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Original Research Article

Fasting Lipid Profile and Its Correlation with Severity of COVID-19 - An Observational Cross-Sectional Study

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Abstract:

Background: The clinical spectrum of COVID-19, caused by SARS-CoV-2 varies from asymptomatic illness to severe multi-organ dysfunction. Emerging evidence suggests lipid metabolism alterations, including reduced cholesterol, HDL, LDL, and increased triglycerides, may influence disease severity. Understanding these lipid profile changes is crucial for risk stratification and management.

Aim: To assess fasting lipid profile in COVID-19 patients and evaluate its correlation with disease severity parameters, including SpO2, respiratory rate, and CT severity scores.

Methods: A cross-sectional study of 106 COVID-19 inpatients was conducted over six months in a tertiary care hospital in Chennai. The disease severity was evaluated using respiratory rate, SpO2, and CT severity scores. Patients with co morbidities (diabetes, hypertension, and dyslipidemia), those currently on statin therapy, pregnant individuals, or those under 18 years were excluded. Fasting lipid profile (total cholesterol, triglycerides, HDL, LDL), inflammatory markers (CRP, ferritin, D-dimer) and disease severity via SpO2, respiratory rate, and CT severity scoring were measured. Statistical analysis was performed using ANOVA, and Pearson's correlation using IBM SPSS v28

Results: Mean lipid levels: total cholesterol (167.83 ± 31.80 mg/dL), HDL (40.43 mg/dL), LDL (88.58 mg/dL), triglycerides (194.63 mg/dL). Total cholesterol, HDL, and LDL levels negatively correlated with disease severity ($p < 0.001$). Triglycerides positively correlated with severity parameters ($p < 0.001$). Respiratory rate showed no significant correlation with lipid levels ($p > 0.05$).

Conclusion: COVID-19 patients exhibit significant alterations in their lipid profiles, including decreased levels of total cholesterol, HDL, and LDL, along with elevated triglycerides. These lipid profile changes correlate with disease severity, suggesting their potential role in COVID-19 pathogenesis. Further research is needed to explore lipid-targeted therapeutic strategies.

Keywords: Covid 19, Lipid Profile, Disease Severity.

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Introduction

SARS-CoV-2, [1] the novel coronavirus responsible for COVID-19, emerged in late 2019 in Wuhan, China, causing a wide spectrum of illness from asymptomatic to severe respiratory failure and multi-organ dysfunction. Declared a pandemic by WHO in March 2020, the disease spreads rapidly, primarily through respiratory droplets, aerosols, and contaminated surfaces, with asymptomatic carriers contributing to transmission. Lipids play a vital role in viral replication and pathogenesis, including membrane fusion, envelopment, and viral assembly, and are crucial for host immune responses. SARS-CoV-2 exploits host lipid pathways, with dysregulated lipid metabolism implicated in disease severity. Proteomics studies reveal hypolipidemia correlates with severity of COVID-19, highlighting lipid metabolism as a potential therapeutic target [2].

Materials and Methodology:

This observational cross-sectional study was conducted over six months in the ICU and non-ICU COVID isolation wards of a tertiary care hospital, Chennai from March to August 2021. It included COVID-19 -confirmed in patients diagnosed via RT-PCR. Disease severity was assessed using

respiratory rate (>30 breaths/min), blood oxygen saturation (SpO2 ≤ 94%), and CT severity scores.

Eligibility Criteria: The study included RT-PCR-confirmed COVID-19 patients aged above 18 years. Exclusion criteria were patients with diabetes mellitus, systemic hypertension, coronary artery disease, those already on statin therapy, and pregnant individuals.

Methodology:

Patients underwent clinical assessments and routine investigations, including a fasting lipid profile. Inflammatory markers like CRP, ferritin, and D-dimer were also measured.

Disease severity was classified as mild, moderate, or severe based on clinical, radiological, and laboratory criteria.

Table 1:

Parameters	Mild	Moderate	Severe
Chest CT Severity Score (CT-SS),	0: Parenchymal opacification involves 0% of the region	1: Parenchymal opacification involves less than 50% of the region	2: Parenchymal opacification involves equal to or more than 50% of the region
Respiratory rate	Normal	≥ 24 per minute	≥30 breaths/min
SpO2,	Normal	≤94% (range 90-94%) on room air	SpO2 ≤90% in room air.

Expected Outcome and Benefit of Study:

This study aims to identify patients at higher risk for severe COVID-19, enabling early medical intervention and better outcomes.

Sample Size: Based on the study by Petrilli et al. (2020), 47% of COVID-19 inpatients had dyslipidaemia. Using this data, a sample size calculation suggested 96 patients. Adjusting for a 10% non-response rate, the final sample size was set at 106.

Data Collection : After obtaining informed written consent from patients, information about fever, cough, breathlessness, and any comorbidities (such as hypertension, diabetes, etc.) was gathered from patients. On admission, vital signs like oxygen saturation, blood pressure, and respiratory rate were measured and clinical examination was done. Blood sample for complete blood count, renal & liver functions, inflammatory markers, fasting lipid profile and CT chest were taken. Patients were categorized based on severity into mild, moderate, or severe.

Statistical Analysis:

Data analysis was performed using IBM SPSS v28. Frequencies and percentages were calculated, and ANOVA was used to compare differences between groups.

Pearson's correlation coefficient was used to determine the relationships between lipid levels and disease severity.

Results

Patient Demographics and Clinical Parameters:

65.1% of the study population were male, with a higher proportion of severe cases among males. Distribution across severity categories: Mild: 36.8%, Moderate: 26.4%, Severe: 36.8%

Mean Values of Key Parameters:

- Age: 40.02 ± 9.034
- Total Cholesterol: 167.83 ± 31.80 mg/dL
- Triglycerides: 194.63 ± 67.15 mg/dL
- HDL: 40.43 ± 4.94 mg/dL
- LDL: 88.58 ± 33.87 mg/dL
- CT Severity Score: 11.97 ± 5.74
- Serum Ferritin: 871.26 ± 704.14
- D-Dimer: 1328.14 ± 1352.60 ng/ml
- CRP: 50.18 ± 32.23 mg/L
- SpO2: 88.80 ± 8.16%
- Respiratory Rate: 24.13 ± 9.32 breaths/min

1. Correlation between CT Severity Scores and Other Parameters:

Significant Differences:

- Age: Significant difference between mild and severe CT severity score categories ($p < 0.001$)
- Total Cholesterol, Triglycerides, HDL, LDL, Serum Ferritin, D Dimer, CRP, and SpO2: Showed significant differences across all CT severity categories ($p < 0.001$).

Respiratory Rate (RR): No significant difference ($p = 0.760$).

The table below summarizes the findings:

Table 2:

Variable	CT severity score category	Mean value	F value	p value
Age	Mild	36.08	8.584	**<0.001**
	Moderate	40.03		
	Severe	44.05		
Total Cholesterol	Mild	190.05	61.199	**<0.001**

	Moderate	177.97		
	Severe	137.29		
Triglycerides	Mild	151.46	17.716	**<0.001**
	Moderate	208.76		
	Severe	228.16		
HDL	Mild	44.03	33.314	**<0.001**
	Moderate	40.38		
	Severe	36.79		
LDL	Mild	115.95	74.318	**<0.001**
	Moderate	94.72		
	Severe	55.79		
Serum Ferritin	Mild	203.82	146.004	**<0.001**
	Moderate	795.97		
	Severe	1613.74		
D Dimer	Mild	255.79	93.471	**<0.001**
	Moderate	935.14		
	Severe	2728.63		
CRP	Mild	18.51	131.379	**<0.001**
	Moderate	50.66		
	Severe	82.32		
SpO2	Mild	96.64	231.356	**<0.001**
	Moderate	90.32		
	Severe	79.55		
RR	Mild	23.69	0.758	0.760
	Moderate	22.93		
	Severe	25.50		

2. Correlation between SPO 2 and other parameters:

Significant Differences:

- Age and Total Cholesterol: Significant differences were found between mild and severe SpO2 categories ($p < 0.001$).
- Triglycerides: Significant differences between mild and moderate, and mild and severe categories ($p < 0.001$).
- HDL, LDL, Serum Ferritin, D Dimer, and CRP: Significant differences were found across all SpO2 categories ($p < 0.001$).

The results are summarized in the following table:

Table 3:

Variable	SpO2 category	Mean value	F value	p value
Age	Mild	36.08	8.390	**<0.001**
	Moderate	40.07		
	Severe	43.92		
Total Cholesterol	Mild	190.05	72.960	**<0.001**
	Moderate	180.61		
	Severe	136.44		
Triglycerides	Mild	151.46	17.111	**<0.001**
	Moderate	211.75		
	Severe	225.51		
HDL	Mild	44.03	37.105	**<0.001**
	Moderate	40.75		
	Severe	36.62		
LDL	Mild	115.95	79.970	**<0.001**
	Moderate	96.36		
	Severe	55.62		
Serum Ferritin	Mild	203.82	162.147	**<0.001**
	Moderate	759.79		
	Severe	1618.74		
D dimer	Mild	255.79	96.945	**<0.001**
	Moderate	887.89		

	Severe	2716.56		
CRP	Mild	18.51	141.953	**<0.001**
	Moderate	49.18		
	Severe	82.56		
RR	Mild	23.69	0.794	0.719
	Moderate	23.25		
	Severe	25.20		

3. Correlation between Respiratory Rate (RR) and Other Parameters: LDL had a significant negative correlation with RR ($p = 0.048$). Other variables such as age, total cholesterol, triglycerides, HDL, serum ferritin, D Dimer, CRP, and SpO2 did not show significant correlations with RR.

Table 4:

Variables	**Subcategory**	**Respiratory Rate (in min) N (%)**		
		Mild	**Moderate**	**Severe**
Total Cholesterol	100-150	15 (45.5)	7 (21.2)	11 (33.3)
	151-200	31(52.5)	12(20.3)	16(27.1)
	More than 200	9(64.3)	3(21.4)	2(14.3)
Triglycerides	Less than 150	12 (41.4)	5 (17.2)	12 (41.4)
	151-199	28 (63.6)	6 (13.6)	10 (22.7)
	200-299	12 (60)	5 (25)	3(15)
	More than 300	3 (23.1)	6 (46.2)	4 (30.8)
HDL	Less than 40	19 (47.5)	8 (20)	13 (32.5)
	More than 40	36(54.5)	14(21.2)	16(24.2)
LDL	Less than 50	9 (40.9)	7 (31.8)	6 (27.3)
	51-100	16 (51.6)	5 (16.1)	10 (32.3)
	101-160	30(56.6)	10(18.9)	13(24.5)

Correlation between RR and Other Variables: RR and other variables were subjected to seen for Pearsons's correlation and it was found that RR had only one negative correlation with LDL levels as it had a p value of less than 0.05**.**

Table 5:

S.No	**Variable**	**r value**	**p value**
1	RR and Age	0.089	0.364
2	RR and Total Cholesterol	-0.159	0.104
3	RR and Triglycerides	0.018	0.856
4	RR and HDL	-0.055	0.576
5	RR and LDL	-0.178	0.048
6	RR and Serum ferritin	0.093	0.344
7	RR and D Dimer	0.042	0.668
8	RR and CRP	0.029	0.768
9	RR and SpO2	-0.798	0.427
10	RR and CT severity score	0.05	0.55

Observation and Results

The study population consisted of 65.1% males and 34.9% females, with a higher prevalence of severe disease among males. SpO2 and CT severity scores categorized patients as mild (36.8%), moderate (26.4%), and severe (35.8%). Total cholesterol levels were consistently below 200 mg/dL in severe cases, highlighting an association between lipid alterations and disease severity. Significant correlations were observed between CT severity scores and age, triglycerides, serum ferritin, D-dimer, and CRP (positive), as well as with total cholesterol, HDL, LDL, and SpO2 (negative). SpO2 also showed significant negative correlations with age, inflammatory markers, and CT severity scores, and positive correlations with lipid levels. ANOVA revealed significant differences in clinical and biochemical parameters across severity categories ($p < 0.001$). Pearson's correlation confirmed strong linear relationships between variables, while respiratory rate (RR) showed only a weak negative correlation with LDL ($r = -0.178$, $p = 0.048$) and no significant correlation with other variables. These findings underscore the role of lipid metabolism and inflammatory markers in COVID-19 severity.

Discussion

Numerous studies [3] have demonstrated a significant correlation between lipid profile abnormalities and the severity of COVID-19. Aparisi A et al [5], reported lower total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels in non-survivors compared to survivors, with these parameters showing an inverse correlation with inflammatory markers like CRP and a positive correlation with lymphocyte counts. In their multivariate analysis, LDL-C ≤ 69 mg/dL and CRP > 88 mg/dL at admission were independently associated with increased 30-day mortality.

Similarly, Hu X et al. [6] observed significantly reduced TC, HDL-C, and LDL-C levels in COVID-19 patients compared to healthy controls. Severe cases showed markedly lower HDL-C levels, with these levels negatively correlated with CRP and positively correlated with lymphocytes.

Their findings underscore the predictive utility of lipid profiles, as evidenced by the area under the curve (AUC) for HDL-C in ROC analysis being 0. 732. Fan J et al. [7] reported consistently low LDL-C levels throughout the disease course, with significant reductions noted upon admission and in non-survivors. Unlike LDL-C, HDL-C levels remained low during the recovery phase.

Logistic regression analysis linked lower LDL-C levels to disease progression and in-hospital mortality. These lipid alterations inversely correlated with inflammatory markers like hsCRP. Other studies, including Sun JT et al. [8] and Nie S et al. [9], further highlighted the inverse relationship between lipid profiles and COVID-19 severity. Severe cases consistently showed reduced TC, LDL-C, and HDL-C levels compared to mild cases. Roshan Kumar Mahat et al. [10] corroborated these findings in a meta-analysis, which demonstrated significant reductions in TC, LDL-C, and HDL-C levels in severe cases and non-survivors.

In our study, we observed significant negative correlations between TC, HDL-C, LDL-C, and SpO2, and positive correlations between Triglyceride levels and CT severity, CRP, D-dimer, and ferritin. Despite the wealth of data, research on the correlation between lipid profiles and COVID-19 severity remains limited, especially in the Indian context. Further studies are necessary to better understand these relationships and their potential clinical implications.

Conclusion

Dyslipidaemia in COVID-19, characterized by low LDL and HDL cholesterol levels, is associated with increased disease severity and poor outcomes. Possible contributing factors include:

- Liver injury, viral-induced inflammation, and increased vascular permeability, which lead to lipid imbalances.
- The negative correlation between lipid levels and inflammation markers (CRP, D-dimer, and ferritin) suggests that dyslipidaemia may worsen prognosis in COVID-19 patients.

Given the complex mechanisms behind this dyslipidaemia, further research is needed to explore potential therapeutic strategies, including the role of lipid-modulating treatments in COVID-19 management. Monitoring lipid profiles could serve as an important clinical tool in predicting disease severity and guiding treatment decisions.

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