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**Original Research Article**

# Patterns of lipid profile abnormalities in hypertensive patients and normotensive subjects: a cross-sectional observational study

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## ABSTRACT

**Background:** It is a well-known fact that hypertension and altered lipid profile or dyslipidaemia are leading risk factors for cardiovascular diseases. The coexistence of these two conditions has remained an interesting matter, among cardiologists and researchers alike. In this study, we analysed the serum lipid patterns of hypertensive patients and normotensive control subjects.
**Methods:** This cross-sectional observational study was conducted in a tertiary healthcare and teaching center of Northwestern India during the period of 2010 and 2011. The study comprised of 100 hypertensive patients and 100 normotensive control subjects. Data were collected regarding demographic details, past medical/drug history and lipid profile including total cholesterol (TC), triglyceride (TG), low density lipoprotein (LDL) and high-density lipoprotein (HDL).
**Results:** A total of 200 subjects with the age above 20 years were enrolled in the study. The mean BMI in hypertensive patients (24.14±2.15 kg/m$^2$) was significantly higher than normotensive subjects (22.60±2.62 kg/m$^2$) ($p<0.05$). When we compared the mean of TC and TG among the hypertensive patients and normotensive subjects, highly significant differences were obtained ($p<0.001$). The significant decline in mean HDL level was observed in hypertensive patients than normotensive subjects (40.41±4.57 versus 44.64±5.97, $p<0.005$).
**Conclusions:** The dyslipidaemia has been more evident among hypertensive patients. Hence, the measurement of blood pressure and lipid profile are of great importance to prevent cardiovascular diseases, stroke and other comorbidities.

**Keywords:** Cardiovascular, Dyslipidaemia, Hypertension, Lipid profile, Total cholesterol, Triglyceride

## INTRODUCTION

Abnormalities in serum lipid and lipoprotein levels have been identified as the leading cause of modifiable cardiovascular diseases (CVD) as well as essential hypertension.[1,2] The coexistence of dyslipidemia and hypertension is termed as dyslipidemia hypertension (DH); Williams et al firstly used this term in 1988 or lipitension.[2] According to third report of the National cholesterol education program (NCEP) expert panel, this coexistence has demonstrated more multiplicative adverse consequences compared to the total of individual risk factors.[3] The prevalence of DH showed racial variation; 9.8% prevalence was reported in Hispanics, and this figure was 22% in African-Americans as well as the highest frequency (15 to 31%) was noted in the United States.[4,5] The event of DH has been further raised in circumstances of CVD associated with diabetes mellitus or other metabolic conditions and it accounts for almost 69% of total cases.[4] In agreement with Johnson et al, the event of DH was significantly predominant in women compared to men (20% versus 16%, $p<0.05$).[4] He

further reported the increased DH events (56%) in hypertensive patients more than 80 years of age.[4] No proper treatment algorithm for the coexisting conditions of dyslipidemia and hypertension has been formulated. In fact, dyslipidemia is more apparent in the untreated hypertensive patients compared to normotensives and lipid levels have been positively correlated with blood pressure.[6] In line with previous studies, TC, TG and virtually all fractions of lipoproteins are prone to be consistently abnormal among hypertensive patients than normotensive individuals.[7-9] A few of the earlier reported studies hypothesized the association between hypertension and dyslipidemia.[10] Alteration in lipid profile occurs due to consumption of high caloric fast foods, dietary cholesterol and fats, which ultimately result in hypertension, obesity, atherosclerosis and cardiovascular events.[11] Regarding Indian context, even though extensive data was available that focuses on the individual risk factors for CVD, still there was lack of data on the definitive pattern of lipid profile among Indian hypertensive patients.[12-14] The aim here was to investigate the serum lipid patterns of hypertensive patients and normotensive subjects who had attended a tertiary healthcare and teaching center in Northwestern India.

## METHODS

### *Study design and population*

This was a cross-sectional, observational study. One hundred hypertensive patients and 100 control subjects with normal blood pressure (normotensive control subjects), who had attended the medicine outpatient clinics and wards of tertiary healthcare and teaching center for a routine health check-up during the period of 2010 and 2011 were investigated. The patients who were previously diagnosed as normotensive and hypertensive with age between 20-75 years were included in the study. Patients with history of secondary hypertension, diabetes mellitus (fasting blood sugar >126 mg/dl), renal disease, stroke, terminal illness and hypothyroidism were not recruited in the study. A written informed consent was obtained before recruitment in the study. The study was conducted in accordance with the Helsinki Declaration.

### *Measurements*

Data regarding demographic details, past medical history, previous history of drug intake was reported. At the time of presentation, clinical examination, routine blood test as well as chest X-ray, ECG and other relevant investigation were also performed. Body mass index (BMI) was estimated as weight in kilograms, divided by height in meters squared ($kg/m^2$). For the measurement of blood pressure (BP), a standard BP measurement protocol was used. Sitting right arm brachial BP was measured twice at an interval of 10 minutes using a mercury sphygmomanometer and then average value was calculated.

### *Biochemical estimation*

Under aseptic conditions, a fasting (at least 8 hours) blood sample was collected from each subject for the estimation of lipid parameters including serum TC, HDL, LDL and TG. The blood sample of TC, HDL and TG were analyzed using the Beckham C×4 auto analyzer. LDL cholesterol was calculated using Friedewald's equation.

### *Definitions*

*Hypertension*

It is defined as a systolic blood pressure of 140 mm Hg or more or a diastolic BP of 90 mm Hg or more. The patients who were previously diagnosed with hypertension and since then, has been continued on antihypertensive drugs were also deemed as hypertensive patients.

*Elevated TC/TG*

It was defined as TC/TG levels of >200 mg/dl.

*Low HDL*

It was defined as HDL levels of <40 mg/dl.

*Elevated LDL*

It was defined as LDL levels of ≥200mg/dl.

### *Statistical analysis*

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 16.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean and standard deviation and were compared using the student t tests. Chi square ($\chi^2$) test was used to compare categorical variables that were presented as percentages. A $p<0.05$ was taken as statistically significant.

## RESULTS

In total, 200 subjects over the age of 20 years were enrolled in the study. The socio-demographic and anthropometric characteristics for recruited hypertensive patients and normotensive control subjects are illustrated in Table 1.

The mean age of the hypertensive patients was 48.67±11.77 years and 42.54±15.10 years in normotensive subjects. Higher events of hypertension were observed in subjects over the 4th decade of life (Figure 1).

Of 100 hypertensive patients, the majority of patients (67%) were male. The presence of family history was noted higher in hypertensive patients than normotensive subjects (58% versus 42%; p>0.05), but the value was statistically not significant. In our study, we found that mean BMI for hypertensive patients was 24.14±2.15 kg/m$^2$ and for normotensive control subjects it was 22.60±2.62 kg/m$^2$ (p<0.05). As shown in Figure 2, there was a highly significant difference in the mean of TC, HDL and TG between hypertensive patients and normotensive control subjects with identical p<0.001.

Table 2 presents the summary statistics of the lipid parameters among study subjects. The events of reduced HDL level (47 patients versus 25 patients, p<0.005) and elevated TG level (31 patients versus 13 patients, p<0.001) were observed more in hypertensive patients than normotensive subjects.

**Table 1: Baseline demographic characteristics of subjects.**

| Characteristics | Hypertensive patients (n=100) | Normotensive subjects (n=100) |
|---|---|---|
| **Age (mean±SD)** | 48.67±11.77 | 42.54±15.10 |
| **Male, %** | 67 | 56 |
| **Family history, %** | 58 | 42 |
| **BMI (kg/m$^2$), %** | | |
| <25 | 55 | 86 |
| 25-29.99 | 36 | 13 |
| ≥30 | 9 | 1 |

† SD=standard deviation; BMI=body mass index.

**Table 2: Comparison of various lipid parameters for hypertensive patients and normotensive control subjects.**

| Lipid parameters | % hypertensive patients (n=100) | % normotensive subjects (n=100) | P value |
|---|---|---|---|
| **TC (mg/dl)** | | | |
| <200 | 88 | 96 | >0.05 |
| ≥200 | 12 | 4 | |
| **HDL (mg/dl)** | | | |
| Low | 47 | 25 | <0.005 |
| Normal | 53 | 75 | |
| **LDL (mg/dl)** | | | |
| <150 | 93 | 94 | >0.05 |
| ≥150 | 7 | 6 | |
| **TG (mg/dl)** | | | |
| **<200** | 69 | 87 | <0.001 |
| **≥200** | 31 | 13 | |

†TC=total cholesterol; HDL=high-density lipoproteins; LDL=low-density lipoprotein; TG=triglycerides; bold values indicate statistically significant findings.

**Table 3: Distribution of various lipid parameters according to smoking habit in subjects.**

| Lipid parameters | % hypertensive patients (n=100) | | | % normotensive subjects (n=100) | | |
|---|---|---|---|---|---|---|
| | % Smokers | % non-smokers | P value | % Smokers | % non-smokers | P value |
| **TC (mg/dl)** | | | | | | |
| <200 | 34 | 54 | >0.05 | 27 | 69 | <0.05 |
| ≥200 | 10 | 2 | | 4 | 0 | |
| **HDL (mg/dl)** | | | | | | |
| Low | 22 | 25 | <0.01 | 14 | 11 | >0.05 |
| Normal | 22 | 31 | | 17 | 58 | |
| **LDL (mg/dl)** | | | | | | |
| <150 | 40 | 53 | >0.05 | 29 | 65 | >0.05 |
| ≥150 | 4 | 3 | | 2 | 4 | |
| **TG (mg/dl)** | | | | | | |
| <200 | 22 | 47 | <0.001 | 21 | 66 | <0.001 |
| ≥200 | 22 | 9 | | 10 | 3 | |

†TC=total cholesterol; HDL=high-density lipoproteins; LDL=low-density lipoprotein; TG=triglycerides; bold values indicate statistically significant findings.

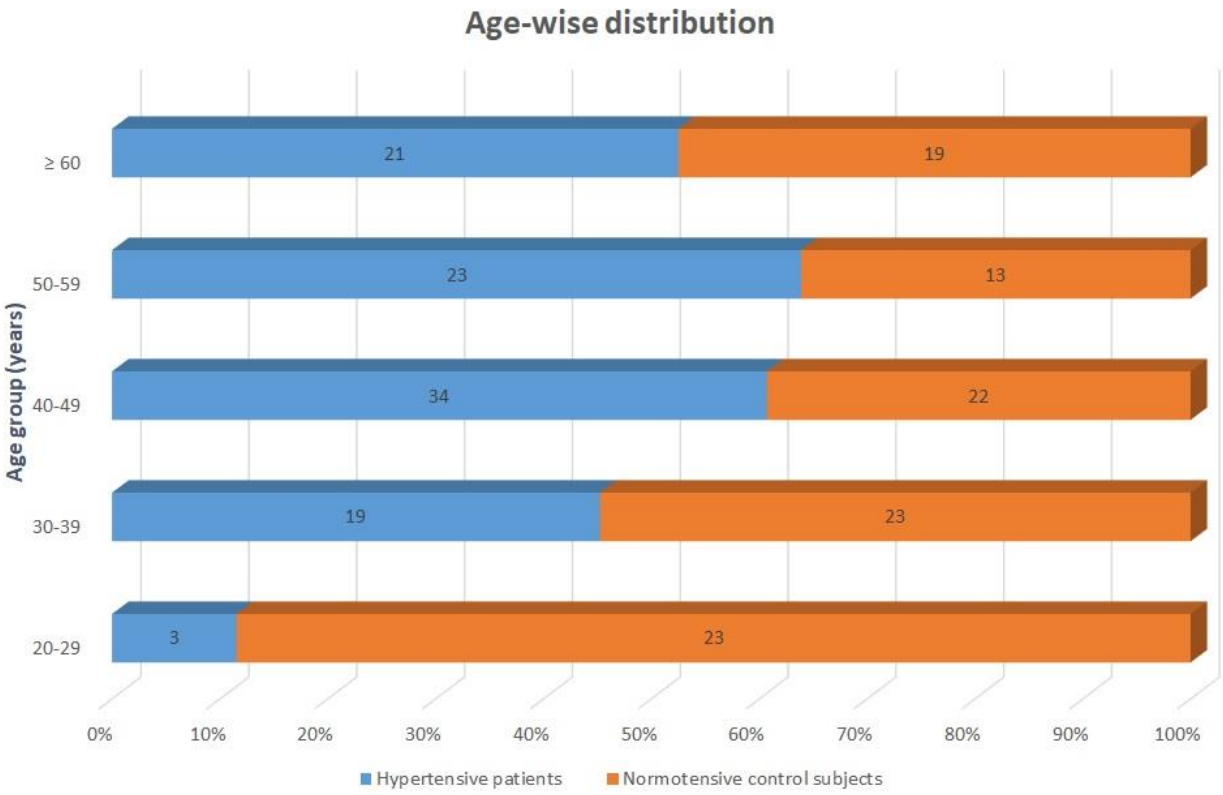


**Figure 1: Age wise distribution of all study participants.**

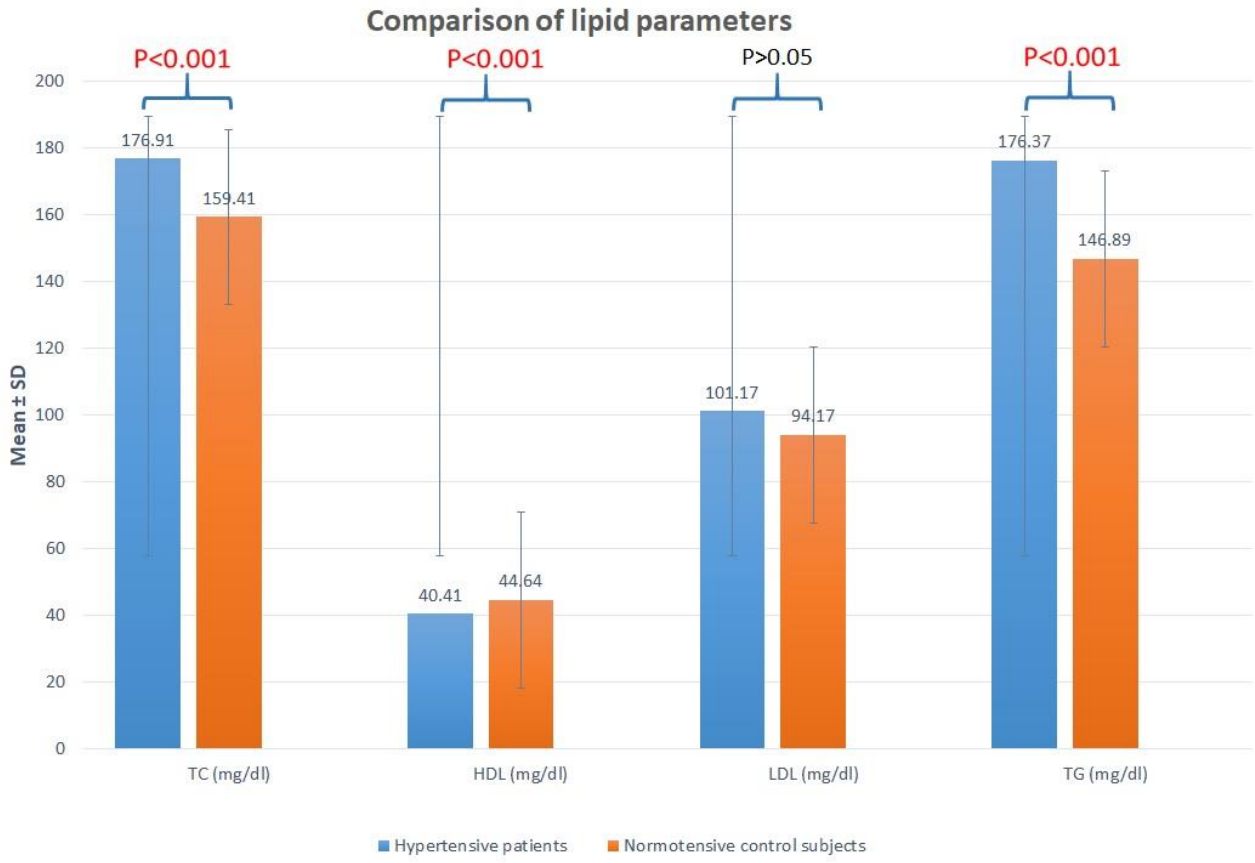


**Figure 2: Comparison of various lipid parameters among hypertensive patients and normotensive subjects.**

Table 3 outlines the distribution of various lipid parameters based on smokers and non-smokers among the study population. Our findings revealed that elevated level of TG ($p<0.001$) and reduced level of HDL ($p<0.01$) were significantly associated with smoking habits in hypertensive patients. On the other hand, elevated level of TC (4 patients versus 0 patients; $p<0.05$), and TG (10 patients versus 3 patients; $p<0.001$) were found in normotensive subjects with smoking habits than non-smokers.

## DISCUSSION

In the present study, we investigated the association between serum lipid profile and hypertension among Indian population. Despite the fact that a vast amount of literature has been focused on the association between hypertension and altered lipid profile or dyslipidemia, there was a lack of data for the Asian population and especially for Indians. Importantly, the elevated levels of TG, TC, LDL, VLDL (very-low-density lipoprotein) and declined levels of HDL in individuals have been blamed as the leading risk factors related to cardiovascular events. The Framingham heart study documented that almost 80% cases had at least one additional cardiovascular disease risk factor with an atherogenic nature.[1]

As a matter of interest, the interaction between two risk factors, dyslipidemia and hypertension, occured at the vascular endothelial level. Atherosclerosis occured due to lipids accumulation within the lumen of blood vessels, which resulted in obstruction of blood flow in the vascular system, then ended up in hypertension. This accumulation of lipids also resulted in altered lipid profile or dyslipidemia.

In our study, we found that the hypertensive patients had significantly higher BMI than normotensive subjects. This finding may be either due to obesity or dyslipidaemia, which was the most common risk factor for hypertension or key role of obesity in the causation and sustenance of insulin resistance.[15] However, definite pathogenic mechanisms for the occurrence of CVD risk mediated by dyslipidemia had not been well-established.

The findings obtained from our study revealed that mean values of serum TC were significantly higher among the hypertensive patients than normotensive control subjects. Otsuka et al reported a higher risk for progression of hypertension (hazard ratio: 1.28; 95% CI: 1.06-1.56) in subjects with a TC level >167 mg/dl than subjects with a TC level ≤167 mg/dl.[10] Apart from this, high low-density lipoprotein cholesterol (LDL-C) and non-high-density lipoprotein cholesterol (HDL-C) levels were also correlated with an increased risk of hypertension. This was comparable to previously reported studies from India as well as other parts of the world.[16-19] The higher level of serum TC had been well recognized for the raised risk of progressing macrovascular complications like CHD and stroke.[20] Osujiet al reported a significantly positive association between serum TC and BP (both systolic and diastolic) in both hypertensive patients and normotensive subjects.[18] Moreover, it had been reported that the serum TC level more than 5.0 mmol/l indicated a gradual increase in risk of CHD.[21]

Other most important finding was associated with serum TG level, it was higher in hypertensive patients compared to normotensive subjects. Multiple studies reported from Southeast Nigeria suggested that serum TG levels were significantly higher in newly diagnosed hypertensive patients than normotensive control subjects.[16,18] In contrast, Kesteloot et al postulated that the TC, TG and LDL-C levels were higher in newly diagnosed hypertensive Nigerian patients, but these values were not significantly different from the values of normotensive subjects.[22] TG level was related to BP as TG level, itself can cause endothelial dysfunction, arterial stiffness and thus the loss of vasomotor reactivity.[23-25]

Since a long time, low level of HDL cholesterol had been well-established as an important predictor of increased risk of cardiovascular events.[26] The HDL cholesterol, was a protective protein, played major role in the impairment of endothelium dependent dilation. The level of HDL cholesterol had declined in DH patients implied the higher risk to develop complications of hyperlipidemia. This chronic persistent hyperlipidemia may cause target organ damage.[27] In our study, a lower level of HDL was reported in hypertensive patients compared to non-hypertensive control subjects. This finding was consistent with other earlier reported studies.[16-18]

Cigarette smoking may tend to alter lipid profile and thus raising risk for atherosclerosis and CHD.[28] However, the exact correlation between altered lipid profile and smoking in hypertensive patients had not been documented in literature. Our findings postulated that overall lipid abnormalities were more common among hypertensive and normotensive subjects. In addition, we also evaluated that cigarette smoking had an impact on lipid profile irrespective of their BP status.

Finally, a number of potential shortfalls needed to be considered. The present study was a hospital based study, so the outcomes may not be extrapolated to the entire population. Further the study could not shed light on factors such as diet, physical activity, medication or other factors that may alter lipid levels. On a wider level, further research was required to determine the effect of these mentioned factors on alteration of lipid levels.

## CONCLUSION

This work has highlighted that hypertensive patient are more likely associated with dyslipidemia, pertaining to elevated TC, LDL, TG and reduced HDL cholesterol levels than normotensive subjects. Hypertensive patients require meticulous watch on the lipid profile at regular

intervals in order to prevent future events of CVD and stroke.

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