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ORIGINAL ARTICLE

Interleukin-17 and myeloperoxidase levels in patients with non-alcoholic fatty liver disease and effect of disease severity on blood counts and liver enzymes

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ABSTRACT

Objectives: To compare the circulating levels of interleukin-17 (IL-17) and myeloperoxidase (MPO) in non-alcoholic fatty liver disease (NAFLD) patients and healthy controls, and to assess the impact of disease severity on blood counts and liver enzyme levels, exploring their potential as early markers.

Methods: This cross-sectional study was conducted at Hayatabad Medical Complex and Khyber Medical University, Peshawar, Pakistan from January to December 2023 after ethical approval. Using purposive sampling, 20 healthy controls and 60 NAFLD patients (20 each with mild, moderate, and severe disease) aged ≥25 were enrolled. NAFLD was diagnosed via ultrasonography. Blood samples were collected for complete blood counts and liver enzyme assays (ALT and AST), while serum IL-17 and MPO levels were measured by ELISA. NAFLD severity was assessed using FIB-4, APRI, and AST/ALT ratios. Data were analyzed with Prism Graphpad using ANOVA with Dunnett's tests and Kruskal-Wallis tests, with $p \leq 0.05$ considered significant.

Results: Controls had a mean age of 32.9±7.0 years, versus 59.3±10.1 years in NAFLD patients. Liver enzymes, severity scores, and the AST/ALT ratio increased significantly with NAFLD severity. IL-17 levels rose from 0.064 ng/ml in controls to 0.133, 0.223, and 0.278 ng/ml in mild, moderate, and severe cases ($p < 0.05$ to < 0.0001). MPO levels were significantly higher in moderate and severe NAFLD, while platelet counts and hemoglobin decreased.

Conclusion: Elevated IL-17 and MPO levels correlate with NAFLD severity, suggesting their potential as biomarkers for early detection and monitoring of disease progression in high-risk patients. These findings warrant further clinical evaluation.

Keywords: Interleukin-17 (MeSH); Myeloperoxidase (MeSH); Peroxidase (MeSH); Non-alcoholic Fatty Liver Disease (MeSH); Fatty Liver (MeSH); Liver Enzymes (Non-MeSH); Alanine Transaminase (MeSH); Aspartate Aminotransferases (MeSH); Blood Cell Count (MeSH); Platelets (MeSH).

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INTRODUCTION

Non-alcoholic fatty liver disease (NAFLD) is a chronic disease characterized by ≥5% fat accumulation in liver parenchyma and no history of alcohol intake. Severity of NAFLD varies from mild steatosis to severe non-alcoholic hepatitis (NASH), depending on the extent of fat deposition and inflammation.[2] Risk factors include obesity, type-2 diabetes, hyperlipidemia, age, gender, race, genetics, poor dietary habits and sedentary lifestyle.[3] Worldwide prevalence of NAFLD and NASH ranges from 6-21% and 3-5% respectively, with increasing incidence.[4] NASH has been associated with severe inflammation and fibrosis leading to cirrhosis and hepatocellular carcinoma.[5]

Although the mechanisms underlying the pathogenesis of NAFLD remain largely unknown, the role of immune system remains critical.[6] Neutrophils are an important part of innate immune system and contributes to persistent inflammation in NAFLD.[7] Myeloperoxidase (MPO) present in neutrophilic granules is involved in the generation of reactive oxygen species (ROS), contributes to oxidative stress and hepatocyte death.[8,9] Over 90% of circulatory MPO is produced by activated neutrophils while remaining by other immune and Kupffer cells.[9] Apart from neutrophils, Kupffer cells and Th17 [6] helper T-cells are also involved in hepatic inflammation.[10] Neutrophils are important for activation of Th17 cells which promote liver damage by producing proinflammatory cytokines including Interleukin (IL)-17. Regulatory T-cells which are critical for controlling chronic inflammation are reduced in NAFLD resulting in sustained inflammation.[11] The balance between Th17 and regulatory T-cells in circulation is important for maintaining an equilibrium between protective mechanisms and autoimmunity.[12] Murine studies have shown that decrease in serum MPO level reduces liver inflammation in mice.[7] Similarly experimental mice study has shown that IL-17 restriction by gene deletion or anti-IL-17 antibody treatment provide protection from liver damage.[13] On the other hand, administration of IL-17 was seen to damage the liver.[14]

Clinically, NAFLD presents with no or vague symptoms such as weakness, tiredness and abdominal pain, contributing to delayed diagnosis.[15] Diagnostic modalities used for NAFLD includes ultrasonography, computed tomography and magnetic resonance

imaging or invasive liver biopsy. Although useful in the diagnosis, these are associated with radiation exposure, high cost, lack of expertise and availability as well as pain and risks associated with biopsy.[16] Readily available routine investigations such as liver enzymes and changes in blood counts could be informative but generally non-specific.[17,18] Additionally, the scoring systems used to determine the degree of fibrosis such as the fibrosis-4 (FIB-4) index, AST to platelet ration index (APRI) and NAFLD fibrosis score remain debatable.[19,20] There is a need for less invasive, easily accessible and reliable serological markers for not only the diagnosis but also to monitor NAFLD progression.

The objectives of this study were to compare the levels of IL-17 and MPO in NAFLD of varying severity and effects of disease severity on blood counts and liver enzyme levels. Studies have shown their role in NAFLD pathogenesis but not their usefulness as a potential marker of NAFLD severity. Findings of this study will be useful in showing their potential role in early prediction of NAFLD progression and as a diagnostic or monitoring test in high-risk patients.

METHODS

Patient selection: This cross-sectional study was conducted at Hayatabad Medical Complex (HMC) and Khyber Medical University (KMU) Peshawar after approval from the Advanced Studies and Research Board and Ethical Review Committee (Reference # DIR/KMU-AS&RB/EA/IPDM/001880 and DIR/KMU-AS&RB/IR/IPDM/001905). This study was conducted over a period of one year from January 2023 to December 2023. Using non-probability purposive sampling technique, a total of 20 controls and 60 patients with mild, moderate and severe NAFLD (n=20 each) of 25 years or above age, regardless of gender were included. Pregnant women and patients with acute illness, autoimmune disorders, taking antibiotics or any comorbidities which could affect any of the study parameters were excluded.

Sample Collection: Patients were selected after ultrasonographic evidence of fatty liver by a consultant radiologist/ sonologist. Complete clinical history was recorded after informed written consent and blood samples were taken in EDTA and gel tubes for further analysis. Serum samples for ELISA were stored at -80C freezer until further use.

Hematological and biochemical tests: Complete blood counts (CBCs) were performed on whole blood samples collected in EDTA tubes while serum samples were utilized for liver enzymes levels which included Alanine Aminotransferase (ALT), and Aspartate Aminotransferase (AST) only.

ELISA for MPO and IL-17: Quantitative ELISA was performed on serum samples of all patients using Human Interleukin 17, IL-17 (BT-LAB kit, Cat No. E0142Hu) and Human Myeloperoxidase, MPO (BT-LAB kit, Cat No. E0880Hu) as per the manufacturer guidelines

NAFLD severity scoring systems: Severity of the NAFLD was calculated based on commonly used scoring systems such as FIB-4 index, AST/ALT ratio and APRI scores. The following formulae were used for calculation of these scores:

$$\text{FIB-4} = \text{Age (years)} \times \text{AST (U/L)} / [\text{platelets } (10^9/\text{L}) \times \text{ALT}^{1/2} \text{ (U/L)}]$$

APRI score = [AST level / AST (upper limit of normal)] / Platelet count (10^9/L) x 100

Statistical analysis: All the data were recorded in the Microsoft Excel sheet and statistical analysis was performed using Prism Graphpad (Version 10.2.3). Numerical data were checked for distribution and expressed as mean± standard deviation (SD) or median with interquartile range. ANOVA with post-hoc Dunnett's and Kruskal Wallis with Dunn's tests were applied for parametric and non-parametric data respectively. Categorical variables such as gender is expressed as frequency. P value of ≤ 0.05 is considered statistically significant.

RESULTS

A total of 80 participants irrespective of age and gender were enrolled in this study after written informed consent. The mean age of the healthy controls (n=20) was 32.90±7.026 years and cases with NAFLD was 59.25±10.08 years. Majority of our study participants were females with n=19 controls, 35 NAFLD cases and less male participants (n=1 control, 25 NAFLD cases). Data summarized in Table I.

In this study, the NAFLD severity scoring systems used included FIB-4 index, APRI score and AST/ALT ratio. Our data suggests that the severity of NAFLD coincides with the increased FIB-4 index and APRI scores as shown in Figure 1A. Similarly, AST/ALT ratio also increased with the increasing severity of NAFLD compared to healthy control group ($p < 0.05$ in all) (Figure 1B).

Liver enzymes such as AST and ALT levels were measured in NAFLD cases and healthy controls. AST levels in NAFLD cases with mild (31.70 ± 10.06, $p < 0.05$), moderate (99.80 ± 15.0, $p < 0.0001$) and severe (143.70 ± 9.19, $p < 0.0001$) disease showed an exponential increase with increasing severity compared to control group (20.65 ± 6.62). Similarly, ALT levels showed a similar trend with rising levels

Table I: General characteristics of study participants

Variable	Study group	Value
Age (years) mean ± SD (Range)	Controls	32.90±7.026 (26-50)
	NAFLD	59.25±10.08 (32-75)
Males (n)	Controls	1
	NAFLD	25
Females (n)	Controls	19
	NAFLD	35

NAFLD: Non-Alcoholic Fatty Liver Disease

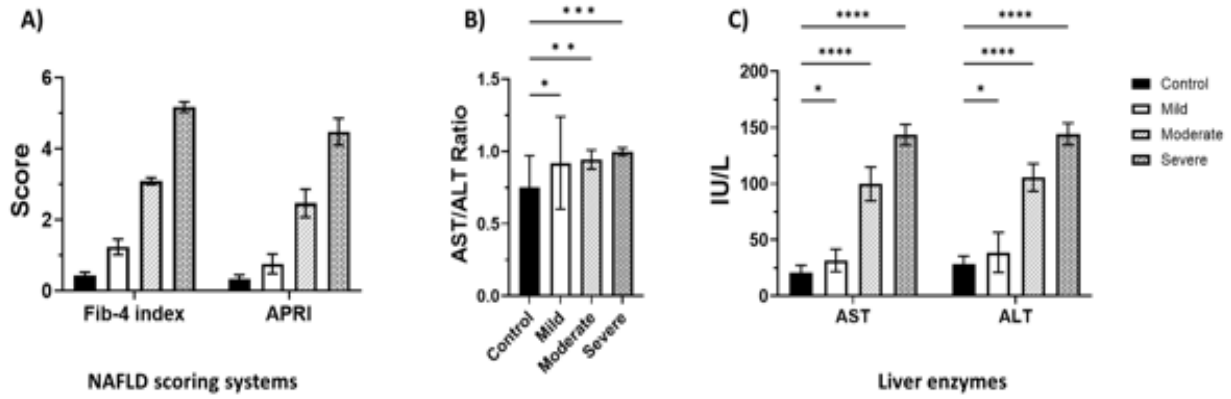

Figure 1: Severity scores and liver enzyme levels of controls and NAFLD cases. **(A)** Commonly used scoring systems FIB-4 index and APRI scores in varying severity of NAFLD. **(B)** AST (IU/L), ALT (IU/L) and **(C)** AST/ALT ratio in controls (n=20) and NAFLD cases with mild (n=20), moderate (n=20) and severe (n=20) NAFLD. Data are represented as mean±SD and analysed using ANOVA with post-hoc Dunnett's tests comparing mild, moderate and severe with control group.P value = *; < 0.05, **; < 0.01, ***; < 0.001, ****; < 0.0001.

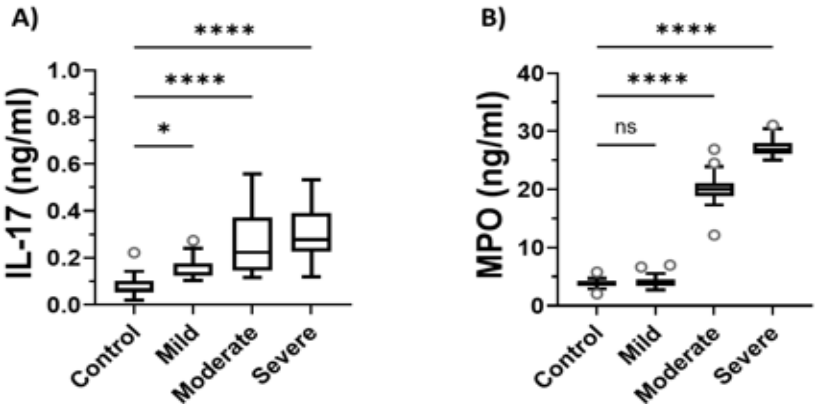

Figure 2: Circulating levels of IL-17 and MPO in controls and cases with varying severity of NAFLD. **(A)** IL-17 (ng/ml) and **(B)** MPO (ng/ml) in controls (n=20) and NAFLD cases with mild (n=20), moderate (n=20) and severe (n=20) disease. Data are represented asmedian with interquartile range and analysed using Kruskal Wallis with post-hoc Dunn's tests comparing mild, moderate and severe with control group. P value = ns;non-significant, *; < 0.05, ****; < 0.0001.

corresponding to the NAFLD severity (mild: 38.75±17.83; p<0.05, moderate: 105.50 ± 12.32; p < 0.0001, severe: 144.4±9.60; p<0.0001) compared to control (28.25±7.26). Data shown in Figure 1C.

Serum IL-17 and MPO levels were quantified in both NAFLD cases and controls as shown in Figure 2 (A, B). The median IL-17 concentration was 0.064 ng/ml in control group which was seen to be exponentially increasing with the severity of the disease (mild: 0.133 ng/ml; p < 0.05, moderate: 0.223 ng/ml; p <0.0001 and severe: 0.278 ng/ml; p < 0.0001) as shown in Figure 2 A. Similarly, MPO levels were significantly high in the moderate (20 ng/ml; p< 0.0001) and severe (26.78 ng/ml; p< 0.0001) NAFLD while no significant difference was noted in mild cases (3.84 ng/ml; p> 0.05) as compared to control group (4.0 ng/ml) (Figure 2B).

Platelet counts showed a progressive decrease with increasing severity of NAFLD (mild: 209.5±0.87; p <0.0001, moderate: 194.6±24.43; p <0.0001, severe:153.4±8.97; p<0.0001) as compared to the controls (296.7±65.97) (Figure 3A). Slight reduction in the hemoglobin (g/dl) was seen in moderate (11.01±0.91; p< 0.05) and severe (10.83±1.29; p< 0.05) disease compared to controls (12.12±1.57) (Figure 3B). No statistically significant difference in the total white cell count (TLC) and differential white cell counts (DLC) was seen in between NAFLD cases and controls (Figure 3C, D).

DISCUSSION

NAFLD is a highly prevalent liver disorder worldwide, with increasing incidence driven by risk factors such as obesity, diabetes, advanced age, and hyperlipidemia. Although its exact etiopathogenesis remains poorly understood, chronic inflammation and an overactive immune system play key roles in disease progression. Our study found that circulating levels of IL-17 and MPO rise in tandem with NAFLD severity, paralleled by significant alterations in liver enzymes and blood counts. These findings highlight the critical impact of inflammatory mediators in NAFLD and suggest that IL-17 and MPO could serve as early indicators for disease detection and monitoring. While previous studies have demonstrated that NAFLD risk is associated with increasing age and affects both genders, the higher proportion of female participants in our sample was a result of sampling dynamics rather than an indication of greater regional prevalence. Overall, these results highlight the systemic effects of hepatic inflammation and emphasize the need for targeted interventions in high-risk populations, warranting further research into the

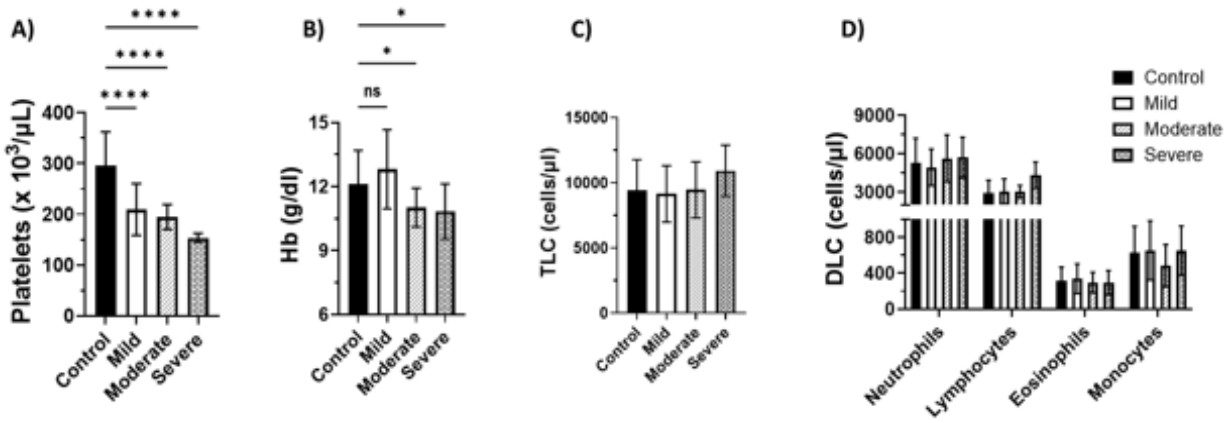

Figure 3: Blood counts in controls and cases with varying severity of NAFLD. **(A)** Platelet counts (x $10^3/\mu l$), **(B)** Hemoglobin (Hb; g/dl), **(C)** Total leucocyte count (TLC; cells per μ/l) and Differential leucocyte count (DLC; cells per μl) in controls (n=20) and NAFLD cases with mild (n=20), moderate (n=20) and severe (n=20) disease. Data are represented as mean±SD and analysed using ANOVA with post-hoc Dunnett's tests comparing mild, moderate and severe with control group. P value = ns; non-significant, *; < 0.05, ****; < 0.0001.

clinical utility of these biomarkers in managing NAFLD.

In this study, we were interested in the estimation of IL-17 and MPO levels in NAFLD cases with increasing disease severity to explore its utility as predictor of disease progression. The results of our study show that the serum levels of IL-17 and MPO were higher in moderate to severe NAFLD. Severity of NAFLD is likely associated with increasing fibrosis in liver parenchyma, however, fibrosis confirmation was beyond the scope of this study. A previous study by Yumei Duan in 2022 showed similar findings with higher IL-17 level in obese NAFLD individuals.[21] Similarly, association between MPO levels and NAFLD progression has also been observed. Experimental murine studies have shown that administration of IL-17 decreased the hepatic function whereas blocking IL-17 using anti-IL-17 antibody was protective against hepatic damage.[22]

Studies have shown that until the liver is severely compromised, the patients remain asymptomatic or present with non-specific symptoms. Liver function tests including ALT and AST are widely done but lack the specificity to determine the extent of liver fibrosis or damage. Our findings are suggestive of a progressive increase in the levels of ALT and AST with increasing severity of disease. Previously conducted studies on patients with NAFLD have shown a high variation in the levels of AST and ALT ranging from normal to increased levels.[23] Although readily available and relatively economical tests with a higher utility in assessing the liver function, these tests lack specificity to differentiate between normally active liver and diseased liver.

Effects of the liver damage in NAFLD on peripheral blood counts do not occur until a very late-stage disease. Platelets production is mainly regulated by thrombopoietin, produced by hepatocytes, hence hepatocyte damage has the capacity to affect the production of platelets. Similarly, the role of platelets in progression of liver fibrosis and promoting inflammation has also been postulated.[24] Our findings suggest a progressive reduction in the platelet counts with increasing NAFLD severity is likely due to reduction in number of healthy hepatocytes capable of producing TPO. Large scale studies are needed to confirm this finding as well as the TPO production in NAFLD with varying degree of fibrosis and disease severity.

There was also a drop in the hemoglobin levels of the NAFLD cases though none of the patients was severely anemic or had related clinical complications. Previous studies have also shown a variable response in hemoglobin levels of patients with NAFLD.[25] No significant changes were seen in the total or differential leukocyte counts, only slight variations in white blood cell subsets have been shown by some studies.[17]

The previously published studies have found a relationship of NAFLD with either IL-17 or MPO and variable changes in blood counts and liver enzymes. None of the published studies have compared the levels of IL-17 and MPO together with the increasing severity of NAFLD. Increase in the incidence of NAFLD has been observed worldwide including Pakistan with limited resources to perform expensive or skilled diagnostic tests for timely diagnosis.[26] To the best of our knowledge, no studies have previously been done in Pakistan to understand the association between these parameters and NAFLD.

Our study suggests that IL-17 and MPO may contribute to NAFLD pathogenesis and serve as non-invasive serological biomarkers for assessing its progression. Additionally, a decrease in platelet counts was observed with increasing disease severity, further supporting the use of these readily available tests for diagnosis and monitoring. However, due to the limited sample size and single-center design, these findings should not be considered definitive or used as the sole indicators of NAFLD severity. Future large-scale, longitudinal, and multicenter studies are necessary to validate their diagnostic and monitoring potential.

Strengths and limitations of the study

This is the first study to simultaneously examine the relationship between both IL-17 and MPO with NAFLD severity, whereas previous research focused on each marker individually or on the effects of NAFLD on blood counts and liver profiles. The study's limitations include its small sample size, single-center nature, absence of follow-up data, and the inability to confirm disease severity via biopsy or advanced imaging techniques.

CONCLUSION

Our study reveals that as the severity of NAFLD progresses, there is a corresponding increase in serum levels of IL-17 and MPO, alongside elevated liver enzymes (ALT and AST). Furthermore, reduced platelet counts and mild anemia observed in severe cases also reflect the progression of liver damage. These findings suggest that these non-invasive markers could potentially serve as valuable tools for the early detection and monitoring of liver damage and disease progression in NAFLD. However, the study's limitations, such as its small sample size, single-center design, and absence of confirmatory follow-up data, highlight the need for larger-scale, longitudinal, and multicenter studies to validate these initial findings and confirm the clinical utility of these biomarkers in the management of NAFLD.

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REFERENCES

1. Niu L, Geyer PE, Wewer Albrechtsen NJ, Gluud LL, Santos A, Doll S, et al. Plasma proteome profiling discovers novel proteins associated with non-alcoholic fatty liver disease. Mol Syst Biol 2019;15(3):e8793.https://doi.org/10.15252/msb.20188793
2. Neuschwander-Tetri BA. Non-alcoholic fatty liver disease. BMC Med2017;15(1):45.https://doi.org/10.1186/s12916-017-0806-8
3. Chalasani N, Younossi Z, Lavine JE, Charlton M, Cusi K, Rinella M, et al. The diagnosis and management of nonalcoholic fatty liver disease: Practice guidance from the American Association for the Study of Liver Diseases. Hepatology 2018;67(1):328-57. https://doi.org/10.1002/hep.29367
4. Povsic M, Wong OY, Perry R, Bottomley J. A structured literature review of the epidemiology and disease burden of non-alcoholic steatohepatitis (NASH). Adv Ther 2019;36(7):1574-94. https://doi.org/10.1007/s12325-019-00960-3
5. Huang T (Dazhong), Behary J, Zekry A. Non-alcoholic fatty liver disease: a review of epidemiology, risk factors, diagnosis and management. Intern Med J 2020;50(9):1038-47. https://doi.org/10.1111/imj.14709
6. Paquissi FC. Immune Imbalances in Non-Alcoholic Fatty Liver Disease: From General Biomarkers and Neutrophils to Interleukin-17 Axis Activation and New Therapeutic Targets. Front Immunol 2016;7:490.https://doi.org/10.3389/fimmu.2016.00490
7. Hwang S, Yun H, Moon S, Cho YE, Gao B. Role of Neutrophils in the Pathogenesis of Nonalcoholic Steatohepatitis. Front Endocrinol 2021;12:751802.https://doi.org/10.3389/fendo.2021.751802
8. Chen Z, Tian R, She Z, Cai J, Li H. Role of oxidative stress in the pathogenesis of nonalcoholic fatty liver disease. Free Radic Biol Med 2020;20;152:116-41. https://doi.org/10.1016/j.freeradbiomed.2020.02.025
9. Bekheet IW, Madkour ME, Ghaffar NA, Nosseir MMF, Moussa MM, Ibraheim RA, et al. The Role of Myeloperoxidase in Hepatitis C Virus Infection and Associated Liver Cirrhosis. Open Trop Med J 2009;19;2(1):517-25. https://doi.org/10.4103/ijpm.ijpm_608_21
10. Chackelevicius CM, Gambaro SE, Tiribelli C, Rosso N. Th17 involvement in nonalcoholic fatty liver disease progression to non-alcoholic steatohepatitis. World J Gastroenterol 2016;22(41):9096-103.https://doi.org/10.3748/wjg.v22.i41.9096
11. Zhou Y, Zhang H, Zhang X, Guan Y, Zheng F. CD4+ T cell activation and inflammation in NASH-related fibrosis. Front Immunol 2022;13:967410.https://doi.org/10.3389/fimmu.2022.967410
12. Li Y, Jiang HT, Han LB, Xiao L, Gan JH. MiR-195 regulates CD40 to maintain Th17/Treg balance in rats with non-alcoholic fatty liver disease. Biomed Pharmacother 2020;124:109930.https://doi.org/10.1016/j.biopha.2020.109930
13. Xu R, Tao A, Zhang S, Zhang M. Neutralization of interleukin-17 attenuates high fat diet-induced non-alcoholic fatty liver disease in mice. Acta Biochim Biophys Sin 2013;45(9):726-33. https://doi.org/10.1093/abbs/gmt065
14. Harley ITW, Stankiewicz TE, Giles DA, Softic S, Flick LM, Cappelletti M, et al. IL-17 signaling accelerates the progression of nonalcoholic fatty liver disease in mice. Hepatology 2014;59(5):1830-9. https://doi.org/10.1002/hep.26746
15. Sheka AC, Adeyi O, Thompson J, Hameed B, Crawford PA, Ikramuddin S. Nonalcoholic Steatohepatitis: A Review. JAMA 2020;323(12):1175-83. https://doi.org/10.1001/jama.2020.2298
16. Zhang YN, Fowler KJ, Hamilton G, Cui JY, Sy EZ, Balanay M, et al. Liver fat imaging-a clinical overview of ultrasound, CT, and MR imaging. Br J Radiol 2018;91(1089):20170959. https://doi.org/10.1259/bjr.20170959
17. Chao YL, Wu PY, Huang JC, Chiu YW, Lee JJ, Chen SC, et al. Hepatic Steatosis Is Associated with High White Blood Cell and Platelet Counts. Biomedicines 2022;10(4):892.https://doi.org/10.3390/biomedicines10040892
18. Forlano R, Mullish BH, Dhar A, Goldin RD, Thursz M, Manousou P.

Liver function tests and metabolic-associated fatty liver disease: Changes in upper normal limits, does it really matter? World J Hepatol 2021;13(12):2104-12. https://doi.org/10.4254/wjh.v13.i12.2104

19. Sugiyama A, Kurisu A, E B, Ouoba S, Ko K, Rakhimov A, et al. Distribution of FIB-4 index in the general population: analysis of 75,666 residents who underwent health checkups. BMC Gastroenterol 2022;22(1):241. https://doi.org/10.1186/s12876-022-02290-1

20. Kim WR, Berg T, Asselah T, Flisiak R, Fung S, Gordon SC, et al. Evaluation of APRI and FIB-4 scoring systems for non-invasive assessment of hepatic fibrosis in chronic hepatitis B patients. J Hepatol 2016;64(4):773-80.https://doi.org/10.1016/j.jhep.2015.11.012

21. Duan Y, Luo J, Pan X, Wei J, Xiao X, Li J, et al. Association between inflammatory markers and non-alcoholic fatty liver disease in obese children. Front Public Health 2022;10:991393.https://doi.org/10.3389/fpubh.2022.991393

22. Shen T, Chen X, Li Y, Tang X, Jiang X, Yu C, et al. Interleukin-17A exacerbates high-fat diet-induced hepatic steatosis by inhibiting fatty acid β-oxidation. Biochim Biophys Acta Mol Basis Dis 2017;1863(6):1510-8. https://doi.org/10.1016/j.bbadis.2017.01.027

23. Amernia B, Moosavy SH, Banookh F, Zoghi G. FIB-4, APRI, and AST/ALT ratio compared to FibroScan for the assessment of hepatic fibrosis in patients with non-alcoholic fatty liver disease in Bandar Abbas, Iran. BMC Gastroenterol 2021;21(1):453.https://doi.org/10.1186/s12876-021-02038-3

24. Dalbeni A, Castelli M, Zoncapè M, Minuz P, Sacerdoti D. Platelets in Non-alcoholic Fatty Liver Disease. Front Pharmacol 2022;13:842636.https://doi.org/10.3389/fphar.2022.842636

25. Juárez-Hernández E, Chávez-Tapia NC, Brizuela-Alcántara DC, Uribe M, Ramos-Ostos MH, Nuño-Lámbarri N. Association Between Serum Hemoglobin Levels and Non Alcoholic Fatty Liver Disease in a Mexican Population. Ann Hepatol 2018;17(4):577-84. https://doi.org/10.5604/01.3001.0012.0920

26. Hassan F, Farman M, Khan KA, Awais M, Akhtar S. Prevalence of nonalcoholic fatty liver disease in Pakistan: a systematic review and meta-analysis. Sci Rep 2024;14(1):19573.https://doi.org/10.1038/s41598-024-70481-9

AUTHORS' CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

MN & AI: Study design, acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

NI & MYK: Analysis and interpretation of data, critical review, approval of the final version to be published

GFR: Conception and study design, analysis and interpretation of data, drafting the manuscript, critical review, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request