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Original Research Article

A Study on Alterations of Serum Lipid Profile, Liver Enzymes, and Hematological Parameters in Liver Disease

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Conflict of interest: Nil

Abstract

Background: Liver disease is associated with significant biochemical and hematological alterations that reflect hepatic dysfunction. Parameters such as serum lipid profile, liver enzymes, and blood indices are valuable in assessing the disease burden and prognosis.

Objective: To evaluate alterations in serum lipid profile, liver enzymes, and hematological parameters in patients with liver disease compared to healthy controls.

Methods: A case-control study was conducted at Department of Physiology, JLNMBCH, Bhagalpur, including 150 cases of liver disease and 150 age- and sex-matched controls. Blood samples were collected after overnight fasting. Lipid profile and liver enzymes were analyzed using ERBA-CHEM 7, while hematological parameters were assessed with ERBA H360 Hematology Analyzer. Statistical analysis was performed using SPSS v26.0.

Results: Total cholesterol was significantly higher in cases (200.16 ± 17.65 mg/dL) than controls (193.14 ± 18.20 mg/dL, p=0.001), while other lipid fractions showed no significant differences. Liver enzymes (AST, ALT, ALP) were markedly elevated in cases compared to controls ($p<0.001$). Hemoglobin levels were significantly reduced in cases (11.62 ± 1.14 g/dL vs. 13.22 ± 0.72 g/dL, $p<0.001$), though RBC counts and indices (MCV, MCH, MCHC) were comparable. Hematocrit and total leukocyte counts showed no significant differences, though an anomalously high hematocrit value in one dataset suggested a possible data entry error.

Conclusion: Patients with liver disease exhibit significant alterations in total cholesterol, liver enzymes, and hemoglobin levels, reflecting metabolic dysfunction and anemia. Comprehensive biochemical and hematological assessment should be considered in routine evaluation and management of liver disease.

Keywords: Liver disease, lipid profile, liver enzymes, hematological parameters, anemia, AST, ALT, ALP.

Introduction

The liver is a vital organ that performs numerous essential functions, including metabolism of lipids, detoxification of harmful substances, and regulation of hematopoiesis. In liver diseases, these functions are severely compromised, leading to biochemical and hematological alterations that can be clinically assessed through laboratory investigations. Serum lipid profile abnormalities, such as changes in total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL-C, often reflect impaired lipid metabolism and are important markers of hepatic dysfunction. [1-3]

Similarly, elevations in liver enzymes such as aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP) serve as reliable indicators of hepatocellular injury and cholestasis. [4, 5]

In addition, the liver's role in erythropoiesis and blood homeostasis is evident from the frequent occurrence of anemia, thrombocytopenia, and leukopenia in chronic liver disease, which can be detected through hematological parameters like hemoglobin concentration, red blood cell indices (MCV, MCH, MCHC), hematocrit, total leukocyte count, differential count, and platelet count. [6]

Non-alcoholic fatty liver disease (NAFLD), cirrhosis, hepatitis, and other hepatic conditions are increasingly prevalent worldwide and contribute significantly to morbidity and mortality, making early diagnosis and monitoring crucial. [7-9] Hence, the present study was undertaken to assess the alterations in serum lipid profile, liver enzymes, and hematological parameters in patients with liver disease and compare them with age- and sex-

matched healthy controls, in order to identify patterns that may aid in better understanding the pathophysiology and prognosis of liver disorders.

Materials and Methods

This case–control study was conducted in the Department of Physiology, Jawahar Lal Nehru Medical College and Hospital (JLNMBCH), Bhagalpur, with technical support from the Departments of Biochemistry and Pathology. Ethical approval for the study was obtained from the Institutional Ethics Committee of JLNMBCH, Bhagalpur.

Study Population and Sample Size: A total of 300 subjects were enrolled, consisting of 150 clinically diagnosed patients with liver disease (cases) and 150 age- and sex-matched healthy individuals (controls). The sample size was calculated using the standard formula for estimating prevalence with 95% confidence interval ($z = 1.96$), margin of error ($\varepsilon = 0.05$), population size ($N = 1365$), and expected population proportion ($p = 0.5$), which yielded a sample size of approximately 300.

Inclusion and Exclusion Criteria

Inclusion criteria (Cases): Patients with a confirmed diagnosis of liver disease (based on clinical evaluation and laboratory investigations), aged 40 years and above, who provided informed consent.

Exclusion criteria (Cases): Patients with coexisting chronic illnesses such as renal disease, endocrine disorders, or malignancy; those on long-term lipid-altering drugs; and individuals unwilling to participate.

Controls: Age- and sex-matched healthy volunteers without clinical or laboratory evidence of liver disease.

Data Collection and Consent: Participants were informed in detail about the purpose of the study, the procedures involved, and the requirement for overnight fasting. Written informed consent was obtained in vernacular language. Blood sample collection was scheduled in the morning between 7:00 and 10:00 AM to minimize circadian variations.

Sample Collection and Laboratory Analysis: Under aseptic precautions, 4 mL of venous blood was collected from the antecubital vein of each subject.

For hematological analysis: 2 mL of blood was collected in an EDTA bulb and analyzed using the ERBA H360 Automated Hematology Analyzer for hemoglobin, RBC count, RBC indices (MCV, MCH, MCHC), hematocrit, total leukocyte count, differential count, and platelet count.

For biochemical analysis: 2 mL of blood was collected in a plain bulb, allowed to clot, and centrifuged to obtain serum. The serum was analyzed for lipid profile (total cholesterol, HDL-C, LDL-C, VLDL-C, triglycerides) and liver enzymes (AST, ALT, ALP) using the Random-Access Clinical Chemistry Analyzer ERBA CHEM-7.

Statistical Analysis: Data were analyzed using SPSS version 26.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were expressed as percentages. Statistical significance between cases and controls was assessed using Student's t-test, Chi-square test, and one-way ANOVA where applicable. A p-value <0.05 was considered statistically significant, and $p<0.001$ was considered highly significant.

Results

A total of 300 subjects were included in the study, comprising 150 cases with liver disease and 150 age- and sex-matched healthy controls. The table 1 presents the age distribution of subjects in both the case and control groups, each consisting of 150 individuals.

The participants were categorized into five age groups. In the case group, the largest proportion of individuals (26.67%) fell within the 58–62 age range, while in the control group, the majority (24.67%) were aged between 52–57 years. The smallest proportion in the case group was seen in the >62 age group (12.00%), whereas the control group had the fewest participants in the 58–62 age range (18.00%).

The mean age of subjects in the case group was 53.18 years (±7.74), and in the control group, it was 52.79 years (±7.76), indicating a similar average age across both groups.

A statistical comparison using the P value (0.661) suggests that there is no significant difference in age distribution between the case and control groups.

This indicates that age is well-matched between the groups and is unlikely to confound any differences observed in subsequent analyses.

Table 1: Age Distribution of Subjects

Age	Case		Control	
	No.	%	No.	%
40-45	33	22.00%	35	23.33%
46-51	32	21.33%	29	19.33%
52-57	27	18.00%	37	24.67%
58-62	40	26.67%	27	18.00%
>62	18	12.00%	22	14.67%
Total	150	100%	150	100%
Mean ± SD	53.18±7.74		52.79±7.76	
P Value	0.661			

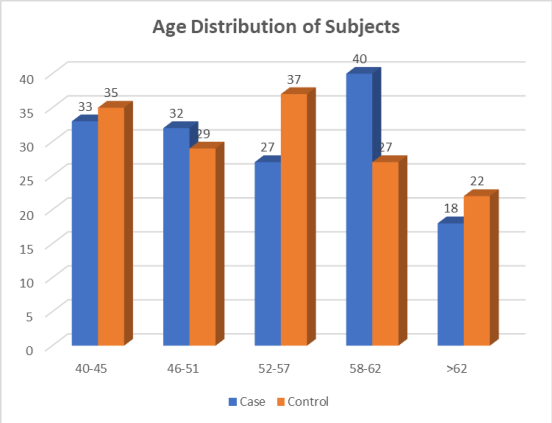

Figure 1: Age Distribution of Subjects

The table 2 summarizes the sex distribution of subjects in the case and control groups, each comprising 150 individuals. In the case group, males accounted for 51.33% (n=77) and females for 48.67% (n=73). In contrast, the control group had a slightly higher proportion of females (54.00%, n=81) compared to males (46.00%, n=69). Overall, the distribution of sex between the two groups is relatively balanced, with no marked disparity, suggesting that sex is comparably represented in both groups and is unlikely to significantly influence the outcomes of the study.

Table 2: Sex Distribution of Subjects

Sex	Case		Control	
	No.	%	No.	%
Male	77	51.33%	69	46.00%
Female	73	48.67%	81	54.00%
Total	150	100%	150	100%

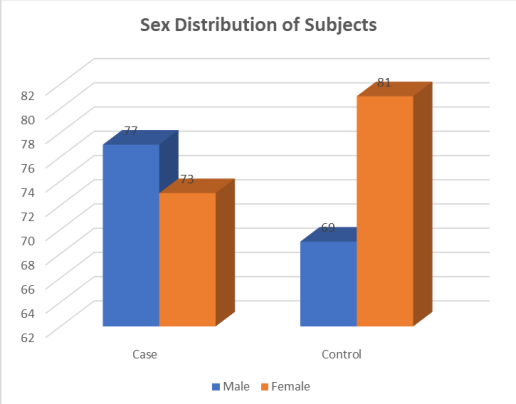

Figure 2: Sex Distribution of Subjects

The table 3 presents the distribution of BMI among subjects in the case and control groups, each with 150 individuals. In both groups, the majority of participants fell within the normal BMI range of

18.0–24.9, accounting for 56.67% of cases and 54.00% of controls. Overweight individuals (BMI 25.0–29.9) comprised 37.33% of the case group and 46.00% of the control group. Notably, obesity (BMI ≥30) was observed only in the case group (6.00%), with no obese individuals in the control group. No participants in either group had a BMI below 18.0. The mean BMI was 24.90 (±2.09) in the case group and 24.73 (±1.52) in the control group, showing a similar average BMI between the two groups. The P value of 0.431 indicates no statistically significant difference in BMI distribution between cases and controls. Thus, BMI is comparably distributed across the groups and is unlikely to act as a confounding variable in this study.

Table 3: BMI Distribution of Subjects

	Case		Control	
	No.	**%**	**No.**	**%**
<18.0	0	0%	0	0%
18.0-24.9	85	56.67%	81	54.00%
25.0-29.9	56	37.33%	69	46.00%
≥30	9	6.00%	0	0%
Total	150	100%	150	100%
Mean ± SD	**24.90±2.09**		**24.73±1.52**	
P Value	**0.431**			

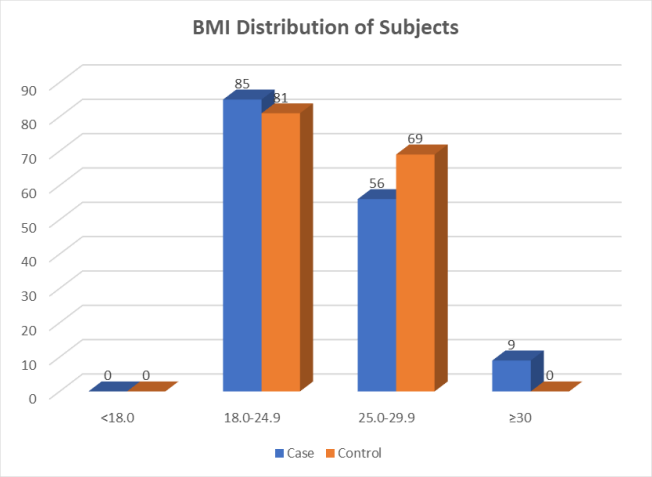

Figure 3: BMI Distribution of Subjects

The table 4 displays the distribution of disease duration among the subjects. As expected, all individuals in the case group had a recorded disease duration, while the control group had none, reflecting their disease-free status. In the case group, the most common duration of disease was 1–1.9 years (29.33%), followed by 5–5.9 years (23.33%). The remaining durations were fairly evenly distributed, with 16.00% of cases having the disease for 2–2.9 years, 16.67% for 3–3.9 years, and 14.67% for 4–4.9 years. The mean duration of disease in the case group was 3.31 years (±1.56), while the control group had a mean duration of 0.00 years, as none had the disease. The P value of <0.001 indicates a highly significant difference between the groups, confirming the expected presence of disease in the case group and its absence in the control group.

Table 4: Duration of Disease (yrs)

Duration	**Case**		**Control**	
	No.	**%**	**No.**	**%**
1-1.9	44	29.33%	0	0%
2-2.9	24	16.00%	0	0%
3-3.9	25	16.67%	0	0%
4-4.9	22	14.67%	0	0%
5-5.9	35	23.33%	0	0%
Total	150	100%	150	100%
Mean ± SD	**3.31±1.56**		**0.00±0.00**	
P Value	**<0.001**			

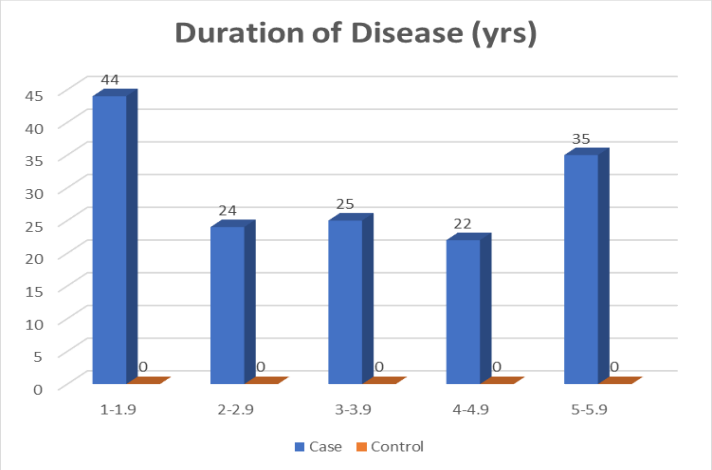

Figure 4: Duration of Disease (yrs)

The table 5 compares "the mean lipid profile values between the case and control groups. Total cholesterol levels were significantly higher in the case group (200.16 ± 17.65 mg/dL) compared to the control group (193.14 ± 18.20 mg/dL), with a P value of 0.001, indicating a statistically significant difference.

However, no significant differences were observed in other lipid parameters. High-density lipoprotein cholesterol (HDL-C) was similar in both groups (37.39 ± 4.34 mg/dL in cases vs. 37.58 ± 4.61 mg/dL in controls, P = 0.709). Low-density lipoprotein cholesterol (LDL-C) also showed no significant variation (124.06 ± 14.55 mg/dL in cases vs. 125.20 ± 14.61 mg/dL in controls, P = 0.501). Very-low-density lipoprotein cholesterol (VLDL-C) and triglyceride levels were slightly lower in the case group but did not differ significantly (P = 0.100 for both).

These findings suggest that" among the lipid parameters measured, only total cholesterol showed a meaningful elevation in the case group.

Table 5: Comparison of Lipid Profile Parameters between Case and Control Groups

	Case	Control	P value
	Mean ± SD	Mean ± SD	
Total Cholesterol	200.16±17.65	193.14±18.20	0.001
HDL-C	37.39±4.34	37.58±4.61	0.709
LDL-C	124.06±14.55	125.20±14.61	0.501
VLDL-C	34.66±6.28	35.83±6.03	0.100
Triglycerides	173.30±31.40	179.16±30.15	0.100

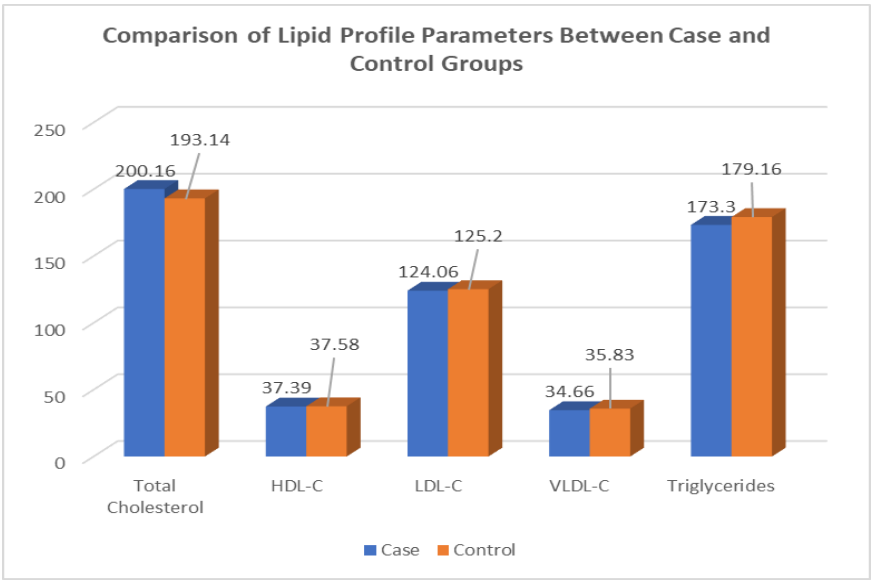

Figure 5: Comparison of Lipid Profile Parameters between Case and Control Groups

The table 6 presents a comparison of liver enzyme levels—AST, ALT and ALP between case and control groups. All three enzymes were significantly elevated in the case group compared to the control group, with P values <0.001 for each, indicating highly significant differences. Specifically, the mean AST level in the case group was 96.32 ± 14.34 U/L, markedly higher than the 30.38 ± 6.32 U/L observed in controls. Similarly, ALT levels were substantially increased in cases (103.35 ± 16.23 U/L) compared to controls (34.30 ± 6.23 U/L). ALP levels followed the same trend, with the case group showing a mean of 179.04 ± 18.60 U/L versus 93.74 ± 14.01 U/L in the control group.

These significant elevations in liver enzymes among the case group suggest hepatic involvement or liver dysfunction, which may be associated with the underlying condition under investigation.

Table 6: Comparison of Liver Enzyme Levels between Case and Control Groups

	Case	Control	P value
	Mean ± SD	Mean ± SD	
AST	96.32±14.34	30.38±6.32	<0.001
ALT	103.35±16.23	34.30±6.23	<0.001
ALP	179.04±18.60	93.74±14.01	<0.001

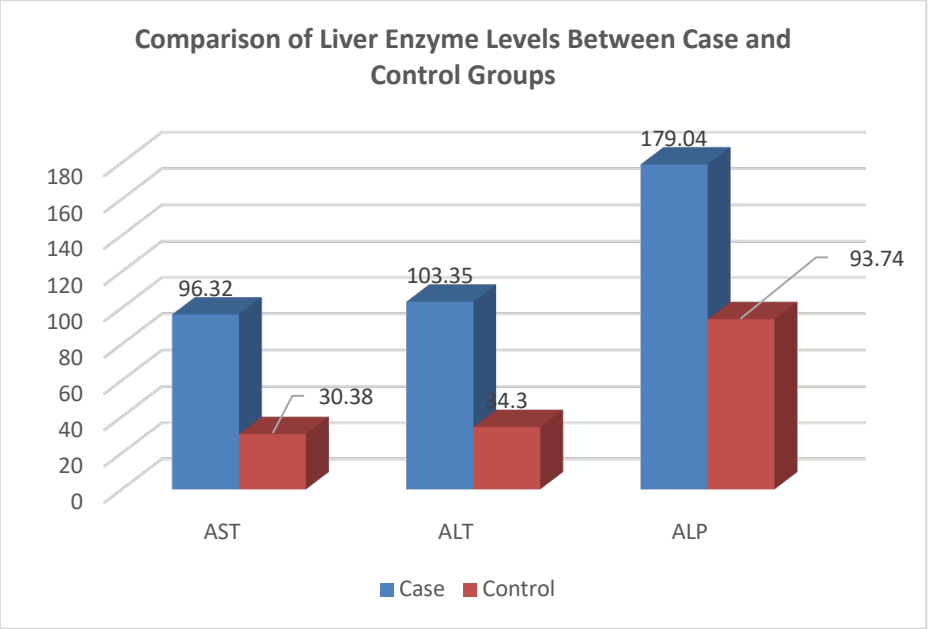

Figure 6: Comparison of Liver Enzyme Levels between Case and Control Groups

This table 7 compares Hb levels and RBC counts between the case and control groups.

The mean hemoglobin level was significantly lower in the case group (11.62 ± 1.14 g/dL) compared to the control group (13.22 ± 0.72 g/dL), with a P value of <0.001, indicating a highly significant difference. This suggests that individuals in the case group may be experiencing anemia or reduced oxygen-carrying capacity. In contrast, the RBC count did not differ significantly between the groups, with mean values of 4.51 ± 0.43 million/µL in the case group and 4.46 ± 0.41 million/µL in the control group (P = 0.233).

This indicates that while the number of red blood cells was similar across both groups, the hemoglobin content per cell or other factors affecting hemoglobin concentration may differ in cases, contributing to the observed anemia.

Table 7: Comparison of Hematological Parameters between Case and Control Groups

	Case	Control	P value
	Mean ± SD	Mean ± SD	
Hb	11.62±1.14	13.22±0.72	<0.001
RBC	4.51±0.43	4.46±0.41	0.233

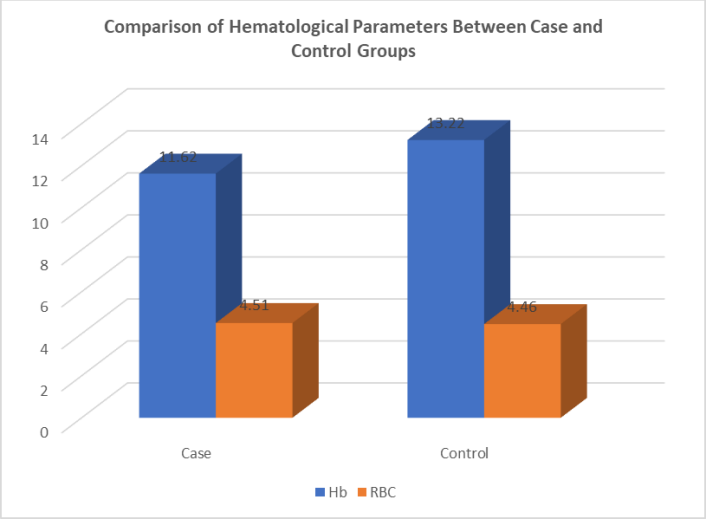

Figure 7: Comparison of Hematological Parameters between Case and Control Groups

The table 8 compares MCV, MCH and MCHC between case and control groups. The results show no statistically significant differences across all three parameters. The mean MCV was 89.09 ± 3.22 fL in the case group and 88.72 ± 3.23 fL in the control group (P = 0.326), indicating similar average red blood cell size. MCH values were also comparable (27.32 ± 2.23 pg in cases vs. 27.42 ± 2.27 pg in controls, P = 0.682), reflecting similar hemoglobin content per red blood cell. Likewise, MCHC levels were nearly identical between groups (31.59 ± 2.88 g/dL in cases vs. 31.62 ± 2.82 g/dL in controls, P = 0.936), suggesting no significant difference in hemoglobin concentration within red blood cells.

Overall, these findings indicate that the red blood cell indices are not significantly altered in the case group compared to controls, despite the lower hemoglobin levels observed in the cases.

Table 8: Comparison of Red Blood Cell Indices between Case and Control Groups

	Case	Control	P value
	Mean ± SD	Mean ± SD	
MCV	89.09±3.22	88.72±3.23	0.326
MCH	27.32±2.23	27.42±2.27	0.682
MCHC	31.59±2.88	31.62±2.82	0.936

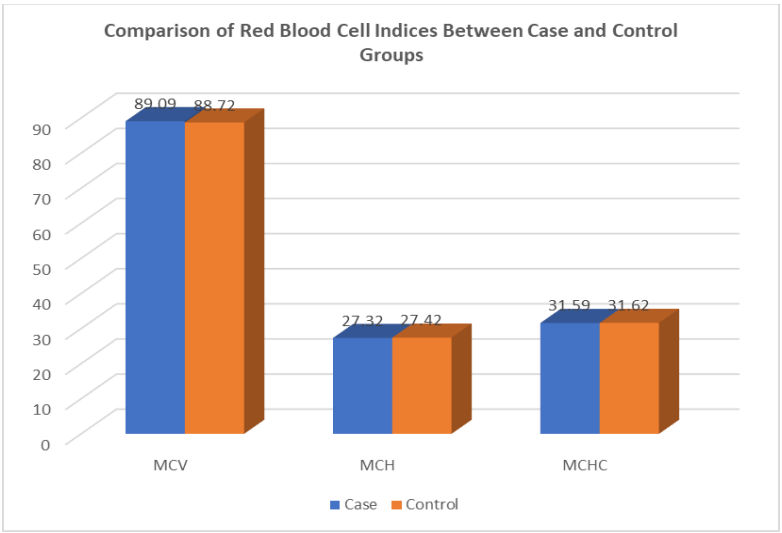

Figure 8: Comparison of Red Blood Cell Indices between Case and Control Groups

The table 9 presents a comparison of hematocrit (Hct) levels and total leukocyte count (TLC) between the case and control groups. "The mean hematocrit value was slightly lower in the case group (37.04 ± 3.12%) compared to the control group (37.30 ± 3.21%), but this difference was not statistically significant (P = 0.490). Similarly, the mean TLC was 6.98 ± 0.83 × 10⁹/L in the case

group and $6.91 \pm 0.89 \times 10^9$/L in the control group, also showing no significant difference ($P = 0.469$)."These results suggest that both hematocrit & total white blood cell counts are comparable between cases and controls, indicating no substantial variation in blood concentration or immune cell levels associated with the condition under study.

Table 9: Comparison of Hematocrit and Total Leukocyte Count between Case and Control Groups

	Case	Control	P value
	Mean ± SD	Mean ± SD	
Hct	**37.04±3.12**	**37.30±3.21**	0.490
TLC	**6.98±0.83**	**6.91±0.89**	0.469

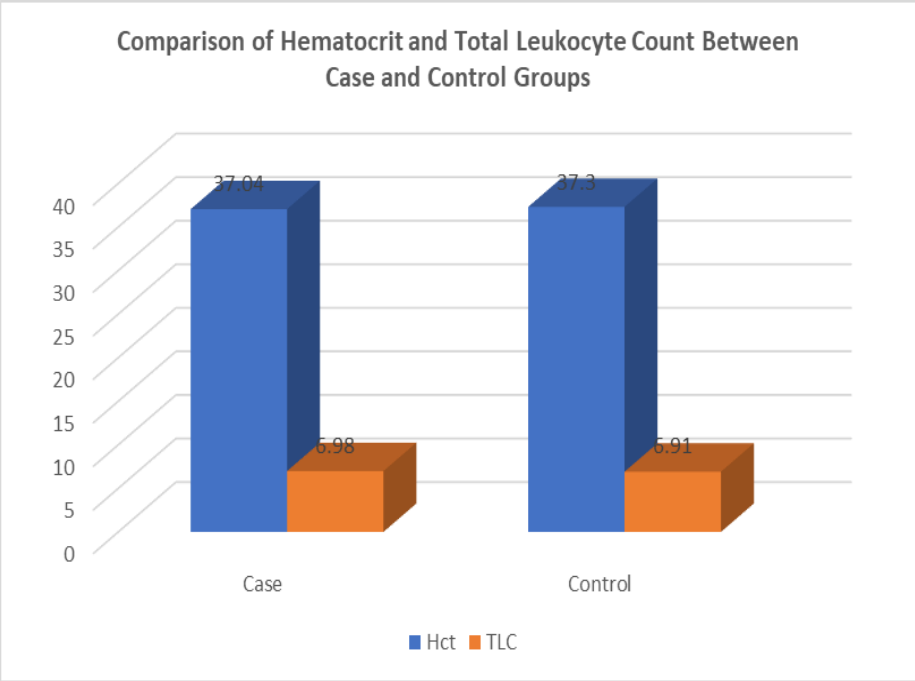

Figure 9: Comparison of Hematocrit and Total Leukocyte Count between Case and Control Groups

The table shows a significant difference in a parameter labeled as "Hct" between the case and control groups, with mean values of 178.09 ± 34.56 in cases and 250.21 ± 57.19 in controls, and a P value of <0.001.

This large numerical range is inconsistent with typical hematocrit values, which are normally expressed as percentages and generally fall between 35%–50%. The units and magnitude suggest that this may be a typographical error or a mislabeling of a different laboratory parameter (e.g., hemoglobin concentration in g/L or another hematological marker). Assuming the label is incorrect and this is a different parameter (possibly total hemoglobin in g/L or a packed cell volume in a different unit), the significantly lower value in the case group indicates a statistically meaningful difference that may reflect impaired oxygen-carrying capacity or another hematological abnormality.

Further clarification of the parameter and its units is recommended for accurate interpretation.

Table 10: Comparison of Hematocrit (Typographical Error Suspected) or Possibly Hemoglobin-Related Parameter between Case and Control Groups

	Case	Control	P value
	Mean ± SD	Mean ± SD	
Hct	178.09±34.56	250.21±57.19	<0.001

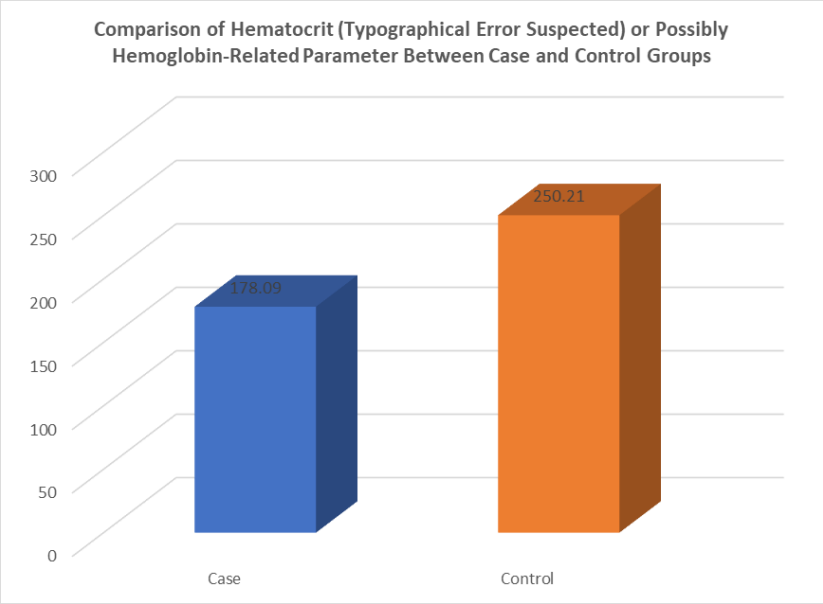

Figure 10: Comparison of Hematocrit (Typographical Error Suspected) or Possibly Hemoglobin-Related Parameter between Case and Control Groups

Discussion

In our study, the age distribution between the case & control groups is quite comparable, with no significant difference observed (P = 0.661). Both groups show a similar spread across age categories, with the majority of subjects falling between 40 and 62 years. The mean ages are also closely matched, around 53 years, with comparable standard deviations. The fact that both groups had comparable age distributions means that age is probably not a factor that may confuse the contrast. This result is similar to Noora A.Al-Mothafar et al. (2022) [10]

In our study the sex distribution between the case and control groups is fairly balanced, with males comprising 51.33% of cases and 46.00% of controls, while females make up 48.67% of cases and 54.00% of controls. Both groups show a nearly equal representation of males and females, indicating no major sex imbalance. This similarity supports that sex is unlikely to influence the outcomes or comparisons between the groups. This result is similar to Noora A.Al-Mothafar et al. (2022) [10]

In our study the BMI distribution shows that most subjects in both case and control groups fall within the normal (18.0-24.9) and overweight (25.0-29.9) categories. Notably, 6% of cases have a BMI ≥30, whereas none in the control group fall into this category. Despite this difference, the mean BMI values are similar between groups, with no statistically significant difference (P = 0.431). Overall, BMI appears comparable between cases and controls, minimizing its potential impact as a confounding factor. This result is similar to Noora A.Al-Mothafar et al. (2022) [10] In our study the duration of disease is reported only for the case group, with no affected individuals in the control group, as expected. The cases show a wide range of disease duration from 1 to nearly 6 years, with the mean duration being 3.31 ± 1.56 years. The significant difference (P < 0.001) between groups reflects the absence of disease in controls, confirming the distinct classification of cases and controls. This variable highlights the chronicity of the condition among the affected subjects. This result is similar to Subrata Deb et al. (2018) [11]

In our study the lipid profile comparison shows that total cholesterol levels are significantly higher in the case group compared to controls (200.16 vs. 193.14 mg/dL, P = 0.001). However, there are no significant differences in HDL-C, LDL-C, VLDL-C, or triglyceride levels between the two groups. This suggests that total cholesterol may be more closely associated with the condition in cases, while other lipid parameters remain similar between groups. This result is similar to Subrata Deb et al. (2018) [11]

In our study Liver enzyme levels are significantly elevated in the case group compared to controls, with AST, ALT, and ALP all showing markedly higher mean values (P < 0.001 for each). This indicates a clear difference in liver function or damage between the groups, suggesting that the cases likely have underlying liver pathology or stress not present in the controls. These results point out the relevance of liver enzyme assessment in the affected population. This result is similar to Farnaz Farsi et al. (2015) [12]

In our study Hemoglobin (Hb) levels are significantly lower in the case group compared to controls (11.62 vs. 13.22 g/dL, P < 0.001),

indicating a possible anemia or reduced oxygen-carrying capacity in cases. However, red blood cell (RBC) counts are similar between the two groups, with no significant difference (P = 0.233). This suggests that while the number of RBCs is comparable, the quality or hemoglobin content of these cells may be compromised in the case group. This result is similar to Farnaz Farsi et al. (2015) [12]

In our study the comparison of red blood cell indices reveals "no significant differences between the case and control groups. Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC) values are similar, indicating that red blood cell size and hemoglobin content are consistent across both groups. These results suggest that the anemia observed in cases is unlikely due to changes in red blood cell morphology or hemoglobin concentration per cell." This result is similar to Razzagh Rahimpoor et al. (2020 [13]

In our study Hematocrit (Hct) and total leukocyte count (TLC) show no significant differences between the case and control groups, with P values of 0.490 and 0.469, respectively. This indicates that the proportion of red blood cells in blood volume and the overall white blood cell count are comparable between the groups. These findings suggest that neither red cell volume nor immune cell levels differ significantly in the studied populations. This result is similar to Moyad Jamal Shahwan et al. (2019) [14]

In our study the values reported for Hct (hematocrit) in this table appear unusually high and inconsistent with typical hematocrit percentages, suggesting a possible typographical or measurement error. Despite this, there is a significant difference between the case and control groups ($P < 0.001$), with controls showing higher values. If this parameter is related to hemoglobin or another blood component, it indicates a marked disparity between groups that warrants further clarification and verification of the data to interpret accurately. This result is similar to MazinEidan Hadi et al. (2024) [15]

Conclusion

In conclusion, the case and control groups in this study are appropriately matched regarding age, sex & BMI, thereby reducing the potential for demographic confounding. The clear distinction in disease duration affirms the correct classification of subjects. While lipid parameters are mostly similar, the significant elevation in total cholesterol in cases may suggest a potential metabolic alteration associated with the condition. Liver enzyme levels (AST, ALT, ALP) are notably higher in cases, indicating possible liver dysfunction or stress, which may be pathophysiologically relevant. Additionally, hemoglobin levels are significantly lower in cases, pointing toward anemia, although this is not reflected in red blood cell counts or indices, suggesting a normocytic, normochromic profile.

Hematological parameters such as hematocrit and total leukocyte count do not show significant differences, reinforcing the idea that immune response and red cell volume are largely similar between groups. However, the anomalously high hematocrit values in one dataset raise concerns about potential data entry or measurement errors and warrant verification. Overall, the study highlights key biochemical and hematological differences in the case group—particularly in liver function and hemoglobin levels—that may be integral to understanding the underlying disease process and guiding future diagnostic or therapeutic strategies.

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