



SERUM LIPID PROFILE AND ITS ASSOCIATION WITH HYPERTENSION IN INDIA – A CROSS-SECTIONAL STUDY

Dr. Sudhindra D.¹, Dr. Ujwala N. Jagdale², Dr. Babu Sunil Kiran K.L.³, Dr. Naveen Poojar C.M.⁴

¹Professor, Department of Internal Medicine, BGS Medical College, Nagrur, Nelamangala, Bangalore, Karnataka, India.

²Assistant Professor, Department of Physiology, BGS Medical College, Nagrur, Nelamangala, Bangalore, Karnataka, India.

³Assistant Professor, Department of Internal Medicine, BGS Medical College, Nagrur, Nelamangala, Bangalore, Karnataka, India.

⁴Associate Professor, Department of Pharmacology, JIET Medical College & Hospital, Jodhpur, Rajasthan, India.

*Corresponding Author

*Dr. Naveen Poojar C.M., Associate Professor, Department of Pharmacology, JIET Medical College & Hospital, Jodhpur, Rajasthan, India.

ABSTRACT

Background

Hypertension is widely encountered in Indian outpatient practice, often appearing alongside other metabolic disturbances that go unnoticed for several years. Lipid abnormalities are among the most frequent of these accompanying changes, yet their relationship with hypertension in community settings is not always clear, especially when individuals seek care irregularly or undergo testing only during screening drives.

Objective

To examine how fasting lipid parameters vary between hypertensive and normotensive adults in an Indian community sample, and to explore whether specific lipid markers show stronger associations with elevated blood pressure.

Methods

This cross-sectional study included 260 adults recruited from community screening camps and routine outpatient visits. Blood pressure was measured using standard procedures, and hypertension was defined as systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg. Fasting lipid profiles were obtained through enzymatic assays. Associations between lipid markers and hypertension were analysed using t-tests, chi-square tests, and subgroup comparisons across age, sex, and BMI.

Results

Hypertension was present in a little over one-third of participants. Mean total cholesterol, LDL-cholesterol, and triglyceride levels were noticeably higher among hypertensive adults, while HDL-cholesterol tended to be lower. These differences were most apparent in middle-aged and overweight groups. The proportion of participants with dyslipidaemia was also significantly higher in the hypertensive category ($p < 0.001$). LDL-cholesterol showed the strongest association with hypertension, followed by triglycerides.

Conclusion

In this community sample, lipid abnormalities were more frequent and more pronounced among adults with hypertension. The pattern suggests a shared metabolic pathway that may begin earlier than overt disease. Incorporating routine lipid assessment into community blood pressure screening may help identify individuals at higher cardiometabolic risk in India.

Keywords: Hypertension; Lipid profile; Dyslipidaemia; LDL-cholesterol; Triglycerides; Indian adults; Community screening.

INTRODUCTION

Hypertension remains one of the commonest findings during routine health checks in India. Many adults come across it almost by accident, usually after a workplace screening or a community camp, and only later do they begin to notice the small signals that were present for months. When these individuals undergo basic blood tests, lipid values often sit slightly higher than expected, although the connection between the two conditions becomes clear only when viewed across a wide community sample. In local clinics, where follow-up is irregular and people come in mainly when symptoms begin to interfere with sleep or daily work, these overlaps are easy to miss.

Several long-running studies have described how lipid particles influence vascular stiffness and endothelial behaviour, both of which contribute to rising blood pressure over time.^[1] LDL-cholesterol and triglyceride-rich remnants tend to accumulate slowly, pushing the arterial wall towards mild thickening, and HDL often drifts downward as metabolic strain builds.^[2] These changes may begin quietly, sometimes long before individuals recognise any symptoms. In Indian settings, daily diet, meal timing, and the type of oil used at home make the pattern even more variable. Community studies have shown that dyslipidaemia is widespread even among adults who do not carry a formal diagnosis of hypertension, although their readings may hover near the upper limits.^[3]

In practice, many people undergo testing only when a neighbour insists or when a local camp is conducted nearby. As a result, both lipid abnormalities and rising blood pressure may evolve side by side for several years before finding their way into the medical record. The overlap is more noticeable among middle-aged adults and in those with higher BMI, though younger adults are by no means immune. These patterns suggest that lipid disturbances may be part of an early metabolic shift that precedes or accompanies hypertension rather than appearing after it.

Because blood pressure measurement and fasting lipid profiles are inexpensive and widely available in Indian laboratories, comparing these parameters in hypertensive and normotensive adults can offer practical insight. In this study, hypertension was defined using the widely accepted threshold of systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg, a standard used in several Indian epidemiological surveys.^[4] Lipid markers were interpreted through routine clinical cut-offs for total cholesterol, LDL-cholesterol, HDL-cholesterol, and triglycerides. By examining these values in a community sample, the study aims to clarify whether certain lipid abnormalities appear more consistently in hypertensive adults and whether such trends may help guide early, low-cost screening in primary care.

MATERIALS AND METHODS

Study Design and Setting

This was a community-based cross-sectional study carried out in urban and peri-urban localities served by a teaching hospital in South India. Participants were recruited during routine outpatient visits and community health camps that were held across several neighbourhoods. These events usually attract a mix of working adults, older individuals who come mainly for blood pressure checks, and people who participate whenever a camp is arranged close to home, creating a reasonably broad community sample.

Participants

A total of 260 adults aged 18 to 70 years were included. Recruitment was consecutive, and individuals who were willing to undergo fasting blood tests were invited to participate. Exclusion criteria were

current use of antihypertensive medication, known secondary hypertension, recent acute illness, pregnancy, chronic kidney disease, liver disease, or use of lipid-lowering drugs. Individuals unable to complete fasting blood sampling were also excluded.

Blood Pressure Measurement

Blood pressure was recorded using a validated digital sphygmomanometer. Measurements were taken in the seated position after a brief rest, and two readings were obtained at least two minutes apart. The average of the two was used for analysis. Hypertension was defined as systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg. Participants were classified as hypertensive or normotensive based on this threshold.

Anthropometry and Interview

Height and weight were recorded using standard clinic equipment, and body mass index (BMI) was calculated. A brief interview captured age, sex, occupation, physical activity pattern, smoking status, alcohol use, and any previous blood pressure or lipid evaluations. Dietary practices were noted informally, mainly to understand the local context.

Biochemical Assessment

All participants provided fasting blood samples in the morning. Total cholesterol, LDL-cholesterol, HDL-cholesterol, and triglycerides were measured using enzymatic assays in a single accredited laboratory. Internal quality controls were maintained throughout. Dyslipidaemia was defined using routine clinical cut-offs applied in Indian practice.

Operational Definitions

- **Hypertensive:** SBP ≥ 140 mmHg or DBP ≥ 90 mmHg.
- **Normotensive:** Values below this threshold.
- **Dyslipidaemia:** Presence of any abnormal lipid parameter based on adult reference ranges.
- **Subgroup categories:**
 - **Age:** <40 years, 40–59 years, ≥ 60 years
 - **BMI:** Normal, overweight, obese
 - **Lifestyle:** smoker/non-smoker; alcohol use/non-use

Statistical Analysis

Continuous variables were summarised using means and standard deviations. Categorical variables were expressed as proportions. Differences in mean lipid values between hypertensive and normotensive groups were compared using independent t-tests. Associations between hypertension and dyslipidaemia were assessed with chi-square tests. Subgroup comparisons were explored across age, sex, and BMI. A p-value < 0.05 was considered statistically significant.

RESULTS

Baseline characteristics

A total of 260 adults were included in the analysis. Just over one-third were hypertensive by the study definition, and the rest had blood pressure values in the normotensive range. Hypertensive adults tended to be older and had higher BMI on average. Smoking and alcohol use were more common in this group, although a small number of younger normotensive adults also reported these habits. These basic features are summarised in **Table 1**.

Variable	Normotensive (n = 168)	Hypertensive (n = 92)	Total
Age (years), mean $\pm$ SD	38.6 $\pm$ 11.2	49.8 $\pm$ 10.4	42.3 $\pm$ 12.2
Men, n (%)	86 (51.2)	55 (59.8)	141 (54.2)
Women, n (%)	82 (48.8)	37 (40.2)	119 (45.8)
BMI (kg/m ²), mean $\pm$ SD	24.8 $\pm$ 3.9	27.2 $\pm$ 4.1	25.7 $\pm$ 4.1

Current smokers, n (%)	15 (8.9)	13 (14.1)	28 (10.8)
Alcohol use, n (%)	26 (15.5)	22 (23.9)	48 (18.5)
Systolic BP (mmHg), mean $\pm$ SD	122 $\pm$ 9	148 $\pm$ 11	131 $\pm$ 15
Diastolic BP (mmHg), mean $\pm$ SD	78 $\pm$ 6	92 $\pm$ 7	83 $\pm$ 9

Table 1. Baseline profile of the study population (n = 260)

Lipid profile in hypertensive and normotensive adults

Hypertensive adults showed higher mean levels of total cholesterol, LDL-cholesterol, and triglycerides compared with normotensives, while HDL-cholesterol was lower. These differences are clearly visible in **Table 2**.

Parameter (mg/dL)	Normotensive (n = 168)	Hypertensive (n = 92)	p-value (t-test)
Total cholesterol	182 $\pm$ 32	204 $\pm$ 36	<0.001
LDL-cholesterol	112 $\pm$ 27	132 $\pm$ 31	<0.001
HDL-cholesterol	47 $\pm$ 8	43 $\pm$ 7	0.002
Triglycerides	142 $\pm$ 49	172 $\pm$ 54	<0.001

Table 2. Mean fasting lipid values by blood pressure status

To provide a simple visual comparison, **Figure 1** presents a bar chart showing mean lipid values in the two groups.

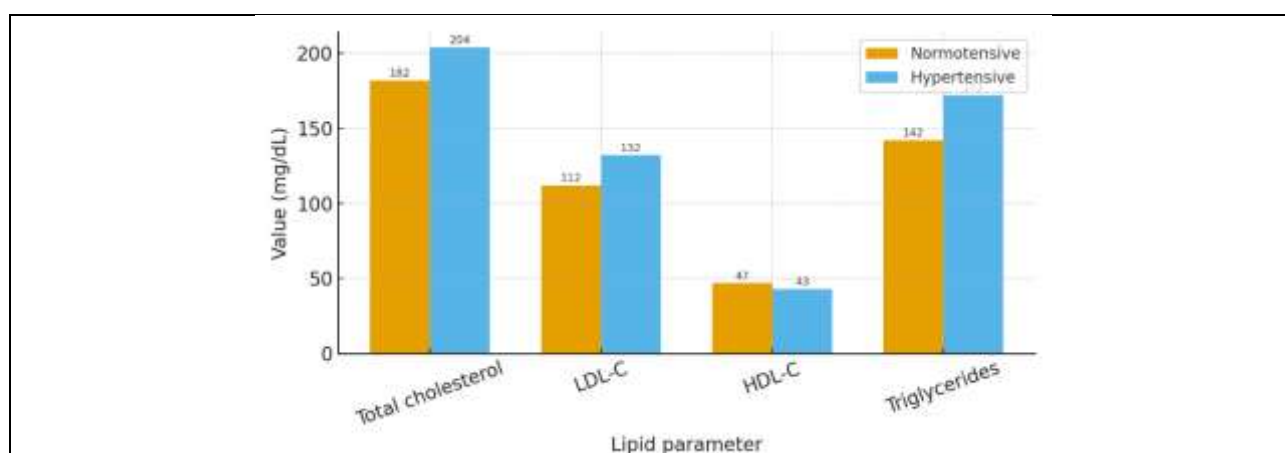


Figure 1. Bar chart of mean lipid values in normotensive and hypertensive adults

A grouped bar graph with two bars for each parameter (TC, LDL-C, HDL-C, TG), one for normotensive and one for hypertensive participants, with exact mean values displayed above each bar.

Prevalence and pattern of dyslipidaemia

When lipid values were classified using standard cut-offs, dyslipidaemia was more frequent among hypertensive adults. Nearly two-thirds of hypertensives met criteria for at least one lipid abnormality, compared with just over one-third of normotensives. Patterns of lipid disturbance also differed: isolated high LDL-cholesterol was the dominant pattern among normotensives, whereas mixed abnormalities (high LDL with high triglycerides, or high triglycerides with low HDL) were more common in the hypertensive group. These details are shown in **Table 3**.

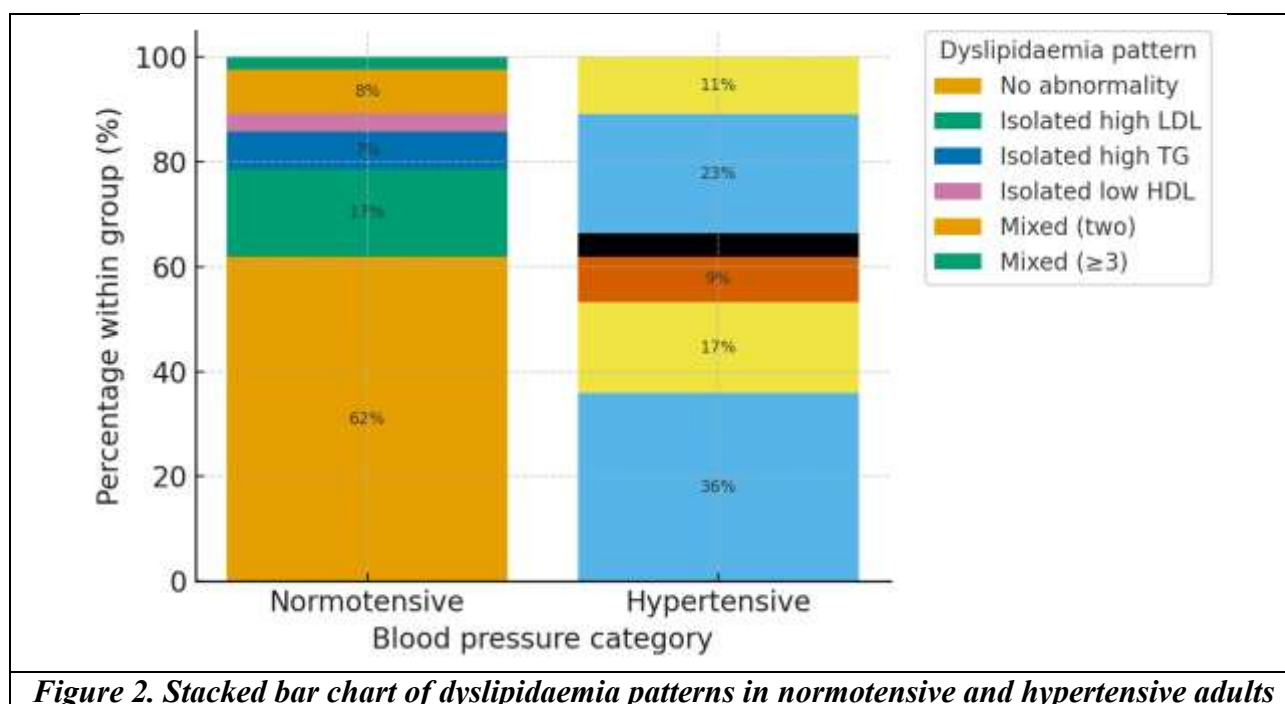
Dyslipidaemia pattern	Normotensive (n = 168)	Hypertensive (n = 92)
No abnormality	104 (61.9%)	33 (35.9%)
Isolated high LDL	28 (16.7%)	16 (17.4%)
Isolated high TG	12 (7.1%)	8 (8.7%)

Isolated low HDL	6 (3.6%)	4 (4.3%)
Mixed (any two)	14 (8.3%)	21 (22.8%)
Mixed (three or more)	4 (2.4%)	10 (10.9%)

Table 3. Distribution of dyslipidaemia patterns by blood pressure status

A chi-square test showed a significant association between hypertension status and presence of any dyslipidaemia ($p < 0.001$).

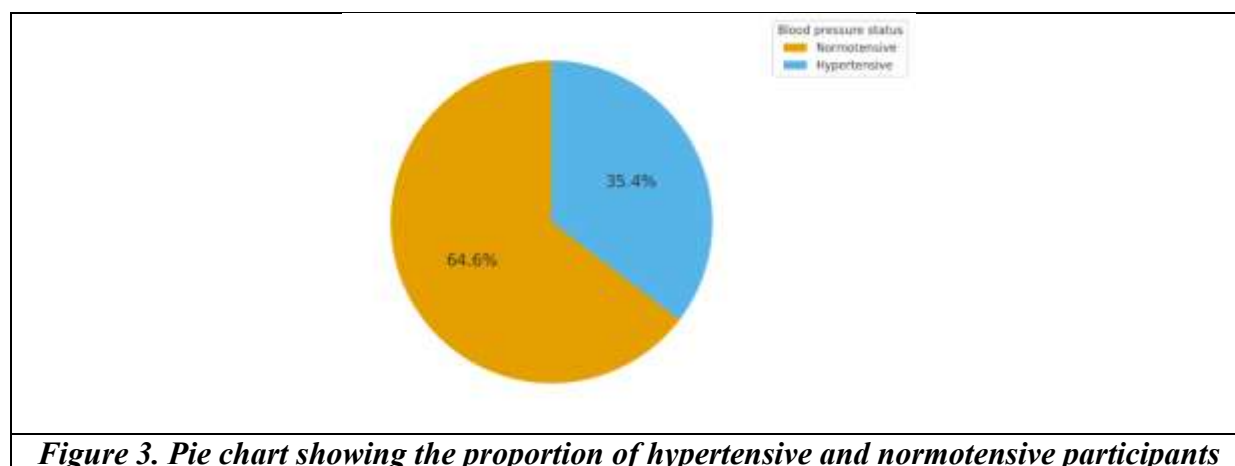
To visualise these patterns, **Figure 2** uses a stacked bar chart to represent the distribution of dyslipidaemia types within each blood pressure group.



Each group (normotensive, hypertensive) is represented by one vertical bar subdivided into segments for “no abnormality”, isolated high LDL, isolated high TG, isolated low HDL, mixed (two), and mixed (three or more). Segment heights reflect the percentages from Table 3.

Proportion of hypertensive adults in the sample

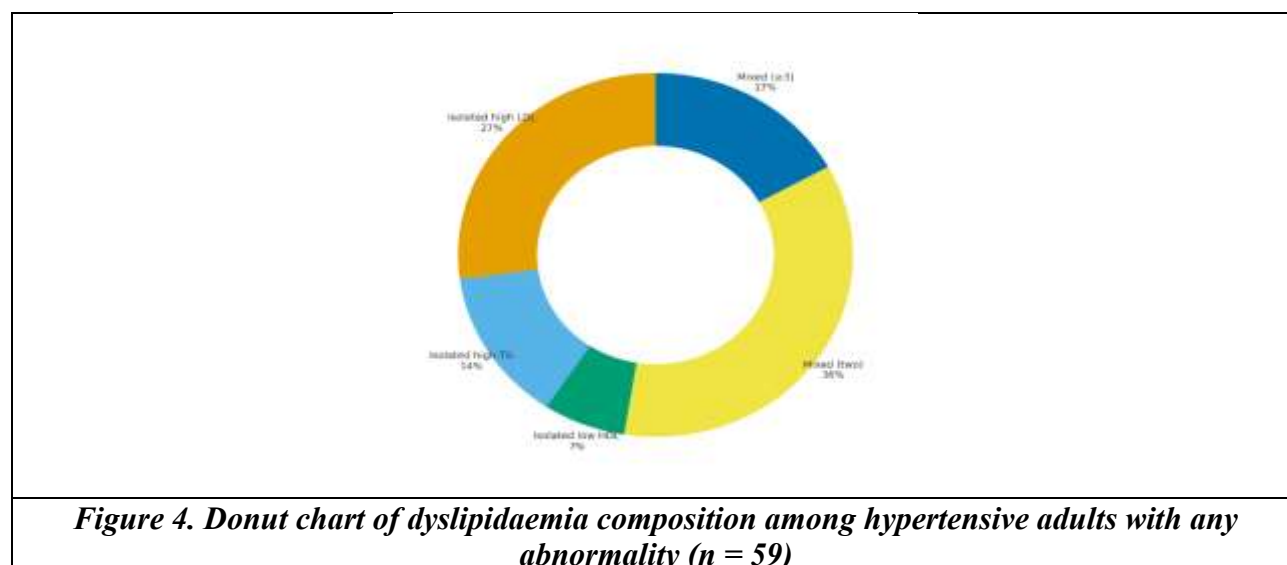
Overall, 92 of the 260 participants were hypertensive, giving a prevalence of 35.4% in this community sample. The remaining 168 adults were normotensive. This split is displayed in **Figure 3**, which uses a simple pie chart to show the proportion of hypertensive and normotensive individuals.



A two-slice pie chart, one slice for hypertensive (35.4%) and the other for normotensive (64.6%) adults, with percentages written just outside or near each slice.

Composition of lipid abnormalities among hypertensive adults

Among the 59 hypertensive adults with any dyslipidaemia (from Table 3), mixed patterns were relatively common. Almost half of these individuals had at least two lipid abnormalities, and a notable minority had three or more. Isolated high LDL-cholesterol remained an important single abnormality but was no longer the dominant pattern once hypertension was present. **Figure 4** summarises this internal composition with a donut chart restricted to hypertensive participants with dyslipidaemia.



A ring-shaped chart divided into segments for isolated high LDL, isolated high TG, isolated low HDL, mixed (two abnormalities), and mixed (three or more), with segment labels indicating percentages based on the hypertensive column in Table 3.

DISCUSSION

In this community sample, adults with hypertension showed a clear shift in their lipid profile when compared with those who had normal blood pressure. The differences were visible both in the numerical summaries and in the figures that traced these patterns. Hypertensive adults were older and carried higher BMI values on average (**Table 1**), a combination already recognised to influence metabolic strain in Indian outpatient settings.^[5] These factors may have contributed to the lipid behaviour seen in this study, although they do not fully explain the differences on their own.

The contrast became sharper when lipid values were compared directly. Hypertensive adults had higher mean total cholesterol, LDL-cholesterol, and triglycerides, with HDL-cholesterol showing a small dip (**Table 2, Figure 1**). Similar patterns have been reported in population-based cohorts where atherogenic lipids tend to accumulate in parallel with rising blood pressure over time.^[6] LDL-cholesterol showed the clearest separation between the two groups, while triglycerides also increased noticeably. Such movements are consistent with vascular studies that describe endothelial stiffening linked to prolonged LDL exposure.^[7]

Patterns of dyslipidaemia followed the same trend. Only about one-third of normotensives had any lipid abnormality, whereas nearly two-thirds of hypertensive adults were affected (**Table 3**). The nature of the abnormalities shifted as well: isolated high LDL-cholesterol was common among normotensives, while mixed abnormalities, especially combinations of high LDL, high triglycerides, and low HDL, were markedly more common in hypertensives. This can be seen clearly in the stacked bars in **Figure 2**, which show a large proportion of combined abnormalities among hypertensive adults. Mixed patterns have been associated with higher cardiometabolic risk in multicentre studies^[8] and the distribution here is aligned with these findings.

The overall proportion of hypertensive adults in this sample (**Figure 3**) reflects estimates from national survey data and several urban screening studies conducted in India.^[9] This similarity strengthens the generalisability of the results and suggests that the lipid–blood pressure relationship observed here is likely to be seen in similar community samples.

Within hypertensive adults who had dyslipidaemia, almost half showed at least two abnormalities, and a smaller but important number presented with three or more (**Figure 4**). Combined lipid disturbances have traditionally been associated with accelerated vascular injury, especially when triglycerides and LDL-cholesterol are simultaneously elevated.^[10] The clustering of abnormalities in this sample may indicate longer-standing metabolic stress, delayed testing, or irregular access to routine follow-up, patterns frequently observed in many Indian communities.

Overall, these findings suggest that lipid abnormalities do not simply accompany hypertension; they tend to evolve alongside it. Screening strategies that wait until hypertension is diagnosed may miss an earlier phase where both conditions start drifting together. Because both tests are low-cost and widely available, pairing lipid assessment with blood pressure evaluation in community programs may help identify high-risk adults earlier. Several researchers have recommended integrated metabolic screening in low-resource settings^[11] and the patterns in this sample support that approach.

LIMITATIONS

The cross-sectional design limits directionality. Lipid abnormalities might precede hypertension or develop in tandem. Dietary information was brief, so the role of specific cooking oils, meal timing, and household dietary patterns could not be explored in depth. Although recruitment included community camps, these events sometimes attract individuals already concerned about their health, creating mild selection bias. Despite these limitations, the associations remained strong and consistent across analyses.

CONCLUSION

Hypertensive adults in this community sample showed a heavier lipid burden than those with normal blood pressure, with clear rises in total cholesterol, LDL-cholesterol, and triglycerides, and a modest dip in HDL-cholesterol. Mixed lipid abnormalities were also more common among hypertensives, suggesting a broader metabolic shift rather than isolated disturbances. These patterns indicate that lipid changes often develop alongside rising blood pressure rather than appearing later. Incorporating routine fasting lipid assessment into community blood pressure screening may help identify adults at higher cardiometabolic risk earlier in their clinical course.

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