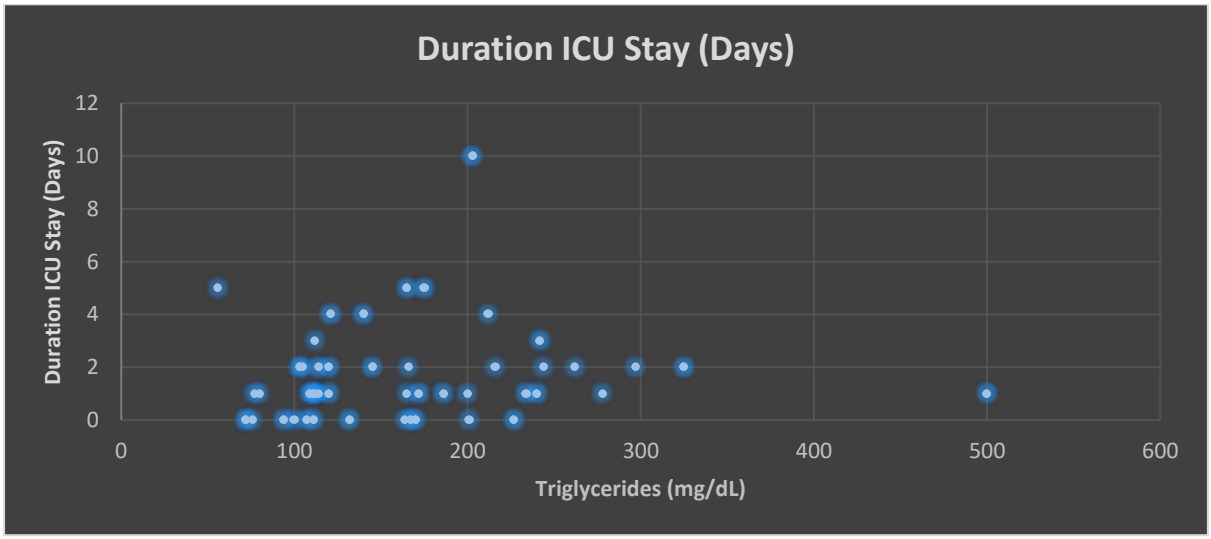
Association with In-Hospital Outcomes

In-hospital arrhythmias occurred in 15% of patients (n=18). Patients with arrhythmias had significantly higher median levels of total cholesterol (224 vs. 188 mg/dL, p=0.029), LDL (165 vs. 134 mg/dL, p=0.002), and triglycerides (203 vs. 132 mg/dL, p=0.036) (**Table 3**).

Table 3: Comparison of Lipid Parameters in Patients with and without Arrhythmias

Lipid Parameter	Median (Arrhythmia Present) n=18	Median (Arrhythmia Absent) n=102	p-value
Total Cholesterol (mg/dL)	224	188	0.029*
LDL (mg/dL)	165	134	0.002*
HDL (mg/dL)	37	32	0.183
Triglycerides (mg/dL)	203	132	0.036*
Mann-Whitney U Test. p<0.05 considered significant.			

A significant positive correlation was found between triglyceride levels and the duration of ICU stay (Spearman's ρ=0.240, p=0.008) (**Figure 2A**). A similar but weaker correlation was observed for total cholesterol (ρ=0.193, p=0.035).



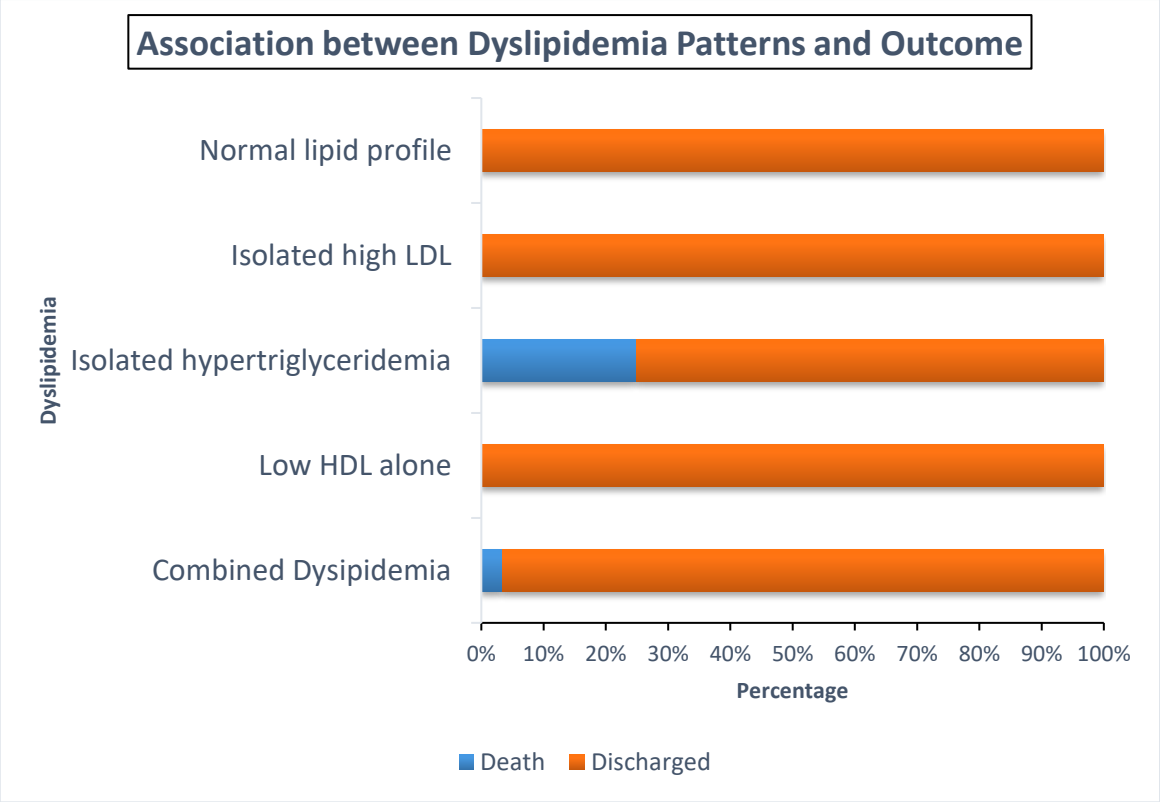


Figure 2:(A) Scatter plot demonstrating the significant positive correlation between serum triglyceride levels and the duration of ICU stay (days). (B) Stacked bar chart showing the association between different patterns of dyslipidemia and in-hospital mortality.

The overall in-hospital mortality was 4.2% (n=5). A statistically significant association was observed between dyslipidemia pattern and in-hospital mortality (χ^2=9.84, p=0.043) [Table 4]. Isolated hypertriglyceridemia appeared to be associated with a significantly higher mortality rate (25%, 2 of 8 patients) than did combined dyslipidemia (3.4%, 3 of 89 patients) (post hoc analysis). However, there were no significant differences in individual lipid levels (total cholesterol, LDL, HDL, triglycerides) between the survivors and non-survivors (**Table 4**).

Table 4: Association Between Dyslipidemia Pattern and In-Hospital Mortality

Dyslipidemia Pattern	Total Patients	Deaths (%)	Discharged (%)
Combined Dyslipidemia	89	3 (3.4%)	86 (96.6%)
Low HDL Alone	13	0 (0%)	13 (100%)
Isolated Hypertriglyceridemia	8	2 (25%)	6 (75%)
Isolated High LDL	8	0 (0%)	8 (100%)
Normal Lipid Profile	2	0 (0%)	2 (100%)
Total	120	5 (4.2%)	115 (95.8%)
Chi-square test: $\chi^2 = 9.84$, $p = 0.043$			

Additional objective-linked analyses showed that dyslipidemia pattern was significantly associated with type of ACS (χ^2=9.84, p=0.005). In contrast, dyslipidemia pattern was not significantly associated with duration of ICU stay (χ^2=18.03, p=0.115) or occurrence of in-hospital arrhythmias (χ^2=5.31, p=0.257). Thus, the significant arrhythmia findings related to individual lipid levels—total cholesterol, LDL and triglycerides—rather than to the categorical dyslipidemia pattern.

When individual lipid parameters were correlated with ICU-stay duration, triglycerides showed a significant positive correlation (ρ=0.240, p=0.008) and total

cholesterol showed a weaker but significant positive correlation (ρ=0.193, p=0.035). LDL (ρ=0.065, p=0.478) and HDL (ρ=-0.045, p=0.627) were not significantly correlated with ICU-stay duration. Likewise, comparison of individual lipid levels between patients who died and those discharged showed no statistically significant differences: total cholesterol p=0.248, LDL p=0.386, HDL p=0.171 and triglycerides p=0.270. This distinction is important because the significant mortality result concerned the distribution of dyslipidemia patterns, not a significant difference in any single baseline lipid parameter.

DISCUSSION

This cross-sectional study in Central India provides information regarding the clinical and metabolic characteristics of young adults with CAD-ACS. The cohort showed a high prevalence of modifiable risk factors and a predominantly combined atherogenic dyslipidemic profile characterized by low HDL, elevated LDL and hypertriglyceridemia. Associations with in-hospital outcomes varied by lipid parameter and by the way dyslipidemia was analysed, emphasizing the importance of interpreting individual lipid levels separately from categorical dyslipidemia patterns.

Demographics and Risk Factors: The mean age (37.46 years) and male predominance (73.3%) were consistent with published Indian cohorts of premature CAD and young ACS, which have also reported marked male predominance and substantial tobacco exposure **[5,6,15,18]**. Smoking was common (45%), with additional metabolic and familial risk factors including diabetes mellitus (25%), hypertension (15%) and a positive family history of CAD (10%). STEMI was the predominant presentation (60.8%), broadly consistent with reports that ST-elevation ACS is frequent among younger Indian patients **[15,16,18,19]**.

Lipid Profile and Patterns of Dyslipidemia: Combined dyslipidemia was the predominant pattern (74.2%), showing that lipid abnormalities commonly clustered rather than occurring in isolation. Low HDL was the most prevalent abnormality (76.7%), followed by elevated LDL (55%) and hypertriglyceridemia (50%). This pattern is compatible with prior South Asian and Indian literature describing a high prevalence of low HDL-C together with elevated triglycerides, LDL-C, non-HDL-C and other atherogenic lipoprotein abnormalities **[12–14,18,20,21]**. Thus, the dominant phenotype in the present cohort was a broad atherogenic lipid profile rather than hypertriglyceridemia alone. Dyslipidemia pattern was also significantly associated with type of ACS (p=0.005).

Association with In-Hospital Outcomes: Patients who developed arrhythmias had significantly higher total cholesterol, LDL and triglyceride levels, with the strongest statistical association observed for LDL (median 165 vs. 134 mg/dL, p=0.002), followed by total cholesterol (p=0.029) and triglycerides (p=0.036); HDL did not differ significantly. However, dyslipidemia pattern as a categorical variable was not significantly associated with arrhythmia occurrence (p=0.257). These findings indicate that individual lipid measurements and categorical dyslipidemia patterns should not be interpreted interchangeably.

For ICU stay, triglycerides showed a significant positive correlation with duration (ρ=0.240, p=0.008), while total cholesterol showed a weaker significant correlation (ρ=0.193, p=0.035); LDL and HDL were not significantly correlated with ICU duration. The categorical dyslipidemia pattern was also not significantly associated with ICU-stay duration (p=0.115). Dyslipidemia pattern was significantly associated with in-hospital mortality (p=0.043), with 2 deaths among 8 patients with isolated hypertriglyceridemia compared with 3 among 89 patients with combined dyslipidemia; however, the subgroup was small and the post-hoc comparison was only borderline significant. None of the individual lipid parameters differed significantly between survivors and non-survivors.

Therefore, the mortality finding should be interpreted as an association with dyslipidemia pattern rather than evidence that a single lipid parameter independently predicts death.

Clinical Implications and Future Directions: The findings support early and comprehensive lipid assessment in young adults with ACS. Risk assessment should consider the complete lipid phenotype because low HDL was the most prevalent abnormality, elevated LDL was common and showed the strongest association with arrhythmias, and triglycerides and total cholesterol correlated with ICU-stay duration. The established causal role of LDL-C in ASCVD is supported by genetic, epidemiological and clinical evidence [8–10], while INTERHEART and other South Asian studies demonstrate a broader burden of atherogenic lipid abnormalities **[12–14,20,21]**. These findings support an integrated approach rather than prioritizing a single lipid fraction. Low HDL, although highly prevalent, was not significantly associated with the measured in-hospital outcomes in this cohort. The isolated hypertriglyceridemia mortality finding is hypothesis-generating because of the small subgroup size and should not overshadow the broader combined dyslipidemic pattern observed in the cohort.

Further studies with larger samples and longitudinal follow-up should evaluate the independent prognostic contributions of LDL-C, HDL-C, triglycerides and combined dyslipidemia to short- and long-term cardiovascular outcomes in young ACS patients. Interventional research should similarly assess comprehensive lipid-lowering and lifestyle strategies rather than focusing exclusively on triglyceride lowering.

Limitations

This was a single-center study with a relatively small sample size (n=120), which may limit generalizability. The cross-sectional nature of this work does not allow causal inferences. Outcomes were assessed only during hospitalization and did not include long-term follow-up. The study also did not include coronary angiographic correlation, which could have added information on the relationship between lipid patterns and disease severity.

CONCLUSION

This study from Central India demonstrates a high burden of dyslipidemia among young patients with CAD-ACS, predominantly as combined dyslipidemia. Low HDL was the most prevalent lipid abnormality (76.7%), followed by elevated LDL (55%) and hypertriglyceridemia (50%). Dyslipidemia pattern was significantly associated with type of ACS and in-hospital mortality, but not with categorical ICU-stay duration or arrhythmia occurrence. At the individual lipid level, total cholesterol, LDL and triglycerides were significantly higher in patients who developed arrhythmias, with LDL showing the strongest association; triglycerides and total cholesterol correlated with ICU-stay duration, whereas LDL and HDL did not. Individual lipid levels were not significantly different between survivors and non-survivors. Overall, the findings support comprehensive evaluation of low HDL, elevated LDL, hypertriglyceridemia and combined dyslipidemia rather than disproportionate emphasis on hypertriglyceridemia alone.

Declaration

Ethical Approval: Approved

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

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