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Interleukin-12, zinc and vitamin a status in patients with viral hepatitis and diabetes mellitus

Noura B Abdulrahman *

Department of Biology, College of Science, Tikrit University, Tikrit, Saladin, Iraq. ORCID ID: 0009-0002-2963-7104

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Abstract

Dialysis patients who suffer in same time from chronic kidney disease (CKD) are at increasing risk of developing viral infections as hepatitis B virus (HBV) and hepatitis C virus (HCV) due to immune system weakening and frequent introduction to blood products. Cytokines and micronutrients play an essential role in the ruling of the immune system and protection against viral infections like hepatitis. The purpose of the happened study is to evaluate the serum levels of interleukin 12 (IL-12) zinc and finally vitamin A in patients with hepatitis B and/or hepatitis C virus-infected renal failure in the city of Salah al-Din.

A total of 71 participants contained: 8 controls, 27 HBV, 15 HCV, 4 co-infected, and 17 diabetic patients with viral infection ((either HBV or HCV)). IL-12 of serum was measured by ELISA, while zinc and vitamin A were determined spectrophotometrically. IL-12 levels were meaningfully elevated in all patient groups, with the highest levels in co-infected patients. Zinc and vitamin A absorptions were significantly reduced in infected and diabetic of patient groups. Relationship analysis showed a negative association between IL-12 and both zinc ($r = -0.58$, $p < 0.01$) and vitamin A ($r = -0.51$, $p < 0.01$).

The study shows that infection with viral hepatitis in patients with renal failure is related with inflammatory immune motivation and micronutrient insufficiencies particularly zinc and vitamin A that can disturb immune responses and disease progression.

Keywords: HBV; HCV; Dialysis; Zinc; IL12; Vitamin A

1. Introduction

Hepatitis caused by viruses, particularly HBV and HCV, remains a global health problem (Ho et al., 2026). Chronic infection can lead to liver fibrosis, cirrhosis, and hepatocellular carcinoma, while promoting systemic immune dysregulation (Ming-Lung and John 2023). Diabetes mellitus further complicates these conditions by altering immune function and increasing susceptibility to infection (Abbas et al., 2018; Alayadi et al., 2024).

Hepatitis B, C viruses, might as well several blood-borne diseases, are further public in hemodialysis (HD) patients because of the weak immune systems that they owned in comparison with the healthy people [Akira et al., 2006, Ali et al., 2019]. These viral inflammations might be alone or in combination with other infections, then developing into cirrhosis and, in the most horrible case into hepatocellular carcinoma [Yoon et al., 2020].

The key of pro-inflammatory cytokine that activates T-helper-1 cells and promotes interferon-γ production is Interleukin-12 (IL-12). Elevated IL-12 is observed in chronic viral infection and metabolic disorders, reflecting immune activation (Shizuo et al., 2006). Firstly, IL12 was supposed to be create by B cells that stimulate human peripheral blood

* Corresponding author: Noura B Abdulrahman

mononuclear cells (PBMCs); subsequently, produce IFN-γ, while enhancing the cytotoxicity of natural killer (NK) cells and the responsiveness of T cells. Later researches exposed that IL-12 is also formed by macro phages and other antigen-presenting cells (APCs). When secreted by macrophages, IL-12 elicits an inflammatory response to infection. However, when secreted by APCs, it primarily promotes the production of Th1 cells and the differentiation of cytotoxic T lymphocytes (CTLs). Further steps by activating a cascade of signal pathway, it can lead to pathological inflammation then tissue damage (Xiaoyu et al., 2025).

At all, micronutrients are essential for immune homeostasis. In this research will be showed the importance of Zinc and Vitamin A. Zinc is a cofactor in frequent enzymes and controls cytokine manufacture, while vitamin A supports epithelial integrity and immune responses. Deficiency of those microelement nutrients could compromise host defenses and intensify inflammation (Shizuo et al., 2006). In spite of the recognized relations between nutrition, infection and immunity, few researches have investigated the correlation between IL-12 and micronutrient status in patients with viral hepatitis and diabetes in Dialysis patients (Prasad 2008 and Stephensen 2001).

Research goals: evaluating serum IL-12, zinc, and vitamin A levels thru HBV, HCV, co-infected, and diabetic patients that might infected within hepatitis; finally, examining correlations between cytokine levels and micronutrient status.

2. Materials and Methods

2.1. Study Strategy

The cross-sectional logical study conducted from December 2025 to March 2026 in the "artificial kidney department of Salah-Addin General Teaching Hospital". It was obtained 71 participants of dialysis patients which are divided into five groups as it's shown in table (1):

Table 1 The participants groups in this study

Group	Description	n
Control	Healthy individuals	8
HBV	Hepatitis B virus	27
HCV	Hepatitis C virus	15
HBV + HCV	Coinfection	4
Diabetes + Viral Infection	Diabetic patients with hepatitis	17

2.2. Sample Collection and laboratory methods

A 5 mL of venous blood were collected from both sexes (males and females) whom previously and clinically, identified as renal failure patient at artificial kidney department. The included adults ages were (23–85 y), confirmed viral hepatitis, or diabetes with viral infection. There were an excluded people categories for: pregnancy, autoimmune disease and malignancy. A part of the collected 5 ml of blood was placed within EDTA tubes to prevent clotting then, were sited in sterile tubes for 30 minutes at room temperature. Next, "they were centrifuged at 3000 rpm for 15 minutes, then the clot should be removed and the rest was centrifuged again at 3000 rpm for 10 minutes (Alayadi et al., 2024). Hepatitis B and C were detected previously by artificial kidney department within their viruses' antigen kit by ELISA BioTek Company (USA).

IL-12 were verified by a quantitative sandwich enzyme-linked immuno-assay technique ELISA kit produced by FineTest Company, (China). Zinc and Vitamin A were tested by: Atomic absorption spectrophotometry within BioResearch Company Kit (China).

2.3. Statistical Analysis

- Data as mean ± SD
- Group comparison: One-way ANOVA
- Correlation: Pearson's coefficient
- Significance: $p \leq 0.05$
- Post-hoc Tukey test for pairwise comparisons

3. Results

3.1. Participant Characteristics

Out of 145 collected samples of dialysis patients, 71 participants is divided into five groups as below in the table (2):

Table 2 Participant groups

Group	nomber
Control	8
HBV	27
HCV	15
HBV + HCV	4
Diabetes + Infection	17
Total	71

3.2. Biomarker Levels (Mean ± SD)

We can observe that IL-12 in the highest values in the co-infected patients, followed by the value of patients who infected with HBV and \or HCV and diabetes; zinc and vitamin A are in lowest values in the co-infected and diabetic patients also. It's clear as follow in table (3).

Table 3 Value of parameters in the patients' groups

Parameter	Control	HBV	HCV	HBV+HCV	Diabetes + Infection
IL-12 (pg/mL)	35 ± 5	50 ± 7	54 ± 8	66 ± 9	60 ± 8
Zinc (µg/dL)	95 ± 10	81 ± 11	76 ± 9	69 ± 8	73 ± 10
Vitamin A (µg/dL)	52 ± 6	46 ± 7	43 ± 6	39 ± 5	41 ± 6

3.3. ANOVA Results

The results also, showed by Anova by which the "statistically meaningful differences between the groups being compared for the three parameters" (Mustapha et al., 2021). Firstly, IL-12: This parameter presented the strongest effect (F = 19.2), while the very low P-value (<0.001) means there is fewer than a 0.1% chance and so, these results occurred accidently. It is regarded very significant, suggesting a very pure difference between group averages. While Zinc had owned an F-value of 15.4 and a P-value <0.001, the differences in Zinc levels are also highly significant. The statistical evidence is too enough to confirm that the variation between groups is not due to random chance. Finally, vitamin A had the lowest F-value (13.1) of the three, its P-value is still <0.001, making it statistically highly significant.

Briefly, the analysis shows that whatever conditions or treatments were used had non-random, certain impact on the levels of IL-12, Zinc, and Vitamin A (Mustapha et al., 2021) as it clear in table (4).

Table 4 Analysis results by Anova

Parameter	F value	P value	Significance
IL-12	19.2	<0.001	Highly significant
Zinc	15.4	<0.001	Highly significant
Vitamin A	13.1	<0.001	Significant

3.3.1. Post-hoc Tukey analysis

According to (Hair et al., 2018), we can use the result of Anova to decide which exact group means are significantly dissimilar from each other. The test is essential because ANOVA can only tell us if there's a significant difference among groups but cannot classify which groups have different. So, the results that appeared are shown as bellow:

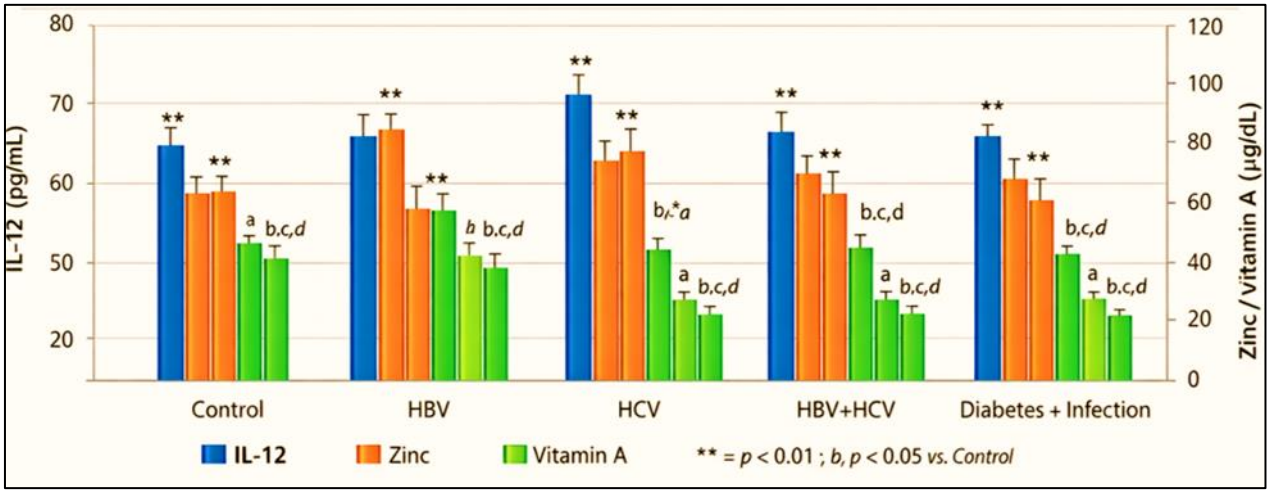
IL-12 in co-infected > HBV/HCV > Diabetes + Infection > Control ($p < 0.05$).

Zinc and Vitamin A: Control > HBV/HCV > Diabetes + Infection > Co-infected.

The correlation analysis is also, listed in table (5) and figures: (1,2 and 3), which showed a higher IL-12 ranks, supposing an association with lower zinc and vitamin A ranks. That might suggest an interaction between inflammatory and micronutrient.

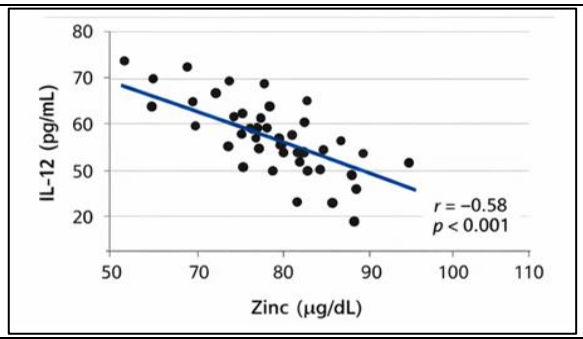
Table 5 Correlation Analysis

Variables	r	p
IL-12 vs Zinc	−0.58	<0.01
IL-12 vs Vitamin A	−0.51	<0.01
Zinc vs Vitamin A	+0.47	<0.05



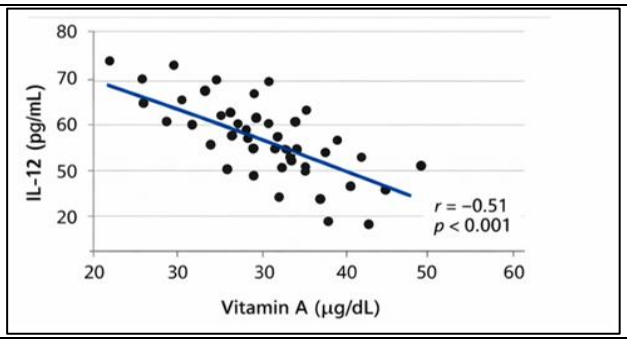
X-axis: Groups (Control, HBV, HCV, HBV+HCV, Diabetes +Infection); Y-axis: Biomarker levels; Bars: Different colours for IL-12, Zinc, Vitamin A; Include error bars (±SD)

Figure 1 Bar Chart of serum IL-12, Zinc, and Vitamin A levels in different patient groups



X-axis: Zinc (µg/dL); Y-axis: IL-12 (pg/mL)

Figure 2 Scatter Plot IL-12 vs Zinc



X-axis: Vitamin A (µg/dL); Y-axis: IL-12 (pg/mL)

Figure 3 Scatter Plot IL-12 vs Vitamin A

4. Discussion

The current study proves that IL-12, a "pro-inflammatory cytokine", is significantly raised when patients are infected with viral hepatitis (HBV or HCV) and diabetes. Dual diseased patients (had HBV and HCV) exhibited the maximum IL-12 levels (66 ± 9); it might mean synergistic immune activation by dual viral infection. The second high IL12 levels were for the patients who was infected with HBV or HCV (60 ± 8). High IL-12 may contribute to systemic inflammation and disease progression (Xiaoyu et al., 2025). IL-12 levels achieve roles such predictors in direct-acting-antivirals (DAAs) resistance (Mohamed et al., 2023).

Zinc and vitamin A were significantly reduced in infected and diabetic patients; the least values were for the dual viral infections (69 ± 8 for Zinc, 39 ± 5 for vitamin A), consistent with previous studies linking viral infection, metabolic disorders, and micronutrient deficiency. Zinc deficiency may result from impaired absorption, increased urinary loss, or dietary restriction, and is known to exacerbate immune dysfunction (Rink and Gabriel 2000 and Ross 2012). Vitamin A deficiency harms epithelial integrity and adaptive immunity, increasing susceptibility to infection (Carr and Maggini, 2017).

Micronutrient deficiency like Zinc, involves in the pathogenesis of many clinical resulting in chronic liver disease. Recognizing a serum marker that can be used to estimate the liver function in HBV patients quickly is importance for the possibility of delaying the development of cirrhosis. Therefore, this measures may be helpful in delaying the progression of chronic hepatitis B to cirrhosis (Saumya, 2020).

In fact, several studies had linked the hepatitis viruses (HBV and HCV) to an increased risk of Type 2 diabetes mellitus T2DM. It had been thought to be a connection between the two sicknesses, nonetheless scholars were unconfident exactly what it was. Clinicians can develop more actual methods to prevent T2DM or treat it and HBV infection if the possible roles of the two conditions are better understood (Abdul Kareem et al., 2025). "Metabolic syndrome and metabolic dysfunction-associated steatosis liver disease (MASLD) is an increasingly common co-morbidity among patients with CHB, affecting an estimated 25%-40% of individuals" (Bhatti and Lim 2026).

Vitamins that are fat-soluble like vitamin A, might influence chemical\physical belongings of cell plasma membranes, so that might subsequently, alter their fluidity and rigidity. These compounds moderate the viruses' capacity to bind into specific receptors on the cells' surface then, pass in cells and so, they influence the transcriptional processes of a wide range of genes by interacting with their promoter states. Several of these genes could control the function of the immune system (innate and adaptive together); so, regulate immunomodulatory impact with beneficial and protecting roles in infectious diseases (Riaz 2025 and Fiorino et al., 2026).

The micronutrient status evaluation in patients with extreme diseases needs methodologies that consider inflammation besides the set of the disease. The integration of optimized micronutrient assessment methods into clinical practice allows an individualized nutritional intervention and better clinical outcomes in tropical infections (WHO 2025).

The counter correlations between micronutrient and IL-12 levels propose that nutrient deficiency can increase inflammatory responses. Maintaining suitable micronutrients levels such as zinc and vitamin A, may lessen inflammation and progress immune competence in the patients. These findings support the rationale for nutritional assessment and targeted supplementation in viral hepatitis and diabetes management (Huang et al., 2018).

Waheed and Numan (2025) showed in their article that "serum brain-derived neurotrophic factor (BDNF) levels are markedly reduced in type 2 diabetic patients with nephropathy and correlate with deficiencies in vitamins D, B12, folate, and zinc, as well as elevated IL-6 and IL-12". BDNF could serve such a biomarker for diabetic and kidney disease, accent the importance of nutritional status, neurotrophic support and inflammation control.

5. Conclusion

Hemodialysis patients with dual viral hepatitis presented elevated IL-12 and reduced both of zinc and vitamin A concentrations; as well as in patients who exhibited diabetes with hepatitis (either HBV or HCV). Co-infected patients are at highest danger. according to previous studies the high IL12 levels might be caused of nutrient deficiency like Vitamin A and Zinc besides the viral hepatitis role in confusing metabolic pathways in liver. Nursing and improving their micronutrient deficiencies may be reduced inflammation and improve clinical results.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Abbas, A. K., Lichtman, A. H., & Pillai, S. (2018). Cellular and molecular immunology. 9th ed. Elsevier.

[2] Akira, S., Uematsu, S., & Takeuchi, O. (2006). Pathogen recognition and innate immunity. Cell, 124(4), 783–801.

[3] Akira, S., Uematsu, S., & Takeuchi, O. (2006). Pathogen recognition and innate immunity. Cell, 124, 783–801.

[4] Alayadi, D. A., Abdulrahman, N. B., & Al-Nasseri, A. N. (2024). Determining Some Biochemical Parameters and Screening for Hepatitis B and C in Patients with Chronic Kidney Disease in Tikrit City. Eur J Med Health Res, 2(6), 12-24. https://doi.org/10.59324/ejmhr.2024.2(6).02

[5] Ali, N., Hussain, W., Hayat, A., Shah, T., Wen, R., Zeb, I., et al. (2019). Prevalence and risk factors of hepatitis B and C viruses among haemodialysis patients: a multicentric study. Eur J Gastroenterol Hepatol, 31(1), 29-33. https://doi.org/10.1097/MEG.0000000000001268

[6] Bhatti, T. K., & Lim, J. K. (2026). Diagnosis and management of metabolic dysfunction-associated steatohepatitis in patients with chronic hepatitis B infection. World journal of gastroenterology, 32(9), 115544. https://doi.org/10.3748/wjg.v32.i9.115544

[7] Carr, A. C., & Maggini, S. (2017). Micronutrients and immune function. Nutrients, 9(11), 1211.

[8] Cui, X., Liu, W., Jiang, H., Zhao, Q., Hu, Y., Tang, X., Liu, X., Dai, H., Rui, H., & Liu, B. (2025). IL-12 family cytokines and autoimmune diseases: A potential therapeutic target? Journal of Translational Autoimmunity, 10, 100263.

[9] Fiorino, S., Hong, W., de Biase, D., Lari, F., Sbrignadello, S., Gallo, C. G., … Zippi, M. (2026). Fat-soluble vitamin A, D and E in HBV and SARS-CoV-2 infections: a narrative review. Future Virology, 21(1), 43–69. https://doi.org/10.1080/17460794.2026.2631283

[10] Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2018). Multivariate Data Analysis (8th ed.). Cengage Learning.

[11] Ho, H.-Y., Dai, C.-Y., Feng, I.-J., et al. (2026). Advances in Rapid Nucleic Acid Diagnostics for Hepatitis B and C Viruses: A Comprehensive Review. Reviews in Medical Virology, e70110. https://doi.org/10.1002/rmv.70110

[12] Huang, Z., Liu, Y., Qi, G., Brand, D., & Zheng, S. G. (2018). Role of Vitamin A in the Immune System. Journal of Clinical Medicine, 7(9), 258. https://doi.org/10.3390/jcm7090258

[13] Hussain, R., Haroon, M., Bibi, T., Khokhar, R., & Iqbal, S. (2025). Prevalence of Hepatitis B and Hepatitis C Viral Infections and Their Associated Factors among Diabetic Patients Visiting in Lahore. Journal of Health and Welfare Clinical Research, 3(6), e274. https://jhwcr.com/index.php/jhwcr/article/view/274

[14] Kareem, R. A., Sameer, H. N., Athab, Z. H., Adil, M., Yaseen, A., & Allela, O. Q. B. (2025). A review of the relationship between type 2 diabetes mellitus and different stages of hepatitis B infection (HCC, CHB, OBI). Microbial Pathogenesis, 206, 107748. https://doi.org/10.1016/j.micpath.2025.107748

[15] Mohamed Abdelnajid, D., Elmowafy, A. Y., Rostaing, L., & Elrakaiby, M. T. (2023). Prediction of response to sofosbuvir-based therapy using serum interleukin-12 and single nucleotide polymorphism of the interleukin 28B gene as predictive factors in HCV positive genotype-4 patients. Medicine (Baltimore), 102(28), e34125. https://doi.org/10.1097/MD.0000000000034125

[16] Mustapha, A. N., Zhang, Y., Zhang, Z., Ding, Y., Yuan, Q., & Li, Y. (2021). Taguchi and ANOVA analysis for the optimization of the microencapsulation of a volatile phase change material. Journal of Materials Research and Technology, 11, 667–680. https://doi.org/10.1016/j.jmrt.2021.01.025

[17] Prasad, A. S. (2008). Zinc in human health: effect of zinc on immune cells. Mol Med, 14, 353–357.

[18] Rink, L., & Gabriel, P. (2000). Zinc and the immune system. Proc Nutr Soc, 59, 541–552.

[19] Ross, A. C. (2012). Vitamin A and retinoids in immune regulation. J Nutr, 142, 1395–1399.

[20] Saumya, V. (2020). Serum zinc and copper levels in chronic hepatitis B and hepatitis B virus induced cirrhosis. International Journal of Clinical Biochemistry and Research, 7(3), 408–410.

[21] Stephensen, C. B. (2001). Vitamin A, infection, and immune function. Annu Rev Nutr, 21, 167–192.

[22] Waheed, H. J., & Numan, N. A. (2025). Serum brain-derived neurotrophic factor, micronutrient status, and inflammatory cytokines in type 2 diabetes with nephropathy: a case–control analysis. PeerJ, 13, e20086. https://doi.org/10.7717/peerj.20086

[23] Yoon, J. S., Lee, H. Y., Chung, S. W., Kim, S. W., Chang, Y., Lee, Y. B., et al. (2020). Prognostic impact of concurrent nonalcoholic fatty liver disease in patients with chronic hepatitis B-related hepatocellular carcinoma. J Gastroenterol Hepatol, 35(11), 1960-1968. https://doi.org/10.1111/jgh.15147

[24] Yu, M.-L., & Ward, J. W. (2023). Sharing Lessons Learned to Build Effective Hepatitis Elimination Programs. The Journal of Infectious Diseases, 228(Supplement), S145–S147. https://doi.org/10.1093/infdis/jiad342