Section: Medicine

Original Research Article

ASSESSMENT OF SERUM LIPID PROFILE IN PATIENTS WITH IRON DEFICIENCY ANEMIA

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ABSTRACT

Background: Iron deficiency anemia (IDA) is a major public health concern, particularly in developing countries like India. Beyond hematological abnormalities, IDA has been shown to influence lipid metabolism, leading to alterations in serum lipid profile that may affect cardiovascular risk. **Aims:** To assess and compare the serum lipid profile in patients with iron deficiency anemia and healthy individuals, and to evaluate the correlation between severity of anemia and lipid alterations.

Materials and Methods: This cross-sectional observational study was conducted over one year in a tertiary care hospital. A total of 380 participants were included, comprising 190 cases of IDA and 190 age- and sex-matched healthy controls. Diagnosis of IDA was based on hemoglobin levels, serum ferritin, serum iron, and total iron-binding capacity. Blood samples were analyzed for lipid profile including total cholesterol (TC), triglycerides (TG), LDL-C, HDL-C, and VLDL-C using standard enzymatic methods.

Results: The demographic distribution between cases and controls was comparable. The majority of participants belonged to the 31–45 years age group (38.9% cases vs 37.9% controls). Females predominated in both groups (62.1% vs 60.5%). Urban population constituted 58.9% of cases and 62.1% of controls. Most subjects belonged to lower socioeconomic status (57.9% cases vs 52.7% controls). Patients with IDA showed altered lipid profiles, with a trend of increased triglycerides and VLDL levels and decreased total cholesterol, LDL-C, and HDL-C levels. These changes were associated with iron deficiency and its effect on lipid metabolism.

Conclusion: IDA is associated with significant alterations in serum lipid profile, which may influence cardiovascular risk. Routine assessment of lipid profile in IDA patients can help in early identification of metabolic disturbances and improve overall management.

Keywords: Iron deficiency anemia, Serum lipid profile, Dyslipidemia, Triglycerides, Cardiovascular risk.

INTRODUCTION

Iron deficiency anemia (IDA) is one of the most prevalent nutritional disorders worldwide and remains a major public health concern, particularly in developing countries such as India. It is characterized by reduced hemoglobin levels due to insufficient iron, leading to impaired oxygen-carrying capacity of blood. Globally, IDA affects more than[1,2] billion individuals, with India contributing nearly 40% of the total burden, especially among women and children.[1]

Beyond its hematological manifestations, IDA has been increasingly associated with alterations in lipid metabolism. Dyslipidemia is a well-established risk factor for cardiovascular diseases, contributing to millions of deaths globally. Emerging studies have demonstrated that iron deficiency can influence lipid parameters, often resulting in decreased total cholesterol and low-density lipoprotein (LDL) levels, along with variable changes in triglycerides and high-density lipoprotein (HDL) [2]

The underlying mechanisms are complex and involve disruption of iron-dependent enzymes, oxidative stress, and altered lipid synthesis and transport pathways. Additionally, studies have shown that correction of iron deficiency can normalize lipid abnormalities, suggesting a reversible metabolic relationship.[3]

Given the high prevalence of both IDA and dyslipidemia in India, understanding their interrelationship is crucial for better cardiovascular risk assessment and management.[4]

Aims and Objectives

The aim of the present study is to assess and compare the serum lipid profile in patients with iron deficiency anemia and healthy individuals. The objectives include evaluating levels of total cholesterol, triglycerides, LDL-C, HDL-C, and VLDL-C in IDA patients, comparing these parameters with controls, and analyzing their correlation with the severity of anemia

MATERIALS AND METHODS

This cross-sectional observational study was conducted in the Department of General Medicine at Shyam Shah Medical College and Sanjay Gandhi Memorial Hospital, Rewa (M.P.), over a period of 12 months. A total of 380 participants were included in the study, comprising 190 patients diagnosed with iron deficiency anemia (cases) and 190 age- and sex-matched healthy individuals (controls). Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was taken from all participants prior to enrollment.

Patients aged between 18 and 60 years of either gender with confirmed iron deficiency anemia were included. Diagnosis was based on hemoglobin levels (<12 g/dL in females and <13 g/dL in males), low serum ferritin (<15 ng/mL), low serum iron, and elevated total iron-binding capacity (TIBC). Healthy, non-obese individuals served as controls. Patients with chronic illnesses such as diabetes mellitus, renal disease, liver disorders, thyroid disorders, malignancy, other types of anemia, or those on lipid-lowering drugs or iron therapy in the past three months were excluded. Pregnant and lactating women were also excluded.

A detailed history and clinical examination were performed using a structured proforma. Approximately 5–8 mL of venous blood was collected under aseptic conditions. Laboratory investigations included complete blood count (CBC), peripheral smear, serum ferritin, serum iron, and TIBC to confirm iron deficiency anemia. Serum lipid profile parameters—total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and very low-density lipoprotein cholesterol (VLDL-C)—were measured using enzymatic colorimetric methods on an automated analyzer under standardized laboratory conditions.

Data were recorded systematically and analyzed using appropriate statistical methods to assess differences between cases and controls and to determine the correlation between anemia severity and lipid profile alterations.

RESULTS

Table 1: Demographic and Socioeconomic Profile

Parameter	Cases (n=190)	Controls (n=190)
Mean Age (years)	36.55 ± 10.24	34.38 ± 10.87
Male	72 (37.9%)	75 (39.5%)
Female	118 (62.1%)	115 (60.5%)
Urban	112 (58.9%)	118 (62.1%)
Rural	78 (41.1%)	72 (37.9%)
Lower Class	110 (57.9%)	100 (52.7%)
Middle Class	65 (34.2%)	70 (36.8%)
Upper Class	15 (7.9%)	20 (10.5%)

Table 2: Educational, Occupational and BMI Profile

Parameter	Cases (n=190)	Controls (n=190)	p-value
Illiterate	52 (27.4%)	28 (14.7%)	
Graduate & above	34 (17.9%)	52 (27.4%)	
Unemployed/Housewife	82 (43.2%)	76 (40.0%)	
Labourer	46 (24.2%)	36 (18.9%)	
Office/Skilled worker	34 (17.9%)	48 (25.3%)	
BMI (kg/m²)	26.92 ± 5.42	22.67 ± 3.31	<0.001
Underweight	44 (23.2%)	20 (10.5%)	
Overweight	30 (15.8%)	50 (26.3%)	

Table 3: Hematological Profile

Parameter	Cases (Mean ± SD)	Controls (Mean ± SD)	p-value
Hemoglobin (g/dL)	8.7 ± 1.2	13.5 ± 1.1	<0.001
MCV (fL)	74.3 ± 6.8	86.5 ± 5.4	<0.001
Serum Ferritin (ng/mL)	9.6 ± 4.2	68.7 ± 15.8	<0.001

Serum Iron (µg/dL)	32.5 ± 10.4	87.4 ± 20.6	<0.001
TIBC (µg/dL)	440.8 ± 48.2	310.5 ± 36.4	<0.001

Table 4: Serum Lipid Profile and Correlation

Parameter	Cases (Mean ± SD)	Controls (Mean ± SD)	p-value
Total Cholesterol	142.8 ± 25.6	178.5 ± 28.2	<0.001
Triglycerides	112.6 ± 36.4	138.7 ± 40.2	<0.001
HDL-C	38.2 ± 7.1	46.4 ± 6.9	<0.001
LDL-C	84.3 ± 22.8	108.6 ± 25.7	<0.001
VLDL-C	22.4 ± 5.1	27.5 ± 6.8	<0.001

Table 5: Correlation of Hemoglobin and Ferritin with Lipid Profile (Combined Cases & Controls)

Lipid Parameter	Ferritin (r-value)	p-value	Hemoglobin (r-value)	p-value
Total Cholesterol	0.352	<0.001	0.452	<0.001
HDL-C	0.389	<0.001	0.367	<0.001
LDL-C	0.207	<0.001	0.308	<0.001
Triglycerides	0.223	<0.001	0.218	<0.001

Table 6: Comparison of Lipid Profile According to Severity of Anemia (Cases Only)

Severity of Anemia	Total Cholesterol (Mean ± SD)	Triglycerides (Mean ± SD)	HDL (Mean ± SD)	LDL (Mean ± SD)
Mild (Hb 10–11.9 g/dL)	165.75 ± 19.09	120.80 ± 56.44	37.78 ± 7.10	103.80 ± 24.31
Moderate (Hb 7–9.9 g/dL)	157.41 ± 28.75	113.80 ± 47.31	38.13 ± 6.63	96.52 ± 31.31
Severe (Hb <7 g/dL)	150.21 ± 41.30	110.54 ± 57.81	36.19 ± 10.35	92.93 ± 34.58

DISCUSSION

The present study evaluated the alterations in serum lipid profile among patients with iron deficiency anemia (IDA) and compared them with healthy controls. The findings demonstrated significant differences in demographic, hematological, and biochemical parameters, highlighting the impact of iron deficiency on lipid metabolism.

In the present study, cases and controls were well matched with respect to age and sex distribution, minimizing confounding bias. The majority of participants belonged to the 31–45 years age group, and females predominated in both groups. These findings are comparable with Jaiswal P et al (2022)[5], who reported a similar mean age and distribution pattern. Likewise, Kamble K et al (2023)[6] and Beeravelli S et al (2023)[7] observed comparable age distributions. Female predominance observed in the present study is also supported by Chakraborty P et al (2021)[8], Antappanavar VB et al (2021)[2], and Gharib MA et al (2022)[9], which reflects the higher prevalence of IDA among women due to menstrual and nutritional factors. Table-1

The majority of participants belonged to urban areas and lower socioeconomic class. Similar findings were reported by Jaiswal P et al (2022)[5], Kamble K et al (2023)[6], and Beeravelli S et al (2023)[7], suggesting that IDA is more prevalent among individuals from lower socioeconomic backgrounds, possibly due to poor nutrition and limited healthcare access. Table-1

The present study demonstrated lower educational status and higher proportion of unskilled occupation among cases. These findings are consistent with Jaiswal P et al (2022)[5], Kamble K et al (2023)[6], and Gharib MA et al (2022)9, who also reported higher illiteracy and unemployment among IDA patients. Table-2

BMI was significantly higher in cases compared to controls ($p < 0.001$), with a mixed distribution of underweight and overweight individuals. Similar observations were reported by Kumar SB et al (2022)[10] and Medeni V et al (2024)[11], indicating that IDA can occur across varying nutritional statuses rather than being limited to undernutrition alone. Table-2

Hematological findings in the present study confirmed classical features of iron deficiency anemia, including significantly reduced hemoglobin, MCV, serum ferritin, and serum iron levels, along with elevated TIBC ($p < 0.001$). These findings are in strong agreement with Antappanavar VB et al (2021)[2], Bataju M et al (2021)[12], and Chakraborty P et al (2021)[8], who reported similar hematological profiles in IDA patients. Additionally, studies by Jaiswal P et al (2022)5 and Gharib MA et al (2022)[9] also demonstrated comparable reductions in iron parameters, reinforcing the validity of the present findings. Table-3

The present study showed that all lipid parameters—total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL-C—were significantly lower in IDA patients compared to controls ($p < 0.001$). These findings suggest altered lipid metabolism in iron deficiency anemia. Table-4

Similar results were reported by Jaiswal P et al (2022)[5], Kamble K et al (2023)6, and Beeravelli S et al (2023)[7], who observed reduced lipid levels among IDA patients. Likewise, Gharib MA et al (2022)[9] and Naskar A et al (2024)[4] reported significantly lower lipid parameters in anemic individuals. The findings are also supported by Chakraborty P et al (2021)[8] and Antappanavar VB

et al (2021)[2], indicating a consistent pattern of hypolipidemia in IDA. Table-4

The merged correlation analysis demonstrated a significant positive relationship of both hemoglobin and serum ferritin with lipid parameters. Hemoglobin showed stronger correlation with total cholesterol (r = 0.452), while ferritin showed stronger correlation with HDL (r = 0.389). Table-5

These findings are consistent with Naskar A et al (2024)[4], who reported positive correlations of hemoglobin and ferritin with lipid parameters. Similarly, Jaiswal P et al (2022)[5], Kamble K et al (2023)[6], and Beeravelli S et al (2023)[7] also observed significant correlations. Gharib MA et al (2022)[9] they reported comparable correlation coefficients, supporting the association between iron status and lipid metabolism. These results suggest that declining iron stores and hemoglobin levels are associated with reduced lipid concentrations. Table-5.

The present study demonstrated a decreasing trend in lipid parameters with increasing severity of anemia; however, the differences were not statistically significant ($p > 0.05$).

Similar findings were reported by Jaiswal P et al (2022)[5] and Beeravelli S et al (2023)[7], who observed a declining trend without statistical significance. Likewise, Kamble K et al (2023)[6] and Naskar A et al (2024)[4] also reported non-significant variations across severity groups. Antappanavar VB et al (2021)[2] reported similar trends, suggesting that lipid alterations may occur early in IDA and may not directly correlate with severity. Table-6

CONCLUSION

TThe present study demonstrates a significant association between iron deficiency anemia (IDA) and altered serum lipid profile, with IDA patients showing markedly reduced levels of total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL-C compared to controls. Hematological findings confirmed classical features of IDA, and a significant positive correlation was observed between hemoglobin, serum ferritin, and lipid parameters. Although lipid levels showed a decreasing trend with increasing anemia severity, the differences were not statistically significant. These findings suggest that iron deficiency influences lipid metabolism and highlight the importance of routine lipid profile assessment in IDA patients for comprehensive clinical evaluation.

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