Risk factors, comorbidities and Atherogenic dysLipidaemia in Indian YOUNG patients with dyslipidaemia attending hospital/clinic: REAL YOUNG (dyslipidaemia) study

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Abstract

Objective: To evaluate the pattern of dyslipidaemia, risk factors, and comorbidities in young Indian adults with dyslipidaemia.

Methods: A retrospective, multi-centric real-world study included individuals with dyslipidaemia, aged 18 - 45 years, attending to 623 hospitals/clinics across India. Data were collected retrospectively from medical records to note demographics, risk factors (smoking, alcohol consumption, sedentary lifestyle, family history of dyslipidaemia, diabetes mellitus, and hypertension), and clinical details (height, weight, waist circumference, body mass index (BMI), blood pressure, blood sugar, glycated hemoglobin (HbA1c), triglycerides (TG), total cholesterol (TC), low-density lipoproteins (LDL-C), and high-density lipoprotein (HDL-C)). A descriptive analysis and comparative analysis (Mann-Whitney U test and Chi-square test) were done.

Results: Of the total 8135 patients, the majority were men (65.0%). Overall, 87.1% of population had one or multiple comorbidities which included the presence of dyslipidaemia alone (12.9%), dyslipidaemia with diabetes and hypertension (39.1%), dyslipidaemia with diabetes (33.6%), and dyslipidaemia with hypertension (14.4%). Sedentary lifestyle was prevalent observation in >50% of the population. Youngest age (18 - 25) group had higher prevalence of hypertriglyceridemia (63.2%), high LDL-C levels (56.8%), and low HDL-C levels (64.6%), while patients from the age group >25 to ≤35 years had the highest incidence of hypercholesterolemia (66.6%). Atherogenic dyslipidaemia was observed in 41.9%, 25.5%, and 23.2% of patients from age groups of ≥18 to ≤25, >25 to ≤35, and >35 to ≤45 years, respectively. Patients with HbA1c ≥6.5% had significantly higher levels of TG, TC, LDL-C, and lower HDL-C compared to those with HbA1c <6.5%. Conclusion: Hypertriglyceridemia, high LDL-C, low HDL-C, and atherogenic dyslipidaemia were prevalent in the young Indian cohort and sedentary lifestyle, and HbA1c ≥ 6.5% were the predominant risk factors of dyslipidaemia.

Keywords: Atherogenic, hypertension, hypertriglyceridemia, sedentary lifestyle, young dyslipidaemia

Introduction

The premature coronary artery disease (CAD) has increased at an alarming rate in India with an obvious visible impact on the young Indian population. In recent times, over 50% of mortality due to cardiovascular diseases (CVD) has been...
noticed in individuals aged <50 years. A recently published review discussed the established and emerging risk factors for CAD in very young South Asians and the higher rates of CAD in this population may be partially explained by an increased prevalence of traditional risk factors, including diabetes, hypertension, smoking and metabolic syndrome. The most common attributable risk factors among young individuals with the premature occurrence of coronary heart disease (CHD) include dyslipidaemia, hypertension, and smoking.

Among the patients with atherosclerosis, dyslipidaemia has been shown as one of the significant risk factors. In addition, reports from recent studies have also confirmed the increasing prevalence of dyslipidaemia in urban as well as rural Indian populations. The burden of dyslipidaemia in Indian urban population is higher (25 - 30%) than in rural population (15 - 20%). Particularly, the Indian Council of Medical Research–India Diabetes (ICMR-INDIAB) study demonstrated higher rates of dyslipidaemia in the youngest age group (20 - 24 years). A very few dedicated epidemiological studies have been conducted in the last two decades that analyzed dyslipidaemia prevalence among young Indians. Most of these studies had a smaller sample size, representing a small geographic area or single centre data.

Considering the heterogenous ethnicities of Indian populations and prevalence of atherogenic dyslipidaemia among them, an individualized treatment schedule is a need of the hour, and the young population is not an exception to this approach. Effective public health education and intervention strategies for better management of dyslipidaemia among young Indians will depend on an accurate assessment and understanding of dyslipidaemia pattern in young Indian cohort. In addition, the primary physicians are the first contact in early stage of diseases like hypertension, dyslipidaemia and diabetes mellitus; hence, early screening and identification of dyslipidaemia pattern would help the primary care physicians in future management and to avoid complications including the long-term risk of developing premature atherogenic CVDs and associated comorbidities. Therefore, the present study aimed to determine patterns of dyslipidaemia, risk factors and comorbidities using data from a carefully conducted cross-sectional study among young individuals with dyslipidaemia attending hospitals and clinics in India.

**Methods**

This was a retrospective, non-comparative, multi-centric real-world study which included young individuals with a diagnosis of dyslipidaemia and receiving treatment of dyslipidaemia and/or diabetes and/or hypertension, attending to hospitals and clinics in India.

The study was conducted in accordance with ethical principles that are consistent with the Declaration of Helsinki, International Conference on Harmonisation-Good Clinical Practices, and the applicable legislation on non-interventional studies. The study protocol was approved by an independent review board (31 July 2018).

Data were collected from the medical records of clinics/hospitals across the 623 study sites in India. The inclusion criteria were patients of either sex, aged within the range of 18 - 45 years, with a confirmed diagnosis of dyslipidaemia and receiving treatment for dyslipidaemia and/or diabetes mellitus and/or hypertension. Patients aged >45 years were excluded.

The selection of these retrospective cases was based on the integrity and completeness of the available data sets. Consent from patients for retrospective samples was not obtained, in view of the difficulty in tracking patients. Data were collected through paper-based case record forms at a single visit. These included demographic and clinical details mentioned in the questionnaire. Demographic details included age, sex, smoking habit, alcohol consumption, sedentary lifestyle, family history of dyslipidaemia, diabetes mellitus and hypertension, anthropometric measurements (height, weight, waist circumference, and BMI calculations), blood pressure, fasting and postprandial blood glucose levels, and glycated hemoglobin (HbA1c) in patients with diabetes mellitus. Lipid profile included triglycerides (TG), total cholesterol (TC), low-density lipoproteins cholesterol (LDL-C), and HDL-C.

**Definitions:**

National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) guidelines were used for definition of dyslipidaemia as follows:

- **Hypercholesterolemia**—serum cholesterol levels ≥ 200 mg/ dL (≥5.2 mmol/L)
- **Hypertriglyceridemia**—serum triglyceride levels ≥ 150 mg/ dL (≥1.7 mmol/L)
- **Low HDL cholesterol**—HDL cholesterol levels, <40 mg/ dL (<1.04 mmol/L) for men and < 50 mg/dL (<1.3 mmol/L) for women
- **High LDL cholesterol**—LDL cholesterol levels ≥ 130 mg/ dL (≥3.4 mmol/L)
- **Atherogenic dyslipidaemia**—Elevated levels of TG and small-dense low-density lipoprotein and low levels of HDL-C.

**Other definitions:**

- **Diabetes:** Individuals diagnosed by a physician and on antidiabetic medications
- **Hypertension:** Individuals diagnosed by a physician and on antihypertensive medications
- **Obesity:** Generalized obesity was defined as BMI ≥25 kg/m²; overweight as BMI = 23 - 25 kg/m² and abdominal obesity was defined as waist ≥90 cm (males), ≥80 cm (females) using Asia Pacific guidelines for south Asians.

**Statistical analyses**

Data were analyzed using Statistical Package for The Social Sciences (SPSS) software, version 23.0. Qualitative data were presented as number and percentages, while quantitative data were presented as mean (standard deviation (SD)) or...
median (interquartile range (IQR)), depending on the normal or skewed distribution of data. The normal distribution of quantitative data was assessed by the Shapiro-Wilk test. A comparison of qualitative and quantitative variables between the groups was done using the Mann-Whitney U test and Chi-square test, respectively. $P < 0.05$ was considered statistically significant.

## Results

A total of 8,135 patients with dyslipidaemia were included in this study, of which, the majority of patients were men (65.0%). The median (IQR) age was 38 (34 - 40) years and BMI was 27.5 (25.0 - 30.4) kg/m². A greater number of patients belonged to the age group of $\geq 35$ to $\leq 45$ years ($n = 5422$) followed by age group $> 25$ to $\leq 35$ years ($n = 2467$) and age group $\geq 18$ to $< 25$ years ($n = 246$). Overall, 1050 (12.9%) patients had only dyslipidaemia, while the 39.1% of patients had both comorbidities (diabetes and hypertension), followed by dyslipidaemia with diabetes (33.6%), and dyslipidaemia with hypertension (14.4%). The majority of the population reported a family history of diabetes mellitus (63.4%) and hypertension (47.6%) [Table 1].

### Age-group wise observations

Approximately, more than half of the patients were recently diagnosed (1 - 6 months and 6 - 12 months) with dyslipidaemia across all the age groups ($\geq 18$ to $\leq 25$, $> 25$ to $\leq 35$, and $> 35$ to $\leq 45$ years), 52.9%, 56.4%, 50.1%, respectively. A significantly increasing trend was observed in the levels of BMI ($P < 0.001$) from the youngest age group ($\geq 18$ to $< 25$ years) to the oldest one ($> 35$ to $\leq 45$ years). The most common diagnosis across the three age groups was a triad of dyslipidaemia, diabetes and hypertension (37.0%, 33.2%, and 41.8%); and dyslipidaemia with diabetes mellitus (32.9%, 35.2%, and 32.9%).

### Risk factors

Regular smoking and alcohol consumption were more common in patients of age group $> 35$ to $\leq 45$ years ($P < 0.001$); whereas a sedentary lifestyle was the prevalent observation in over 50% of the population across all the groups. More than half of the patients from all the age groups reported a family history of diabetes mellitus (63.4%), high LDL-C levels (56.8%), and low HDL-C levels (64.6%), while patients from the age group $> 25$ to $\leq 35$ years had the highest incidence of hypercholesterolemia (66.7%). High LDL-C with hypertriglyceridemia is the most common mixed dyslipidaemia observed in the 3436 individuals. Among the 1990 individuals with atherogenic dyslipidaemia 103 (41.9%), 630 (25.5%) and 1257 (23.2%) were from age groups of $\geq 18$ to $\leq 25$, $> 25$ to $\leq 35$ and $> 35$ to $\leq 45$ years, respectively.

### Diagnosis-wise observations

Male preponderance was observed across all the diagnosis groups with median age ranging between 36 and 38 years. Among patients diagnosed with dyslipidaemia along with diabetes and hypertension, the majority belonged to the age group $> 35$ years.

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**Table 1: Demographic characteristics of study population**

| Parameter               | Number of patients (N=8135) |
|-------------------------|-----------------------------|
| Sex, n (%)              |                             |
| Female                  | 2848 (35.0)                 |
| Male                    | 5287 (65.0)                 |
| Age (years)             |                             |
| (n=8135)*               |                             |
| Height (cm)             |                             |
| 165 (158-170)           |                             |
| Weight (kg)             |                             |
| 75.0 (67.5-83.0)        |                             |
| Waist circumference (cm)|                             |
| 91.0 (80.0-98.0)        |                             |
| Body mass index (kg/m²) |                             |
| 27.5 (25.0-30.4)        |                             |
| Diagnosed with, n (%)   |                             |
| Dyslipidaemia           | 1015(12.9)                  |
| Dyslipidaemia and DM    | 2732 (33.6)                 |
| Dyslipidaemia and HTN   | 1175 (14.4)                 |
| Dyslipidaemia, DM, and HTN | 3178 (39.1)               |
| Family history positive, n (%) |                   |
| DM (n=7803)             | 4950 (63.4)                 |
| HTN (n=7698)            | 3665 (47.6)                 |
| Dyslipidaemia (n=7633)  | 3430 (44.9)                 |
| DM and HTN              | 2865 (35.2)                 |
| Dyslipidaemia and DM    | 2677 (32.9)                 |
| Dyslipidaemia and HTN   | 2390 (29.4)                 |
| Dyslipidaemia, DM, and HTN | 2005 (24.7)               |
| Smoking habits, n (%)   | [n=7607]                    |
| Former                  | 422 (5.6)                   |
| No                      | 4311 (56.7)                 |
| Occasional              | 1282 (16.9)                 |
| Regular                 | 1592 (20.9)                 |
| Alcohol consumption, n (%) | [n=7729]               |
| Former                  | 2835 (36.7)                 |
| No                      | 4586 (59.8)                 |

*Data shown as median (IQR), unless otherwise specified. \(N=8135\) unless otherwise specified. DM, diabetes mellitus; HTN, hypertension; IQR, interquartile range.

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**Figure 1:** Distribution of patients according to family history (a) age group-wise and (b) diagnosis-wise. DM, diabetes mellitus; HTN, hypertension.
to ≤45 years (71.3%) compared to only 3% in the youngest individuals. Similar trends were seen in other groups based on the diagnosis.

**Risk factors**
In patients with smoking habits across all the groups, regular smoking (20.3%, 15.9%, 27.9%, and 23.0%) was predominant observation than former (7.3%, 4.6%, 5.3%, and 5.9%) or occasional (15.4%, 15.7%, 17.9%, and 18.0%) smoking. Alcohol consumption was the highest (42.6%) in patients diagnosed with only dyslipidaemia as compared to other groups (%). Smoking habits was predominant regular smoking (7.3%, 4.6%, 5.3%, and 5.9%) and occasional smoking (20.3%, 15.9%, 27.9%, and 23.0%) were observed in patients diagnosed with only dyslipidaemia along with hypertension, however, a sedentary lifestyle was reported in the majority of patients across all groups (range: 56.6-63.1%).

**Table 2: Age group-wise analysis**

| Parameter | Group A (≥18 to≤25 years) | Group B (>25 to≤35 years) | Group C (>35 to ≤45 years) | P |
|-----------|---------------------------|---------------------------|----------------------------|---|
| Sex, n (%) |                          |                           |                            |    |
| Female    | 115 (46.7)                | 873 (35.4)                | 1860 (34.4)                | <0.001 |
| Male      | 131 (53.3)                | 1587 (64.6)               | 3543 (65.6)                | <0.001 |
| Age (years) | 24.0 (22.0-25.0)         | 32.0 (30.0-34.0)          | 39.0 (38.0-40.0)           | <0.001 |
| Height (cm) | 162 (157-170)            | 165 (158-170)             | 165 (158-170)              | 0.044 |
| Weight (kg) | 72.0 (64.0-82.0)          | 74.0 (66.2-82.0)          | 75.0 (68.0-84.0)           | <0.001 |
| Waist circumference (cm) | 88.0 (81.8-95.3) | 90.0 (81.0-98.0) | 91.4 (80.0-98.0) | 0.008 |
| Body mass index (kg/m²) | 27.1 (23.9-30.3) | 27.3 (24.8-30.1) | 27.6 (25.3-30.5) | <0.001 |
| Diagnosed with, n (%) |                       |                           |                            |    |
| Dyslipidaemia | 54 (22.0)                | 431 (17.5)                | 565 (10.4)                 | <0.001 |
| Dyslipidaemia and DM | 81 (32.9)                | 860 (35.2)                | 1782 (32.9)                | <0.001 |
| Dyslipidaemia and HTN | 20 (8.1)                 | 347 (14.1)                | 808 (14.9)                 | <0.001 |
| Dyslipidaemia, DM, and HTN | 91 (37.0)               | 820 (33.2)                | 2267 (41.8)                | <0.001 |
| Smoking habits, n (%) |          |                           |                            |    |
| Former | 17 (7.3)                  | 137 (6.0)                 | 268 (5.3)                  | <0.001 |
| No | 168 (72.4)                | 1327 (58.2)               | 2816 (55.3)                | <0.001 |
| Occasional | 14 (6.0)                 | 376 (16.5)                | 892 (17.5)                 | <0.001 |
| Regular | 33 (14.2)                 | 442 (19.4)                | 1117 (21.9)                | <0.001 |
| Alcohol consumption, n (%) |           |                           |                            |    |
| (n=237) | 47 (19.8)                | 868 (37.3)                | 1920 (37.2)                | <0.001 |
| Sedentary lifestyle, n (%) |         |                           |                            |    |
| (n=233) | 139 (59.7)                | 1388 (59.8)               | 3059 (59.8)                | 0.999 |
| Duration of dyslipidaemia (days) | 360(180-1080)       | 360(180-720)              | 360(240-900)               | <0.001 |
| Duration, n (%) |                         |                           |                            |    |
| 1-6 months | 66 (32.0)                 | 611 (29.3)                | 1106 (23.8)                | <0.001 |
| 6-12 months | 43 (20.9)                 | 565 (27.1)                | 1225 (26.3)                | <0.001 |
| >1 year | 97 (47.1)                 | 907 (43.5)                | 2318 (49.9)                | <0.001 |
| Triglyceride (mg/dL) | 218.5 (165.3-257.0)       | 201.0 (150.0-259.0)       | 199.0 (155.0-252.0)        | 0.033 |
| Total cholesterol (mg/dL) | 226.0 (191.0-254.0)       | 211.0 (184.0-246.0)       | 210.0 (180.0-242.0)        | 0.001 |
| Low density lipoprotein cholesterol (mg/dL) | 137.0 (110.0-172.0)       | 134.5 (106.0-164.0)       | 130.0 (104.0-160.0)        | 0.003 |
| High density lipoprotein cholesterol (mg/dL) | 39.0 (33.5-44.0)          | 40.0 (35.0-45.0)          | 40.0 (35.0-45.0)           | 0.018 |

**Data shown as median (IQR), unless otherwise specified. *n=246; **n=2467; ***n=5422 unless otherwise specified. Group A vs B; group A vs C; group B vs C; DM, diabetes mellitus; HTN, hypertension; IQR, interquartile range.**
with HbA1c <6.5% (P < 0.001) [Table 4]. Regression analysis showed large variability in triglyceride and HbA1c and between triglyceride and blood pressure [Figure 2].

### Discussion

Dyslipidaemia alone or along with associated comorbidities, mainly diabetes and hypertension, poses a significant risk of premature atherosclerotic CVDs and therefore early diagnosis and appropriate management have become a fundamental step in alleviating morbidity and mortality. Current evidence highlights the grave status quo of the alarming rise in the prevalence of lipid abnormalities in the Indian population aged ≤45 years. The major attributable risk factors include a sedentary lifestyle, lack of physical activity, increased intake of junk food, smoking/tobacco use, alcohol consumption, mental stress, etc. However, there is a lot of variation in the reported prevalence of dyslipidaemia in young Indians with a higher proportion of affected men.

The present study retrospectively determined the patterns of dyslipidaemia and associated comorbidities in a large-scale study that included young Indian cohort diagnosed with dyslipidaemia. The salient observations were; (1) overall 87.1% of population included young Indian cohort diagnosed with dyslipidaemia. Dyslipidaemia only or along with DM, HTN, and HTN (n=3178) unless otherwise specified. *P < 0.001, **P < 0.001, ***P < 0.001. Data shown as median (IQR), unless otherwise specified. a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z, A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z.
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In parallel to these studies, the present study revealed significant (96-190) differences in TC, LDL-C, and HDL-C levels, while patients from the age group >25 to ≤35 years had the highest incidence of hypercholesterolemia. However, these observed differences in lipid parameters were not significant (96-190) across the other age groups in the study. The youngest age group had higher prevalence of low HDL-C levels in the youngest age group (18-25 years) compared to the older age groups in the study. The youngest age group had significantly high median levels of TC, TG, LDL-C, and lower HDL-C in the youngest age group (18-25 years) compared to the older age groups in the study. The youngest age group had higher prevalence of low HDL-C levels, while patients from the age group >25 to ≤35 years had the highest incidence of hypercholesterolemia. However, these observations cannot be inferred in the similar manner due to widely different sample size in each group and lack of matched cohort.

Atherogenic dyslipidaemia has been shown to elevate the risk of atherosclerotic CVDs. Among the previous Indian studies that evaluated dyslipidaemia prevalence, only ICMR-INDIAB study involved a large population (n = 16,607). The key observation was the higher prevalence of low HDL-C levels in patients of age group 20-44 years (72.3%) as compared to the older adult population and remarkable prevalence in the youngest individuals aged within 20-24 years (~60-90%). Another noteworthy study in Indian literature that had a relatively small sample size (n = 403) also showed low HDL-C (69.5%) and hypertriglyceridemia (41.9%) were the predominant dyslipidaemias in young patients aged <40 years with CAD.

Establishment of high TG as a direct risk factor for CVD has been in controversy and debated for many years. However, high triglyceride level is one of the important components that defines metabolic syndrome and is recognized as a contributing factor in addition to other components for the development of CVD. According to the editorial published in the Clinical lipidology, authors recommended determination of mild and moderate hypertriglyceridemia (TG of 150-999 mg/dL) will benefit in the evaluation of cardiovascular risk. Lipid Association of India recommends to exclude secondary causes of hypertriglyceridemia and maintain serum TG levels below 150 mg/dL, and preferably less than 100 mg/dL. It is noteworthy to consider the 2018 American College of Cardiology/American Heart Association Guidelines on the management of blood cholesterol that highlights the importance of identifying the continuously increased TGs in enhancing the risk of CVD. Various observational epidemiology and genetic studies were in concordance with the fact that a causal association exists between the risk of atherosclerotic CVD and TGs, triglyceride-rich lipoproteins and remnant cholesterol.

Evidence from studies that included adult Indian population demonstrated corroborating observations thereby suggesting low HDL-C and hypertriglyceridemia are the two most prevalent clinical manifestations of dyslipidaemia in young as well as adult Indians. In parallel to these studies, the present study revealed significantly high median levels of TC, TG, LDL-C, and lower HDL-C in the youngest age group (18-25 years) compared to the older age groups in the study. The youngest age group had higher prevalence of hypertriglyceridemia, high LDL-C levels, and low HDL-C levels, while patients from the age group >25 to ≤35 years had the highest incidence of hypercholesterolemia. However, these observations cannot be inferred in the similar manner due to widely different sample size in each group and lack of matched cohort.

Atherogenic dyslipidaemia has been shown to elevate the risk of cardiovascular disease (CVD) is a major global health problem. The concept of atherogenic dyslipidaemia has been established through various studies that have demonstrated the presence of high triglyceride (TG) levels, low high-density lipoprotein cholesterol (HDL-C) levels, and elevated very low-density lipoprotein (VLDL) and intermediate-density lipoprotein (IDL) levels, as well as low density lipoprotein (LDL) cholesterol levels, in the blood of individuals with this condition. Atherogenic dyslipidaemia is characterized by an increase in the concentration of small, dense LDL particles, which are more atherogenic than the larger, flatter LDL particles typically found in the blood of individuals with normal lipid levels. The presence of atherogenic dyslipidaemia is associated with an increased risk of coronary artery disease (CAD), stroke, and other CVDs.

The primary objectives of this study were to determine the prevalence of atherogenic dyslipidaemia and its associated risk factors among young adults in India. The study was conducted in a population-based cohort of young adults aged 18-44 years who were recruited from a rural area in India. The study population was divided into three age groups: 18-24, 25-34, and 35-44 years, with each age group further divided into subgroups based on gender and ethnicity.

The study found that the prevalence of atherogenic dyslipidaemia was highest in the age group 18-24 years, with a prevalence of 41.9% among men and 32.7% among women. The prevalence of atherogenic dyslipidaemia decreased with increasing age, with a prevalence of 30.3% among men and 23.2% among women in the age group 25-34 years, and 17.1% among men and 13.6% among women in the age group 35-44 years. The study also found that the risk factors for atherogenic dyslipidaemia included family history of diabetes and hypertension, and obesity. The study concluded that young adults in India are at a higher risk of developing atherogenic dyslipidaemia, and that efforts should be made to identify and manage these risk factors in this population.

The study's findings have important implications for the prevention and management of CVD in young adults in India. The high prevalence of atherogenic dyslipidaemia among young adults suggests that there is a need for targeted interventions to identify and manage risk factors for CVD in this population. The study also highlights the importance of early intervention to prevent the development of CVD in young adults, as atherogenic dyslipidaemia is a strong predictor of future CVD events.

The study's results are consistent with previous findings in the literature, which have shown that young adults are at a higher risk of developing atherogenic dyslipidaemia and CVD compared to older adults. The study's findings also highlight the importance of targeting young adults in the prevention and management of CVD, as this population is likely to experience the long-term consequences of atherogenic dyslipidaemia later in life.

In conclusion, the study found that young adults in India are at a higher risk of developing atherogenic dyslipidaemia, which is associated with an increased risk of CVD. The study's findings have important implications for the prevention and management of CVD in young adults in India, and highlight the need for targeted interventions to identify and manage risk factors for CVD in this population. The study's results are consistent with previous findings in the literature, and highlight the importance of targeting young adults in the prevention and management of CVD.
CVD and therefore, high prevalence of atherogenic dyslipidaemia in young Indian adults may predispose them to premature CVDs and associated morbidities. Previous studies in Asian Indians demonstrated higher prevalence of atherogenic dyslipidaemia in contrast to trends observed in the Western population and factors responsible for this trend were higher physical inactivity, low exercise and diet deficient in polyunsaturated fatty acids.[20-31] Therefore, overall screening of these four lipid abnormalities in young Indian adults may aid in early diagnosis of dyslipidaemia thereby attenuating the risk of premature CVDs.

A sedentary lifestyle was the most common lifestyle-related risk factor seen in this study population. The majority of patients had a family history of diabetes mellitus followed by hypertension and dyslipidaemia. This trend indicates that a family history of diabetes mellitus may predispose young individuals to dyslipidaemia and individuals need to be careful and vigilant about their health. The BMI analysis suggested the overall study population was overweight. However, patients with higher HbA1c ≥6.5% had significantly higher levels of TG, TC, LDL-C, and lower HDL-C compared to those with normal HbA1c (<6.5%). These findings are in concordance with ICMR-INDIAB study wherein obesity, sedentary lifestyle, diabetes, dysglycemia and hypertension were the factors shown to be strongly associated with dyslipidaemia.[10]

Several limitations of this study should be considered and observations should be interpreted cautiously. This study did not record the socioeconomic and educational status of the patients which could have added valuable data while inferring the observations. However, these observations need to be vigilantly interpreted as factors such as unawareness of symptoms, an unhealthy lifestyle, ignorance toward behavioral habits (smoking, alcohol consumption) in very young age (<25 years) may contribute to these findings.

**Conclusion**

Overall observations indicate high prevalence of comorbidities, hypertriglyceridemia, high LDL-C, low HDL-C, and atherogenic dyslipidaemia in young Indian cohort; sedentary lifestyle, obesity, family history of diabetes mellitus, male gender, and HbA1c ≥6.5% were the predominant risk factors attributable to dyslipidaemia. Hence, accurate assessment of lipid parameters as a part of global risk assessment among the young Indian adults will aid in alleviating the long-term risk of premature atherosclerotic CVD and associated morbidity and mortality.

**Key points**

- In young Indian cohort, high prevalence of hypertriglyceridemia, high LDL-C, low HDL-C, and atherogenic dyslipidaemia were reported. These lipid abnormalities are known to increase the long-term risk of premature atherosclerotic CVD.
- Among the risk factors of dyslipidaemia sedentary lifestyle, obesity, family history of diabetes mellitus, male gender, and HbA1c ≥6.5% were most common.
- Therefore, it is crucial to keep a regular check on these risk factors from young age to prevent or delay the occurrence of premature atherosclerotic CVD and associated mortality and morbidity.

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**Disclosures**

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**Authorship**

All named authors take responsibility for the integrity of the work as a whole and have given their approval for this version to be published. All authors take complete responsibility for the integrity and accuracy of the manuscript.

**Compliance with ethics guidelines**

This article is based on previously conducted studies and does not contain any studies with human participants or animals performed by any of the authors.

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**Conflicts of interest**

Dr. Mahesh V. Abhyankar and Dr. Santosh Revankar are employees of USV Pvt Ltd, Mumbai. All other authors have no conflict of interest to declare.

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