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Assessment of hematological and metabolic marker in relation to NAFLD severity: A gender-based study at Al- Wahda hospital-Derna

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Abstract:
This study aimed to compare various biochemical and hematological parameters between non-alcoholic fatty liver disease (NAFLD) positive and negative individuals, stratified by gender. A significant increase in liver enzymes (AST, ALT), LDL, triglycerides (TG), and ferritin levels was observed in both male and female NAFLD-positive subjects compared to their negative counterparts ($p<0.05$). conversely, HDL levels were significantly lower in the NAFLD-positive group. Hematological parameters such as hemoglobin (Hb) and mean corpuscular hemoglobin (MCH) showed slight but non-significant variations between groups. White blood cell (WBC) counts were elevated in NAFLD-positive males. Additionally, BMI and HbA1c percentages were significantly higher in NAFLD-positive individuals, suggesting a correlation between metabolic syndrome and fatty liver disease. These findings highlight key biomarkers associated with NAFLD and emphasize the importance of early screening and lifestyle interventions.
In conclusion, the study demonstrates that individuals with non-alcoholic fatty liver disease, particularly males, exhibit significant alterations in liver enzymes, lipid profile and metabolic indicators such as BMI and HbA1c. these findings highlight the importance of early detection using non-invasive tools like CT imaging and routine blood test and emphasize the need for gender-specific approaches in the management and prevention of non-alcoholic fatty liver disease.

Keywords: NAFLD, liver Enzymes, Gender Differences, Biochemical Markers, Hematological Parameters, CT scan, BMI, HbA1c, Metabolic Syndrome.

تقييم المؤشرات الدموية والبيوكيميائية لدى مرضى الكبد الدهني غير الكحولي في مستشفى الوحدة- درنة

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الملخص
هدفت هذه الدراسة إلى مقارنة مجموعة من المؤشرات البيوكيميائية والدموية بين الأفراد المصابين بمرض الكبد الدهني غير الكحولي والأفراد غير المصابين، مع التمييز بين الذكور والإناث. أظهرت النتائج ارتفاعًا معنويًا في إنزيمات الكبد (ALT وAST) ، ومستويات الكوليسترول الضار (LDL)، والدهون الثلاثية (TG)، بالإضافة إلى الفيريتين لدى المصابين من كلا الجنسين مقارنة بالمجموعة الضابطة ($p < 0.05$) . وعلى العكس من ذلك، لوحظ انخفاض معنوي في مستويات الكوليسترول الجيد (HDL) في مجموعة المرضى. بالنسبة للمؤشرات الدموية، لم تُسجَّل فروقات معنوية في مستويات الهيموغلوبين (Hb) ومتوسط كتلة الهيموغلوبين (MCH) بين المجموعتين، بينما سجل الذكور المصابون ارتفاعًا معنويًا في عدد كريات الدم البيضاء (WBC). علاوة على ذلك، كانت مؤشرات كتلة الجسم (BMI)ومستوى الهيموغلوبين السكري التراكمي (HbA1c) أعلى بشكل معنوي لدى المصابين، مما يعكس ارتباطًا واضحًا بين متلازمة التمثيل الغذائي ومرض الكبد الدهني.

تشير هذه النتائج إلى أهمية بعض المؤشرات الحيوية كعوامل مساعدة في تشخيص مرض الكبد الدهني غير الكحولي، مما يسلط الضوء على ضرورة الفحص المبكر وتبني التدخلات الوقائية في نمط الحياة، في الختام، تؤكد الدراسة أن الأفراد المصابين بهذا المرض، ولا سيما الذكور، يعانون من تغيرات واضحة في إنزيمات الكبد، ملف الدهون، ومؤشرات التمثيل الغذائي مثل مؤشر كتلة الجسم (BMI) والهيموغلوبين السكري التراكمي (HbA1c) وتبرز أهمية الكشف المبكر باستخدام وسائل تشخيص غير جراحية كالتصوير المقطعي (CT) إلى جانب التحاليل الدموية الروتينية، مع التأكيد على ضرورة اعتماد استراتيجيات علاجية ووقائية تراعي الفروق بين الجنسين.

الكلمات المفتاحية: مرض الكبد الدهني غير الكحولي، إنزيمات الكبد، الفروقات بين الجنسين، المؤشرات البيوكيميائية، المعايير الدموية، التصوير المقطعي، مؤشر كتلة الجسم، الهيموغلوبين السكري التراكمي، متلازمة التمثيل الغذائي.

Introduction

Non-alcoholic fatty liver disease (NAFLD) affects nearly one-quarter of the global population and is increasingly recognized as a major contributor to cirrhosis and hepatocellular carcinoma. This condition encompasses a range of liver abnormalities, starting from simple hepatic fat accumulation (steatosis), with or without mild inflammation, to the more severe form known as non-alcoholic steatohepatitis (NASH), which involves necroinflammation and tends to progress rapidly to fibrosis. NAFLD is closely linked to components of metabolic syndrome, particularly type 2 diabetes, which significantly heightens the risk of liver cirrhosis and its complications. While cardiovascular disease and cancers outside the liver are the leading causes of death in NAFLD patients, the presence of advanced liver fibrosis is a key predictor of both liver-related outcomes and overall survival. Fortunately, fibrosis can now be assessed through several non-invasive diagnostic methods. In patients who progress to cirrhosis, ongoing surveillance for hepatocellular carcinoma and esophageal varices is essential (1).

The accumulation of fat in the liver is a multifactorial process driven by several interconnected physiological disturbances. These include an increased influx of free fatty acids (FFAs) into the liver, enhanced hepatic lipogenesis, reduced mitochondrial β-oxidation of FFAs, and diminished production or export of very-low-density lipoproteins (VLDL) (2,3). Moreover, oxidative stress within hepatocytes can exacerbate hepatic fat accumulation by activating stellate cells, which leads to extracellular matrix deposition and initiates inflammatory cascades. In addition to metabolic dysregulation, other contributing factors to hepatic steatosis include pharmacological agents such as tamoxifen, amiodarone, and methotrexate; inborn errors of metabolism, such as glycogen storage disorders and homocystinuria; as well as dietary and nutritional imbalances, including prolonged parenteral nutrition, undernutrition, overfeeding, and extended fasting periods. Furthermore, liver fat accumulation may be associated with specific systemic conditions, such as Wilson's disease and celiac disease (4).

Aim Of the Work

- To assess hematological and biochemical markers in patients diagnosed with non-alcoholic fatty liver.
- To analyze laboratory parameters such as HbA1c, serum ferritin, BMI and liver function test.
- To compare hematological and biochemical profile between male and female patients.
- To assess the relationship between these laboratories finding and the presence and severity of non-alcoholic fatty liver.
- To generate baseline data, monitoring and management of non-alcoholic fatty liver disease in the studied population.

Material and Methods

This cross-sectional analytical study was conducted at Al-Wahda Hospital, Derna, Libya, to compare biochemical and hematological parameters in individuals with and without non-alcoholic fatty liver disease (NAFLD), focusing on gender differences. A total of 160 participants were enrolled: 44 NAFLD-positive males, 56 NAFLD-positive females, 15 healthy males, and 25 healthy females. Diagnosis of NAFLD was confirmed by abdominal CT scans based on characteristic hypodense findings.

Demographic data (age, sex, BMI) were recorded, and informed consent was obtained. Fasting venous blood samples were collected and analyzed for: **Liver enzymes (AST, ALT), Lipid profile (LDL, HDL, triglycerides), Hematological parameters (WBC, RBC, Hb, MCH, MCV, platelets), Metabolic markers (fasting glucose, HbA1c, ferritin).**

All laboratory procedures followed standardized protocols with validated equipment. Statistical analysis was performed using Minitab and GraphPad Prism. Normality of data was verified, and one-way ANOVA was applied. A p-value < 0.05 was considered statistically significant (5).

Results

Liver enzymes and lipid profile

Significant differences were observed in liver enzyme levels (AST, ALT) between positive and negative individuals in both males and females. In males, AST and ALT levels were significantly elevated in positive

individuals (95.97± 5.1 U/L and 91.58± 2.7 U/L) compared to negatives (29.02±2.08 U/L and 35.38 U/L). A similar pattern was observed in females.
Lipid profile analysis revealed that LDL and triglyceride (TG) levels were significantly higher in positive individuals, while HDL levels were significantly lower. For example, TG levels in positive males reached (257±9.7 mg/dl) compared to (125±2.7 mg/dl) in negative males. Similar trends were seen in females.

Table 1. value of AST, ALT, LDL, HDL, TG parameters in positive and negative non-alcoholic fatty liver disease male and female subjects.

Parameters	Male		Female	
	Negative Mean± SEM	Positive Mean± SEM	Negative Mean± SEM	Positive Mean± SEM
AST (U/L)	29.02±2.08 ^{b}	95.97± 5.1 ^{a}	29.9± 1.06 ^{b}	96.9±5.8 ^{a}
ALT (U/L)	35.38± 1.5 ^{b}	91.58±2.7 ^{a}	33.4±1.06 ^{b}	94.8±3.3 ^{a}
LDL (mg/dl)	109± 4.8 ^{b}	156± 3.2 ^{a}	108±2.4 ^{b}	153±3.2 ^{a}
HDL (mg/dl)	54.7 ±2.9 ^{a}	40.8± 1.22 ^{b}	53.4±1.9 ^{a}	39.3±1.19 ^{b}
TG (mg/dl)	125± 2.7 ^{b}	257± 9.7 ^{a}	116.4± 4.3 ^{b}	262.7± 8.3 ^{a}

Data are expressed as mean ± SEM of each gender. Within each column for male or female separately, means with different superscript (a, b or c) were significantly different at $p<0.05$. Where means without superscripts mean that there is no significant difference ($p>0.05$).
body mass index (BMI) showed a slight increase in positive females (27.1 ± 0.3 Kg/m^2) compared to negative females (25 ± 0.1 Kg/m^2). In males, BMI remained relatively stable. Glycated hemoglobin (HbA1c) levels were significantly elevated in positive individuals in both sexes, suggesting impaired glycemic control. For instance, HbA1c in positive males was (7.7 ± 0.14 %) versus (5.3 ± 0.08 %) in negatives.
Among males, ferritin levels rose from (139.6 ± 12.4 ng/ml) in the negative group to (305.1 ± 11.7 ng/ml) in the positive group. Similarly, in females, the level rose from (151.2 ± 7.5 ng/ml) to (315.9 ± 13.1 ng/ml), indicating a potential association with inflammation or iron metabolism dysregulation.

Table2. value of BMI, HbA1c, Ferritin parameters in positive and negative non-alcoholic fatty liver disease male and female subjects.

Parameters	Male		Female	
	Negative Mean± SEM	**Positive Mean±SEM**	**Negative Mean±SEM**	**Positive Mean± SEM**
BMI(Kg/m^2)	26±0.01 ^{ab}	26.8± 0.2 ^{a}	25± 0.01 ^{b}	27.1±0.3 ^{a}
HbA1c(%)	5.3± 0.08 ^{b}	7.7±0.14 ^{a}	5.3±0.05 ^{b}	7.6±0.15 ^{a}
Ferritin(ng/ml)	139.6± 12.4 ^{b}	305.1± 11.7^{a}	151.2±7.5 ^{b}	315.9±13.1 ^{a}

Data are expressed as mean ± SEM of each gender. Within each column for male or female separately, means with different superscript (a, b or c) were significantly different at $p<0.05$. Where means without superscripts mean that there is no significant difference ($p>0.05$).

Hematological parameters
There were no significant changes observed in RBC count, hemoglobin (Hb), mean corpuscular hemoglobin (MCH), or mean corpuscular volume (MCV) between positive and negative individuals in both sexes.
However, the white blood cell (WBC) count was higher in positive males (8.3±0.2 ×10^3/µl) compared to negative (6.8±0.4 ×10^3/µl), indicating a possible inflammatory or immune response. Platelet count (PLT) showed a mild increase in positive individuals of both genders, but without a strong statistical significance.

Table 3. value of RBC, Hb, MCH, MCV, WBC, PLT parameters in positive and negative non-alcoholic fatty liver disease male and female subjects.

Parameters	Male		Female	
	Negative Mean± SEM	Positive Mean± SEM	Negative Mean± SEM	Positive Mean± SEM
RBC (×10^6/µl)	5±0.09 ^{a}	4.9± 0.08 ^{a}	4.8± 0.08 ^{a}	4.9±0.05 ^{a}
Hb (g/dl)	15± 0.2 ^{a}	14.8±0.1 ^{a}	13.3±0.1 ^{b}	13.8±0.1 ^{b}
MCH (pg)	29.2± 0.4 ^{a}	29.5± 0.3 ^{a}	28.9±0.3 ^{a}	29.1±0.2 ^{a}

MCV (fL)	89 ±0.9 [a]	89.7± 0.7 [a]	86.8±0.5 [a]	89.5±0.8 [a]
WBC (×10^3/µl)	6.8± 0.40 [a]	8.3± 0.2 [a]	7.7± 0.20 [a]	7.7± 0.3 [a]
PLT (×10^3/µl)	282± 7.6 [a]	305± 7.9 [a]	285± 8.9 [a]	301±6.9 [a]

Data are expressed as mean ± SEM of each gender. Within each column for male or female separately, means with different superscript (a, b or c) were significantly different at $p<0.05$. Where means without superscripts mean that there is no significant difference ($p>0.05$).

Distribution of fatty liver severity according to gender:

The severity of fatty liver disease varied between males and females. Among males, the highest frequency was observed in the severe category (22 cases), followed by moderate (21 cases) and then mild (12 cases). In contrast, females showed a higher prevalence in the moderate category (24 cases), followed closely by severe (21 cases) and the lowest in mild (13 cases).

This indicates that severe fatty liver is slightly more common in males, whereas moderate fatty liver is more prevalent in females. These differences suggest a potential gender-based variation in the progression or diagnosis of fatty liver disease.

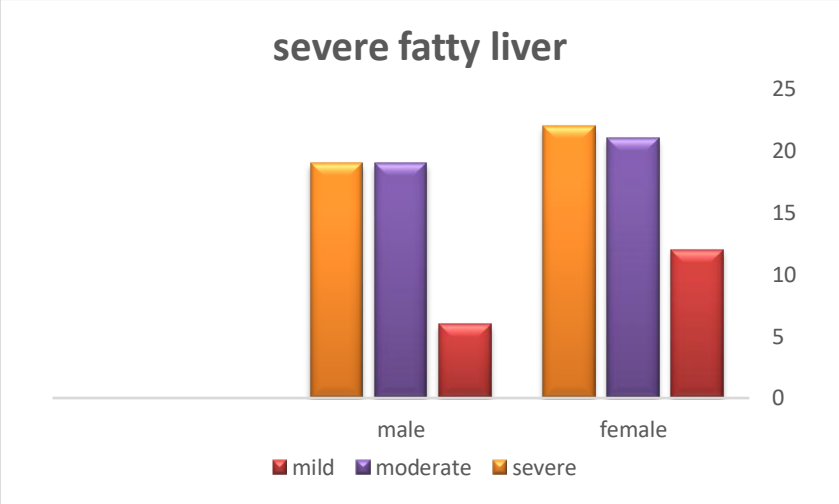

Figure 1. distribution of fatty liver severity (mild, moderate, severe) among male and female patients.

Discussion

This study identified significant biochemical and hematological differences between patients diagnosed with non-alcoholic fatty liver disease (NAFLD) and healthy controls within a Libyan cohort at Al-Wahda Hospital, Derna. These findings add to the growing body of evidence suggesting that NAFLD is not confined to liver pathology alone, but is closely tied to systemic metabolic dysfunction 6).

Elevated levels of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) observed in NAFLD patients align with previous reports (7,6), reinforcing the role of liver transaminases as key markers of hepatocellular injury.

Additionally, our results showed increased levels of triglycerides (TG), low-density lipoprotein (LDL), and total cholesterol, along with decreased high-density lipoprotein (HDL) levels in NAFLD patients. These lipid profile abnormalities support the well-established association between NAFLD and dyslipidemia, further emphasizing the condition's link to metabolic syndrome (8,9).

Elevated HbA1c levels in the patient group indicate poor glycemic control and insulin resistance, consistent with prior studies (10,11) that demonstrate strong interrelations between NAFLD, type 2 diabetes mellitus, and impaired glucose metabolism.

The increase in serum ferritin levels among NAFLD patients suggests an inflammatory state or possible iron overload. This result aligns with the observation reported by (12), who highlighted a correlation between elevated ferritin and the progression of liver fibrosis.

Interestingly, our analysis showed more marked elevations in liver enzymes among male patients, supporting findings from (13,14), who reported that males—especially those with visceral obesity are at higher risk for developing more severe forms of NAFLD.

While many studies focus on liver-specific biochemical markers, fewer have explored hematological parameters in NAFLD. The variation in red blood cell (RBC) indices observed in this study may suggest oxidative stress or

inflammatory responses. However, this contrasts with (15), who did not find consistent hematological patterns in patients with early-stage NAFLD.

In certain patients, AST levels were found to be higher than ALT, a ratio commonly associated with advanced fibrosis or cirrhosis. This deviates from earlier studies (16), which typically identify ALT as a more sensitive marker in early-stage NAFLD. This finding may point to disease progression in a subset of our patient population. Notably, while NAFLD is often linked to obesity and insulin resistance(17), we observed liver abnormalities in some patients with normal body mass index (BMI). This supports more recent evidence (18) suggesting that NAFLD can also occur in lean individuals, particularly those with specific ethnic, genetic, or metabolic predispositions.

Conclusion

This research highlighted clear differences in blood and biochemical tests between people diagnosed with non-alcoholic fatty liver disease (NAFLD) and those without the condition. Patients with NAFLD showed higher levels of liver enzymes (AST and ALT), which indicates liver stress or damage. They also had abnormal cholesterol and fat profiles in their blood with increased bad cholesterol (LDL) and triglycerides, and decreased good cholesterol (HDL). Elevated HbA1c levels pointed to issues with blood sugar regulation. Additionally, higher ferritin and white blood cell counts suggested that inflammation or immune system activation might be involved.

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