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Original Reserach Article

Comparing the Physiological Effects of Anemia in Individuals of Both Sexes on Liver and Kidney Function and Lipid Levels in Salah Al-Din Governorate

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Abstract: Anemia is a physiological condition characterized by a decrease in hemoglobin levels or packed cell volume below normal. This study aimed to evaluate and compare the physiological impact of anemia on liver and kidney function and serum lipid levels in Salah al-Din Governorate, comparing the effects on both sexes. The study included 120 participants with anemia of both sexes. Packed cell volume (PCV), liver enzyme activity (ALT and AST), kidney function (urea and creatinine), and lipid profile levels (TC, TG, VLDL-c, HDL-c) were measured. The results showed a significant decrease ($P \leq 0.05$) in PCV values among anemic individuals, along with a significantly higher urea and creatinine levels compared to healthy individuals, confirming impaired kidney function. No significant differences were found in liver enzyme levels (ALT and AST). The results also revealed a significant difference in lipid levels between the sexes. Males with anemia showed a significant decrease in TC, TG, and VLDL-c levels, while females with anemia showed a significant increase in these values compared to the control groups. The study concludes that anemia leads to significant kidney stress and changes in lipid profiles with sex-specific responses.

Keywords: Anemia, Kidney Function, Liver Enzymes, Lipid Levels.

INTRODUCTİON

Anemia is an ancient and modern disease listed in the World Health Organization (WHO) regulations (AL-Hassan *et al*., 2024). Physiologically, it is defined as a decrease in the level of hemoglobin or hematocrit below the baseline value for an individual (Tefferi, 2003). This condition is a widespread public health problem globally, resulting from multiple factors including malnutrition, parasitic infections, and deficiencies in micronutrients such as cobalamin and folic acid (Mikki *et al*., 2011; Sharourou *et al*., 2018; Teressa, 2019). The gender specificity of this disease is clearly evident; women of reproductive age are the most vulnerable group globally, with an incidence rate reaching 41% (Hussein *et al*., 2015). According to WHO criteria, anemia is defined as a hemoglobin level below 12 g/dL in women and 13 g/dL in men (Stein *et al*., 2016).

Physiologically, blood production depends on a delicate balance between vital organs. The liver is the main organ responsible for producing what are called "blood mixtures" and nourishing the body (Yarjou *et al*., 2014), while the kidneys play a crucial role as oxygen sensors to regulate the production of erythropoietin (EPO), which stimulates the bone marrow (Dowling, 2007; Yarjou *et al*., 2014). The severity of the disease is classified into three levels (mild, moderate, severe) based on hemoglobin levels (Al-Hashemiö & Ali, 2013).

This subclassification is strongly associated with renal damage; anemia is a major and independent risk factor for acute kidney failure, especially using the mechanism of tissue hypoxia, which is a common mechanism of kidney tissue injury (Iseki & Kohagura, 2007; (Mehdi & Toto, 2009; Al-Lami *et al*., 2011; Hu *et al*., 2013). Serum creatinine levels higher than 2 mg/dL are one of the best clinical correlation with decreased

EPO production causing aggravation of anemia (Al-Lami *et al*., 2011).

In contrast, significant hematological abnormalities are common in chronic liver diseases and cntributed to 50% to 87% of these patients with anemia (Ibrahim & Ibraheem, 2023). Anemia is a common cause of liver function tests that show increases in bilirubin and AST, while ALT more specifically indicates hepatocyte damage (Al-Hashemiö & Ali, 2013; Murakami & Shimizu, 2013). An important concern is that chronic anemia or defective iron metabolism can cause secondary increase in cellular iron stores, resulting in cirrhosis over time and careful monitoring of liver function (Hilgard & Gerken, 2005). The lipid profile is not yet fully understood, but severe anemia is associated with a reduction in cholesterol and triglyceride levels according to the concentration of hemoglobin (Choi *et al*., 2001). Anemia, too, have been associated with higher risks of cardiovascular disease and left ventricular hypertrophy (Iseki & Kohagura, 2007; Mehdi & Toto, 2009; Portolés *et al*., 2021). Thus, the study of physiological differences between both sexes is crucial for understanding these complex interactions in Salah al-Din Governorate.

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MATERIALS AND METHODS

The methodology was an experimental comparative type study in Salah al-Din Governorate to assess the physiologic effect of anemia. A research sample consisting of 120 individuals was given and then divided into four groups after matched controls: Healthy males as control group (n = 30, mean age = 44 females as a control group (n = 30 mean age=43; anemic males (n =64); and anemic females (n=60). This classification guaranteed the accuracy of outcomes according to similar local studies methodologies (Ghareeb & Al-Maliki, 2022; AL-Hassan *et al*., 2024). Blood samples were obtained from all subjects using a standard sterile technique. Blood was collected by venipuncture and samples were placed in tubes with EDTA before estimating PCV levels using microcentrifugation. We collected the remainder in dry chemical tubes to obtain serum following centrifugation, which is an internationally and locally adopted method used for precise biochemical analysis of enzymatic activity (Al-Khayat *et al*., 2016; Ghareeb & Al-Maliki, 2022). Laboratory assessments comprised tests of liver enzyme activity such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST) measured using kits and standard colorimetric testing (Ghareeb & Al-Maliki, 2022). Researchers further measured serum urea and creatinine concentrations which are sensitive biomarkers of the effects of anemia to assess renal function (Al-Khayat *et al*., 2016). Similarly, the lipid profile was analyzed by estimating total cholesterol (TC), triglycerides (TG), and high-density lipoprotein (HDL-c) in vitro, while low-density lipoprotein (LDL-c) and very-low-density lipoprotein (VLDL-c) values were calculated mathematically using standard equations used in studies (Choi *et al.,* 2001; AL-Hassan *et al*., 2024). As a final step, all extracted data were subjected to statistical analysis using SPSS software, where the results were expressed in the form of arithmetic mean ± standard error, and the analysis of variance test was used to determine the significant differences between groups at a probability level of ($P \leq 0.05$) Ghareeb & Al-Maliki, 2022; (AL-Hassan *et al*., 2024).

RESULTS

After completing the blood draw and performing the necessary laboratory analyses, the results were extracted. Table (1) shows that individuals with anemia exhibited a significant increase ($P \leq 0.05$) in urea and creatinine levels and a significant decrease in permeable volume (PCV). No significant differences were observed in liver enzymes compared to healthy individuals.

Table 1: Serum Urea, Creatinine, and Liver Enzymes

Standards Group	ALT(mIU/ml)	AST(mIU/ml)	PCV %	Urea(mg/dl)	Creatinine(mg/dl)
Healthy males	12 ± 2a	16 ± 3b	41 ± 3a	13.2 ± 1.3b	1.3 ± 0.1c
Healthy females	16 ± 2a	25 ± 1a	41 ± 2a	19.5 ± 2b	1.2 ± 0.3c
Injured males	17 ± 3a	15 ± 4b	27.4 ± 2b	169 ± 8a	6.5 ± 0.2a
Injured females	14 ± 2a	22 ± 2a	27.2 ± 1.5b	180 ± 6a	5.6 ± 0.3b

– The values represent the arithmetic mean ± standard error.

– Vertically different letters indicate a statistically significant difference at a significance level of ($P \leq 0.05$).

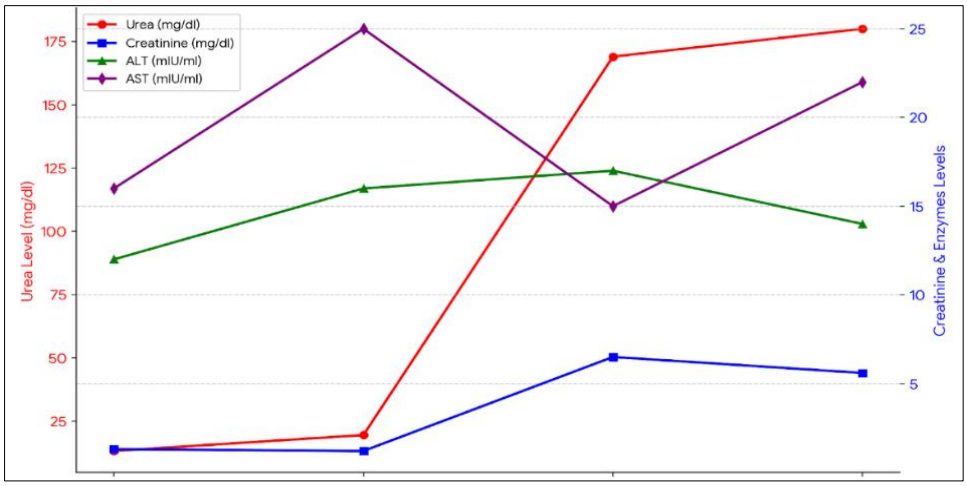

Figure 1: Linear representation of urea, creatinine and liver enzyme levels in blood serum

Regarding lipid levels, Table (2) shows a significant decrease ($P \leq 0.05$) in the concentration of cholesterol, triglycerides, and very low-density lipoproteins (VLDL-C) in males with anemia, while females showed a significant increase compared to healthy individuals. No significant differences were observed in the concentration of cholesterol-lowering lipoproteins (HDL-C) and HDL-C in anemic individuals compared to healthy individuals.

Table 2: Lipid Concentrations in Blood Serum

Standards Group	Cholesterol mg/(100ml)	Triglyceride mg/(100ml)	HDL-c mg/(100ml)	LDL-c	Cholesterol mg/(100ml)
Healthy males	140 ± 9b	150 ± 13a	47 ± 4a	63 ± 3b	30 ± 2b
Healthy females	150 ± 12b	130 ± 7b	39 ± 5a	85 ± 4a	26 ± 2b
Injured males	110 ± 8c	85 ± 6c	36 ± 3a	57 ± 4b	17 ± 3c
Injured females	184 ± 7a	155 ± 9a	38 ± 5a	95 ± 6a	51 ± 5a

– The values represent the arithmetic mean ± standard error.

– Vertically different letters indicate a statistically significant difference at a significance level of ($P \leq 0.05$).

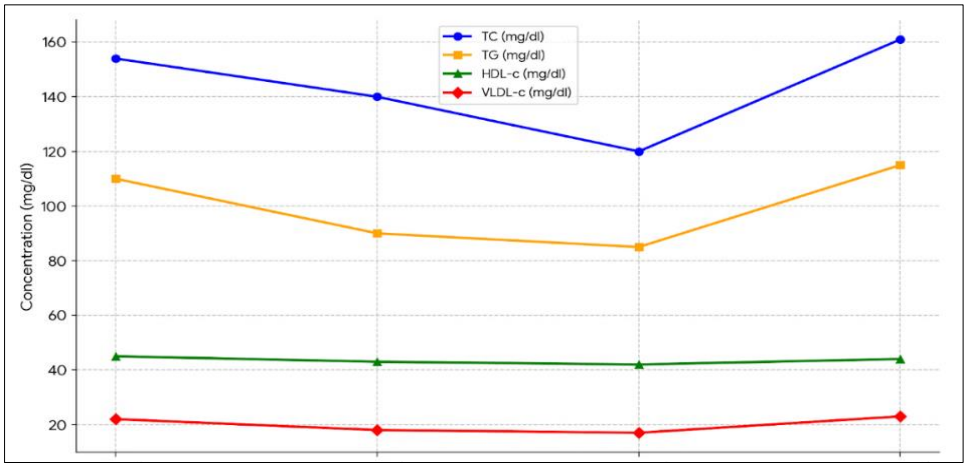

Figure 2: Shows the concentration of fats in blood serum

DISCUSSION

The results of the current study show a clear impact on the physiological and biochemical functions of a group of vital organs as a result of anemia. This significant decrease in packed cell volume (PCV) is attributed to a deficiency in hemoglobin content or a defect in the process of red blood cell formation, which is consistent with the locally and internationally accepted diagnostic criteria for anemia (Ghareeb & Al-Maliki, 2022; AL-Hassan *et al*., 2024).

Regarding kidney function, the significant increase in urea and creatinine levels in patients with anemia reflects a state of renal stress resulting from tissue hypoxia. Anemia leads to a decrease in oxygen flow to the kidneys, which stimulates a decline in the glomerular filtration rate. This is entirely consistent with the findings of the Karbala study (Al-Khayat *et al*., 2016) and other studies (Hu *et al*., 2013), which indicated a close correlation between low hemoglobin and impaired kidney function.

As for the liver enzymes (ALT, AST), the results showed no significant differences compared to the control groups, indicating that the severity of anemia in the study sample did not cause acute tissue damage to the liver cells. This result differs from what was recorded in the Basra study (Ghareeb & Al-Maliki, 2022), which noted an increase in these enzymes. This difference may be attributed to the type of anemia (such as sickle cell anemia) which is accompanied by hemolysis that leads to direct liver stress, which does not appear in cases of simple anemia caused by malnutrition.

Regarding lipid levels, the significant decrease in cholesterol, triglyceride, and VLDL-C levels in males with the condition is consistent with the results of the Mosul study (AL-Hassan et al., 2024) and the Korean study(Choi *et al*., 2001). These studies linked this decrease to increased cholesterol consumption by body tissues or decreased production in the liver due to iron deficiency.

However, the behavior of these lipids differed in females in the current study, registering a significant increase. This discrepancy may be attributed to gender-specific hormonal factors or differences in dietary patterns in Salah al-Din Governorate. This supports the argument presented in some sources regarding the inconsistency of lipid results and their relationship to iron deficiency in human studies compared to laboratory experiments (Choi *et al*., 2001).

CONCLUSIONS

We conclude from the current study that anemia has a broad physiological impact that extends beyond mere hematological abnormalities to include the efficiency of vital organs. The results demonstrated a direct correlation between a significant decrease in packed cell volume (PCV) and a significant, sharp increase ($p \leq 0.05$) in renal function tests (urea and creatinine). It is confirmed that hypoxia itself is a direct damage of renal tissue. On the other hand, liver enzymes (alanine aminotransferase (ALT) and aspartate aminotransferase (AST)) were not significantly affected suggesting that the liver displays temporary, adaptive flexibility within a certain disease period.

The study further detected a considerable gender difference ($P \leq 0.05$) in TC, TG, and VLDL-c levels based on lipid profile response; these lipids decreased in the serum of affective males but increased in affected females.

In light of these findings, this study recommends that renal function tests be included as a staple in the follow-up protocol for patients with anemia to protect from the silent deterioration of renal function. It further recommends strengthening health education programs on specific nutrition to improve iron metabolism and adding future research focusing molecular mechanisms of gender-differences in lipid levels for diagnosis accuracy and personalized therapeutic options for each sex.

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