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Estimation of lipid profile in patients with pulmonary tuberculosis: A cross-sectional observational study.

Prasanjeet Sahu[1], Srinibas Sahoo*[2]
[1]2nd Year PG Resident, PG Department of Respiratory Medicine, Hi-Tech Medical College & Hospital, Bhubaneswar, Odisha, India.
[2]Associate Professor, PG Department of Respiratory Medicine, Hi-Tech Medical College & Hospital, Bhubaneswar, Odisha, India.

Abstract

Background

A significant worldwide health concern is pulmonary tuberculosis (TB) with well-documented effects on host metabolism. Lipid disturbances, particularly hypocholesterolemia and reduced HDL cholesterol, are common in TB and may reflect both nutritional status and disease severity. Understanding these changes can aid in clinical management and nutritional intervention.

Methods

In this resaecrh study was carried on 101 confirmed pulmonary TB patients. Data on demographics, BMI, lifestyle habits, and radiological severity were recorded. Various lipid parameters were measured. Statistical analysis included t-tests, ANOVA, and Pearson correlation, with significance level at $p<0.05$.

Results

The mean age was 51.73 years, with 64.4% male participants. Most patients had a normal BMI, but 16.8% were underweight. Mean lipid values were: total cholesterol 156.68 mg/dL, triglycerides 137.24 mg/dL, HDL cholesterol 34.54 mg/dL, LDL cholesterol 99.38 mg/dL, and VLDL cholesterol 12.53 mg/dL. BMI correlated positively with total cholesterol and LDL cholesterol, whereas disease severity correlated negatively with HDL cholesterol. Smoking showed no significant impact on cholesterol levels.

Conclusion

Pulmonary tuberculosis is associated with marked lipid abnormalities, particularly hypocholesterolemia and low HDL cholesterol, more pronounced in underweight individuals and those with severe disease. Lipid monitoring may serve as an adjunctive marker for disease assessment and prognosis.

Recommendation

Routine lipid profile testing should be considered in TB patients, with timely nutritional support aimed at correcting hypolipidemia to enhance recovery and treatment outcomes.

Keywords: *Pulmonary tuberculosis; Lipid profile; Hypocholesterolemia; High-density lipoprotein; Body mass index; Nutritional status; Disease severity*
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Corresponding Author: *Srinibas Sahoo*
Email: ***srisahoo89@gmail.com***
Associate Professor, PG Department of Respiratory Medicine, Hi-Tech Medical College & Hospital, Bhubaneswar, Odisha, India.

Introduction

Nowadays in developing nations like India, pulmonary tuberculosis (PTB) continues to be a major worldwide health concern. A report of 2023 estimates that India alone accounts for nearly 27% of global TB cases, underscoring the persistent burden of this infectious disease despite decades of public health interventions [1]. PTB is caused by *Mycobacterium tuberculosis*, an intracellular pathogen capable of persisting within host macrophages by subverting immune defenses. In addition to its respiratory

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manifestations, TB induces systemic metabolic changes that can impact the patient's nutritional and biochemical status.

Lipids are critical biomolecules involved in membrane structure, energy storage, and cellular signaling. They assist in immune regulation. There is a complicated and two-way interaction between TB and lipid metabolism. On one hand, *M. tuberculosis* utilizes host-derived lipids, including cholesterol and fatty acids, to sustain its survival within granulomas [2,3]. However, infection causes systemic inflammation, which is mediated by cytokines and tumor necrosis factor-alpha (TNF-α). These factors change the metabolism of hepatic lipids and frequently lead to changes in triglyceride levels, hypocholesterolemia, and decreased HDL-C [4].

Several studies have reported that patients with active PTB tend to exhibit a characteristic lipid pattern marked by reduced total cholesterol (TC) and HDL-C levels, with variable changes in triglycerides (TG) and low-density lipoprotein cholesterol (LDL-C) [5–7]. These alterations may have clinical implications, as HDL possesses anti-inflammatory and antioxidant properties, modulates macrophage activity, and participates in innate immune responses [8]. Low HDL and TC levels have also been associated with increased disease severity, delayed sputum conversion, and poorer treatment outcomes in TB [6,9].

Given the importance of lipids in host defense, understanding the biochemical profile of TB patients can provide insight into disease pathophysiology and open avenues for adjunctive nutritional or pharmacological interventions. Therefore this study seeks to enhance the existing evidence correlating lipid metabolism with tuberculosis progression and therapy through evaluating measured lipid parameters against known reference ranges and examining their relationship with disease severity.

Materials and Methods

Study Design and Aim

The present cross-sectional observational research aimed to assess the lipid profile of patients with pulmonary tuberculosis (PTB). The work emphasizes on the relation between lipid, body mass index (BMI), lifestyle factors, along with the severity of radiological illness.

Study setting

The research experiment was done at Hi-Tech Medical College and Hospital in Bhubaneswar, Odisha, India, along with the Department of Respiratory Medicine and Biochemistry. The investigation period ran from February 2024 to February 2025, a total of 12 months.

Study participants

101 consecutive patients had just been diagnosed with pulmonary tuberculosis that was positive for sputum smears. Chest radiography, clinical characteristics, and sputum smear microscopy for acid-fast bacilli (Ziehl–Neelsen staining) were used to make the diagnosis.

Inclusion criteria

1. Age 18–65 years
2. Newly diagnosed sputum smear-positive PTB patients
3. No prior history of anti-tubercular therapy
4. Willingness to provide informed consent

Exclusion criteria

1. HIV infection
2. Chronic liver or kidney disease
3. Diabetes mellitus or thyroid disorders
4. Pregnancy
5. Current use of lipid-altering medications (e.g., statins, corticosteroids)

Data collection

Demographic data, lifestyle habits (smoking, alcohol, substance use), anthropometric measurements (height, weight, BMI), and radiological severity of TB were recorded.

Data collection tools

1. Structured proforma for demographics and clinical history
2. Standardized weighing scale and stadiometer for BMI calculation
3. Radiological assessment (chest X-ray) for disease severity
4. Fully automated biochemical analyzer (e.g., Mindray BS-240) with enzymatic colorimetric assays for lipid profile estimation

Quality control

Quality control measures were applied daily using manufacturer-provided control sera to ensure precise lipid profile estimations. All biochemical analyses were completed within two hours of sample collection to minimize pre-analytical errors.

Statistical analysis

Data evaluation was done by SPSS version 25.0. Categorical variables were represented as percentages, and continuous

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variables as mean ± standard deviation. ANOVA and t-tests were used for comparisons among the groups. To investigate the correlations Pearson's correlation coefficient was used. P-values less than 0.05 were regarded as statistically significant.

Bias

To minimize bias, consecutive sampling was employed, laboratory personnel were blinded to clinical details, and standardized instruments and protocols were used for all measurements.

Ethical considerations

Ethical approval was granted by the ethical committee of Hi-Tech Medical College, Bhubaneswar.

Result

Participant Flow

118 patients having suspected pulmonary tuberculosis were evaluated for eligibility during the research period. Twelve of these patients were disqualified: three had chronic liver illness, two had diabetes, two were on lipid-altering medications, and five were HIV positive. A total of 106 patients were found eligible, of which 5 declined participation. Ultimately, the study included 101 patients. All enrolled participants completed the data collection and were included in the final analysis.

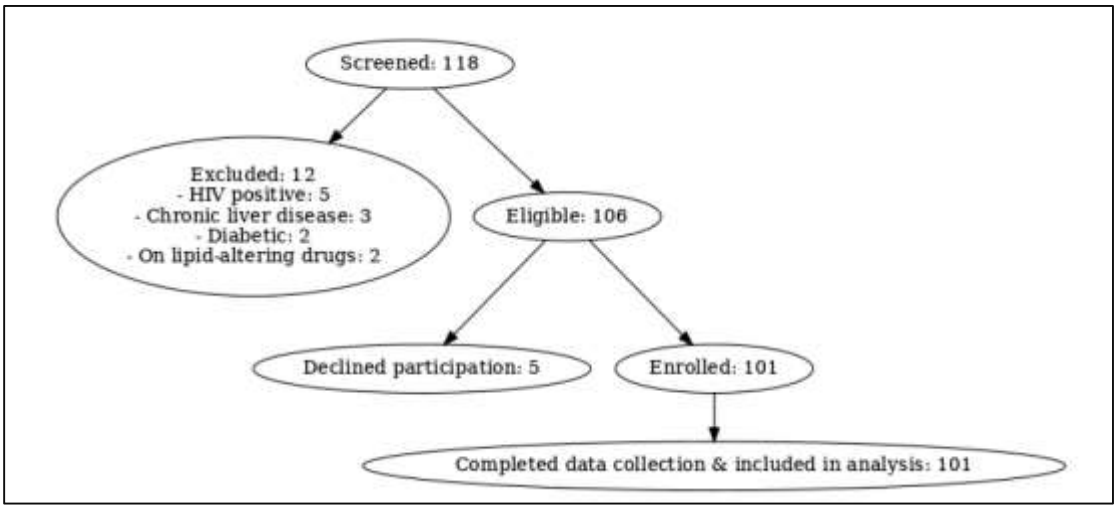

Figure 1. A flow diagram illustrating the screening, exclusion, enrollment, and analysis process

Demographics Summary

The study included 101 patients with a mean age of 51.73 ± 15.59 years (range: 19–89 years) and a median age of 52 years. Males constituted 64.4% (n = 65) and females 35.6% (n = 36), exhibiting ratio of 1.8:1. Most common occupations were housewives (27.7%) and farmers (22.8%), followed by teachers, service employees, and students, with smaller proportions engaged in skilled or unskilled labour. In terms of lifestyle habits, 57.4% (n = 58) were nonsmokers, 40.6% (n = 41) were smokers, and one participant (1.0%) reported habitual cannabis (*ganja*) use.

Table 1. Habit analysis

Habit	Count
Nonsmoker	58
Smoker	41
Ganja addicted	1

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Baseline anthropometric measurements revealed a mean height of 145.29 ± 45.82 cm and mean weight of 54.90 ± 9.39 kg, corresponding to a mean BMI of 21.49 ± 4.63 kg/m². The mean total leukocyte count (TLC) was 7222.32 ± 2088.85 cells/µL. Liver function markers showed a mean serum total bilirubin of 0.55 ± 0.44 mg/dL, mean SGOT of 32.57 ± 10.13 U/L, and mean SGPT of 58.25 ± 17.43 U/L, all within reference ranges.

With respect to lipid profile parameters, the mean total cholesterol was 156.68 ± 30.16 mg/dL, triglycerides 137.24 ± 57.82 mg/dL, HDL cholesterol 34.54 ± 12.64 mg/dL, LDL cholesterol 99.38 ± 19.21 mg/dL, and VLDL cholesterol 12.53 ± 2.80 mg/dL. HDL levels were notably low, a finding consistent with previously reported alterations in lipid metabolism among patients with active pulmonary tuberculosis.

Subgroup analysis

By Sex: Male patients exhibited significantly lower mean HDL cholesterol levels compared to females, while total cholesterol, triglycerides, LDL, and VLDL levels did not differ significantly between the sexes.

By BMI Category: Underweight patients (BMI < 18.5 kg/m²) had lower mean total cholesterol and LDL cholesterol compared to those with normal or higher BMI, whereas triglyceride levels were not significantly different across BMI groups.

By Radiological Severity: Patients with extensive disease had significantly reduced HDL cholesterol and total cholesterol compared to those with limited disease. LDL and triglyceride differences were less marked, although a downward trend was observed in the extensive group.

Values of BMI along with total cholesterol ($r \approx 0.34$, $p < 0.05$) and BMI with LDL cholesterol ($r \approx 0.31$, $p < 0.05$) were found to be positively correlated by correlation analysis, while HDL cholesterol did not significantly correlate with BMI. HDL cholesterol and disease severity had a negative correlation ($r \approx -0.29$, $p < 0.05$).

Table 2 clinical & lab parameters summary

Parameter	Mean	Median	Std Dev	Min	Max
Age	51.73	52.00	15.59	19.00	89.00
Height	145.29	158.00	45.82	1.44	177.00
Weight	54.90	55.00	9.39	35.00	85.00
BMI	21.49	21.28	4.63	2.49	33.33
TLC	7222.32	7600.00	2088.85	4400.00	12400.00
Ser Billirubin Total	0.55	0.39	0.44	0.21	2.09
SGOT	32.57	31.90	10.13	13.36	75.50
SGPT	58.25	60.41	17.43	35.50	114.30
TOTAL CHOLESTEROL	156.68	145.36	30.16	73.00	229.68
TG	137.24	126.31	57.82	41.41	294.10
HDL	34.54	40.14	12.64	10.56	55.25
LDL	99.38	98.81	19.21	43.50	144.22
VLDL	12.53	11.11	2.80	8.24	20.18

Analysis of BMI distribution by sex revealed notable differences between male and female pulmonary tuberculosis patients. Among females (n = 35), 20.0% were underweight, 42.9% had a normal BMI, 28.6% were overweight, and 8.6% were obese. In contrast, among males (n = 65), 15.4% were underweight, 72.3% had a normal BMI, 10.8% were overweight, and only 1.5% were obese. This distribution has direct implications for serum lipid alterations in TB patients. Underweight individuals, particularly prevalent among males, are more likely to exhibit reduced total cholesterol, LDL-C, and HDL-C levels due to chronic undernutrition and the catabolic state induced by active infection. Conversely, the relatively higher proportion of overweight and obese individuals among females may contribute to elevated triglycerides and VLDL-C in some cases, despite the lipid-lowering effects of tuberculosis. These sex-specific BMI trends provide essential context for interpreting the lipid profile variations observed in the present study.

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Table 3. Cross-tabulation: Sex vs BMI Category

Sex	Underweight	Normal	Overweight	Obese
F	7	15	10	3
M	10	47	7	1

Analysis of lipid profile variations by habitual status revealed that the mean total cholesterol level was slightly higher in smokers (157.88 ± 32.09 mg/dL) compared to non-smokers (155.15 ± 28.76 mg/dL), although the difference was not statistically significant. The single participant with cannabis use ("ganja addicted") exhibited a markedly elevated total cholesterol value of 195.92 mg/dL; however, this isolated case does not permit meaningful statistical interpretation. These findings suggest that habitual smoking did not exert a substantial influence on serum cholesterol levels in patients with pulmonary tuberculosis, though extreme values in isolated cases warrant further investigation in larger cohorts.

Table 4. Habit vs Total Cholesterol

Habit	Count	Mean	Std Dev	Min	25%	Median	75%	Max
Ganja addicted	1	195.92	—	195.92	195.92	195.92	195.92	195.92
Nonsmoker	58	155.15	28.76	73.00	140.73	146.01	171.61	224.86
Smoker	41	157.88	32.09	98.60	137.72	143.54	176.63	229.68

Discussion

The present cross-sectional study investigated alterations in serum lipid profiles among patients with pulmonary tuberculosis (PTB) and examined their association with demographic, anthropometric, and lifestyle variables. The findings demonstrated that PTB patients exhibited a generally hypolipidemic profile, most notably characterized by reduced HDL-C levels. This observation is consistent with earlier reports that active *Mycobacterium tuberculosis* infection induces a catabolic state and inflammatory response, resulting in suppressed lipid synthesis and accelerated lipid catabolism [10,11].

According to the study, the mean TC amount was 156.68 ± 30.16 mg/dL, and the mean HDL-C level was 34.54 ± 12.64 mg/dL. These values were significantly low. Similar reductions in HDL-C have been documented in TB patients by Deniz et al. [12] and Rao et al. [13], who suggested that pro-inflammatory cytokines such as TNF-α and IL-6 alter hepatic lipid metabolism and promote the utilization of cholesterol for mycobacterial cell wall synthesis. Reduced HDL-C levels may also be attributed to oxidative modification and increased clearance during active infection [14].

Underweight people, who were more common in men, had lower mean TC and low-density lipoprotein cholesterol (LDL-C) than people with normal or higher BMI, according to the subgroup analysis by BMI. These findings align with the hypothesis that chronic undernutrition and prolonged catabolic stress in PTB exacerbate lipid depletion [15]. Conversely, the higher proportion of overweight and obese females in our cohort may explain the occasional observation of elevated TG and VLDL-C despite the overall lipid-lowering effects of TB. Previous studies have reported that baseline adiposity may buffer against severe lipid loss in TB, although this does not confer protection against disease progression [16].

Analysis by disease severity showed that patients with extensive radiological disease had TC and HDL-C levels much lower than those of people with limited disease. This inverse relationship between disease burden and lipid parameters has been previously reported [17,18], and may reflect both higher metabolic demands of the host and increased cholesterol utilization by *M. tuberculosis* during extensive infection.

Regarding lifestyle factors, smoking did not significantly influence TC levels in this cohort. While smoking is known to induce oxidative stress and reduce HDL-C in the general population [19], the strong lipid-lowering effect of TB itself may have masked such associations in our study. The single case of cannabis use showed unusually high TC, but due to the isolated nature of this finding, no firm conclusions can be drawn.

Overall, results support the notion that PTB is associated with significant alterations in serum lipid metabolism, particularly manifesting as hypocholesterolemia and reduced HDL-C. These lipid changes may have diagnostic and prognostic significance. Low baseline cholesterol, especially HDL-C, has been associated with delayed sputum conversion and poor treatment outcomes [20]. Future longitudinal studies are warranted to assess whether early

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nutritional or lipid supplementation could improve recovery and reduce morbidity in TB patients.

Strengths

One of the major strengths of this study is that it specifically targeted alterations in serum lipid profile among patients with confirmed pulmonary tuberculosis, providing a direct link between disease status and biochemical changes. The inclusion of both anthropometric and lifestyle factors (e.g., BMI categories, smoking, and cannabis use) allowed for a multidimensional assessment of variables influencing lipid metabolism in TB. By capturing a broad age range and both sexes, the study ensured representation of diverse patient characteristics. Another strength lies in the use of multiple lipid parameters which offers a more comprehensive understanding of lipid alterations rather than focusing on a single marker. Furthermore, the cross-sectional design enabled the identification of associations between lipid levels and TB disease burden in a relatively short time frame, which is valuable for hypothesis generation and guiding future longitudinal studies.

Generalizability

The results of the study will be most helpful to patients with pulmonary tuberculosis particularly in nations where TB and malnutrition coexist as major public health concerns.. The study cohort was drawn from a single tertiary care institution, therefore the findings might be representative of the clinical and biochemical characteristics of patients in similar urban and semi-urban healthcare settings. However, caution should be used when extrapolating to populations with varied nutritional origins, those with substantial comorbidities, or rural communities. Multicenter investigations with a range of socioeconomic and geographic groups are necessary to validate the results' wider relevance.

Conclusion

This study demonstrates that pulmonary tuberculosis is associated with significant alterations in serum lipid metabolism, particularly hypocholesterolemia and a significant drop in HDL-C levels. The changes were more pronounced in underweight individuals and in patients with extensive disease, highlighting the potential interplay between nutritional status, disease severity, and lipid depletion. Lifestyle factors such as smoking did not appear to exert a strong influence on lipid profiles in the presence of active TB, possibly due to the overriding metabolic effects of the infection itself.

The findings underscore the potential role of lipid parameters—especially HDL-C—as adjunctive markers for disease monitoring and prognosis in TB. Early identification of hypolipidemia could prompt targeted nutritional interventions, which may improve patient recovery and treatment outcomes. Future prospective studies with larger sample sizes are warranted to explore causal relationships and to assess whether correcting lipid abnormalities can positively influence TB treatment response and reduce morbidity.

Limitations

1. The research was carried out in one tertiary care hospital with a small number of participants, which may reduce how widely the findings can be applied
2. Its cross-sectional design prevents establishment of causal relationships between lipid changes and tuberculosis severity.
3. Potential confounders such as diet, socioeconomic status, and micronutrient deficiencies were not systematically assessed

Recommendations

Routine lipid profile assessment should be integrated into the clinical management of tuberculosis patients, particularly those who are underweight or have severe disease. Providing targeted nutritional support and monitoring lipid levels during treatment may help improve recovery and outcomes. To validate these results and investigate how lipid correction can improve TB treatment, more multicenter and longitudinal research is required.

Data availability

NA

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List of Abbreviations

LDL: Low-Density Lipoprotein
TC: Total Cholesterol
TG: Triglycerides
BMI: Body Mass Index
PTB: Pulmonary Tuberculosis
VLDL: Very Low-Density Lipoprotein
TB: Tuberculosis

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HDL: High-Density Lipoprotein

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