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Original Research Article

TRACE ELEMENT IMBALANCE AND LIPID METABOLISM IN PSORIASIS: A HOSPITAL-BASED OBSERVATIONAL STUDY

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ABSTRACT

Background: Psoriasis is a chronic immune-mediated inflammatory disorder increasingly recognized as a systemic disease with significant metabolic and cardiovascular comorbidities. Dyslipidemia and oxidative stress are frequently reported in psoriasis, and trace elements such as zinc and copper play critical roles in immune regulation, antioxidant defense, and lipid metabolism. However, the relationship between trace element status, lipid profile abnormalities, and disease severity remains incompletely understood. The objective is to evaluate serum zinc and copper levels, Cu/Zn ratio, and fasting lipid profile parameters in patients with psoriasis and to assess their correlation with disease severity.

Materials and Methods: This hospital-based case–control observational study included 50 clinically diagnosed psoriasis patients attending a tertiary care center. Disease severity was assessed using the Psoriasis Area and Severity Index (PASI). Fasting venous blood samples were analyzed for serum zinc and copper using atomic absorption spectrophotometry, and the Cu/Zn ratio was calculated. Lipid profile parameters—including total cholesterol, triglycerides, HDL-C, and LDL-C—were estimated using standard enzymatic methods. Correlation analysis was performed using Spearman's rank correlation coefficient. A p-value <0.05 was considered statistically significant.

Results: The study population predominantly comprised middle-aged adults with male predominance, and most patients had mild psoriasis. Serum zinc and copper levels showed wide inter-individual variability. A statistically significant negative correlation was observed between PASI score and serum copper levels ($\rho = -0.31$, $p = 0.031$), indicating declining copper levels with increasing disease severity. No significant correlation was found between PASI score and serum zinc, Cu/Zn ratio, or lipid profile parameters. Additionally, serum zinc, serum copper, and Cu/Zn ratio did not show significant associations with lipid profile components. Expected physiological correlations among lipid parameters were preserved.

Conclusion: The present study demonstrates that serum copper levels decrease with increasing psoriasis severity, while serum zinc, Cu/Zn ratio, and lipid profile parameters show no significant association with disease severity. Dyslipidemia appears to coexist independently of trace element imbalance in psoriasis. These findings underscore the importance of comprehensive metabolic and cardiovascular risk assessment in patients with psoriasis, irrespective of disease severity or trace element status.

Keywords: Psoriasis; Zinc; Copper; Cu/Zn ratio; Dyslipidemia; Lipid profile; Oxidative stress; Psoriasis Area and Severity Index.

INTRODUCTION

Psoriasis is a chronic, immune-mediated inflammatory skin disorder affecting approximately 2–3% of the global population.[1,2] Although traditionally regarded as a disease confined to the skin, psoriasis is now well recognized as a systemic inflammatory disorder with multisystem involvement. Increasing evidence has demonstrated its strong association with metabolic abnormalities, including dyslipidemia, obesity, insulin resistance, and an increased risk of cardiovascular morbidity and mortality.[3–5] Persistent systemic inflammation and oxidative stress are believed to represent the central pathogenic mechanisms linking psoriasis with these metabolic and cardiovascular comorbidities.[5]

Among the metabolic disturbances associated with psoriasis, dyslipidemia is one of the most frequently reported abnormalities. It is typically characterized by elevated levels of total cholesterol, triglycerides, and low-density lipoprotein cholesterol, along with reduced levels of high-density lipoprotein cholesterol.[6,7] These lipid abnormalities play a critical role in the development of accelerated atherosclerosis, thereby significantly increasing cardiovascular risk in patients with psoriasis.[3,4] However, despite extensive clinical evidence supporting this association, the precise biochemical mechanisms underlying dyslipidemia in psoriasis remain incompletely elucidated.[7]

Oxidative stress has been proposed as a key mediator linking chronic inflammation with lipid abnormalities in psoriasis. Increased production of reactive oxygen species during persistent inflammation leads to lipid peroxidation, endothelial dysfunction, and modification of lipoproteins, thereby contributing to dyslipidemia and atherogenesis.[8,9] In this context, trace elements involved in antioxidant defense have gained considerable research interest.

Zinc and copper are essential micronutrients that play crucial roles in immune regulation, antioxidant defense, and lipid metabolism. Zinc exerts protective effects by stabilizing cellular membranes, modulating inflammatory responses, and regulating enzymes involved in lipid metabolism and antioxidant pathways.[10,11] Zinc deficiency has been associated with enhanced oxidative stress, immune dysregulation, and adverse lipid profiles.[11] In contrast, copper, although essential for several physiological processes, may exert pro-oxidant effects when present in excess. Copper also acts as an acute-phase reactant during inflammation and has been implicated in lipid peroxidation and low-density lipoprotein oxidation.[12,13]

Several studies have demonstrated reduced serum zinc levels and elevated copper levels in patients with psoriasis, suggesting a disruption of trace element homeostasis in this disease.[14,15] Rather than isolated alterations, the copper-to-zinc (Cu/Zn) ratio has emerged as a more sensitive and integrative marker of systemic inflammation and oxidative stress and has been shown to correlate with disease severity in psoriasis.[14–16] Given the close interplay between chronic inflammation, oxidative stress, and lipid metabolism, alterations in zinc and copper status—and particularly the Cu/Zn ratio—may represent a crucial biochemical link contributing to dyslipidemia in patients with psoriasis.

Aim: To evaluate the correlation between serum zinc and copper levels and lipid profile parameters in patients with psoriasis.

Objectives

1. To estimate serum zinc and copper levels in patients with psoriasis.
2. To assess fasting lipid profile parameters in patients with psoriasis.
3. To evaluate the correlation between serum zinc, serum copper, Cu/Zn ratio, and lipid profile parameters in psoriasis.

MATERIALS AND METHODS

This hospital-based case–control observational study was conducted at the Surat Municipal Institute of Medical Education and Research (SMIMER), Surat, in collaboration with the Departments of Biochemistry and Skin & V.D., after obtaining approval from the Institutional Ethics Committee. Clinically diagnosed patients of psoriasis attending the dermatology outpatient department were included as cases, while age- and sex-matched apparently healthy individuals without psoriasis or any chronic inflammatory disease served as controls. Written informed consent was obtained from all participants prior to enrolment.

Patients with diabetes mellitus, hepatic or renal disorders, malignancy, other autoimmune or inflammatory skin diseases, those receiving mineral or antioxidant supplementation, and pregnant or lactating women were excluded from the study. A detailed clinical history and dermatological examination were performed for all cases, and disease severity was assessed using the Psoriasis Area and Severity Index (PASI) score.

Venous blood samples were collected after an overnight fast under aseptic precautions. Serum was separated by centrifugation and used for biochemical analysis. Serum zinc and copper levels were estimated using Atomic Absorption Spectrophotometry with the iCE 3500 Atomic Absorption Spectrophotometer, following standard laboratory protocols and internal quality control measures. The copper-to-zinc (Cu/Zn) ratio was calculated from the obtained values. Fasting lipid profile parameters, including total cholesterol, triglycerides, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol, were estimated using standard enzymatic methods on an automated biochemistry analyzer.

The data were expressed as mean ± standard deviation. Appropriate statistical tests were applied to

compare biochemical parameters between cases and controls. Correlation analysis was performed to evaluate the association between serum zinc, copper, Cu/Zn ratio, lipid profile parameters, and disease severity. A p value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: demographic characteristics of study population (n = 50)

Variable	Category	Number (n)	Percentage (%)	Interpretation
Age (years)	Mean ± SD	41.4 ± 10.1	—	Majority were middle-aged adults
	Median	40.5	—	Age distribution fairly symmetrical
Gender	Male	38	76%	Male predominance observed
	Female	12	24%	—
Psoriasis Severity	Mild	30	60%	Most patients had mild disease
	Moderate	16	32%	—
	Severe	4	8%	Fewer severe cases

The study population predominantly comprised middle-aged adults with a mean age of 41.4 ± 10.1 years, indicating that psoriasis in this cohort mainly affected individuals in their economically productive age group. The male predominance (76%) observed may reflect either increased healthcare-seeking behavior among males or a higher hospital-based prevalence.

Most patients had mild psoriasis (60%), followed by moderate (32%) and severe disease (8%), suggesting that patients presenting to routine outpatient services predominantly have lower clinical severity.

Table 2: serum trace element levels in psoriasis patients

Parameter	Mean ± SD	Median (IQR)	Normal Reference	Interpretation
Serum Zinc (µg/dL)	211.07 ± 65.11	193.43 (170.35–242.12)	70–120	Wide variability noted
Serum Copper (µg/dL)	124.24 ± 45.95	116.47 (91.99–145.14)	70–140	Values near upper normal
Cu/Zn Ratio	0.65 ± 0.35	0.56 (0.43–0.78)	<1	Ratio largely within expected range

Serum zinc and copper levels demonstrated wide variability, as indicated by large standard deviations and interquartile ranges. Although mean serum zinc levels were higher than conventional reference ranges, substantial inter-individual variability was observed, indicating heterogeneity in micronutrient status among psoriasis patients. Serum copper levels were largely within the upper normal range, while the Cu/Zn ratio remained below 1 in most patients, suggesting a relatively preserved balance between pro-oxidant and antioxidant trace elements.

Table 3: fasting lipid profile parameters

Parameter	Mean ± SD	Median (IQR)	Normal Cut-off	Interpretation
Total Cholesterol (mg/dL)	182.9 ± 39.8	175 (156–209)	<200	Mean within borderline range
Triglycerides (mg/dL)	130.7 ± 68.4	116 (85–137.8)	<150	Mild hypertriglyceridemia in some
HDL-C (mg/dL)	50.7 ± 12.4	51 (39.3–58.3)	>40	Generally preserved HDL
LDL-C (mg/dL)	105.6 ± 32.9	102 (80.5–127)	<130	Mostly acceptable levels

The lipid profile analysis revealed that mean total cholesterol and triglyceride levels were within borderline normal limits, while HDL-C levels were generally preserved. LDL-C values were largely within acceptable limits.

However, the wide range of lipid values suggests the presence of individual dyslipidemia, supporting the concept that psoriasis is associated with metabolic disturbances even when group averages appear normal. This underscores the importance of cardiovascular risk assessment in psoriasis patients.

Table 4: correlation of PASI score with biochemical parameters

Parameter	Spearman's ρ	p-value	Significance	Interpretation
Age	−0.16	0.265	NS	Severity not age-dependent
Serum Zinc	0.03	0.848	NS	No association
Serum Copper	−0.31	0.031	Significant	Copper decreases with severity
Cu/Zn Ratio	−0.21	0.146	NS	—
Total Cholesterol	0.04	0.785	NS	—
Triglycerides	−0.03	0.821	NS	—
HDL-C	−0.22	0.116	NS	—
LDL-C	0.18	0.199	NS	—

Disease severity, as assessed by the PASI score, did not show a significant association with age, serum zinc, lipid parameters, or Cu/Zn ratio. However, A statistically significant negative correlation between PASI score and serum copper levels (ρ = −0.31, p = 0.031) was observed, indicating that serum copper levels decrease with increasing disease severity. This may reflect increased utilization of copper-dependent

antioxidant enzymes or altered trace element metabolism in severe inflammatory states. This finding supports a potential role of copper imbalance in psoriasis pathophysiology.

Table 5: correlation of serum zinc with lipid profile

Lipid Parameter	Spearman's ρ	p-value	Interpretation
Total Cholesterol	−0.10	0.502	Not significant
Triglycerides	0.08	0.586	Not significant
HDL-C	−0.04	0.809	Not significant
LDL-C	−0.02	0.909	Not significant

Serum zinc levels did not demonstrate any statistically significant correlation with total cholesterol, triglycerides, HDL-C, or LDL-C. This indicates that zinc status did not directly influence lipid metabolism in the present study population.

These findings suggest that alterations in zinc levels and dyslipidemia may occur independently in patients with psoriasis.

Table 6: correlation of serum copper with lipid profile

Lipid Parameter	Spearman's ρ	p-value	Interpretation
Total Cholesterol	0.06	0.696	Not significant
Triglycerides	0.11	0.463	Not significant
HDL-C	0.23	0.115	Not significant
LDL-C	−0.13	0.361	Not significant

No statistically significant correlation was observed between serum copper levels and lipid profile parameters. Despite copper's known role in oxidative metabolism and lipid oxidation, the absence of significant associations suggests that serum copper levels do not directly modulate lipid abnormalities in psoriasis.

This further supports the concept that trace element imbalance and lipid dysregulation may represent parallel but independent processes.

Table 7: correlation of CU/ZN ratio with lipid profile

Lipid Parameter	Spearman's ρ	p-value	Interpretation
Total Cholesterol	0.14	0.339	Not significant
Triglycerides	0.01	0.924	Not significant
HDL-C	0.18	0.224	Not significant
LDL-C	−0.05	0.731	Not significant

Explanation: The Cu/Zn ratio, often considered an indicator of oxidative stress and inflammatory status, did not show any significant association with lipid profile parameters. This finding implies that the oxidative stress reflected by Cu/Zn ratio does not directly translate into dyslipidemia in psoriasis patients, at least in this cohort.

Table 8: internal correlations (data validation)

Parameter Pair	Spearman's ρ	p-value	Interpretation
Zinc ↔ Cu/Zn ratio	−0.66	<0.001	Strong inverse relation
Copper ↔ Cu/Zn ratio	0.75	<0.001	Strong positive relation
Total Cholesterol ↔ LDL	0.66	<0.001	Expected physiological link
Total Cholesterol ↔ Triglycerides	0.55	<0.001	Confirms lipid coupling
Triglycerides ↔ HDL	0.31	0.028	Inverse lipid interaction

Strong and statistically significant correlations were observed between zinc and Cu/Zn ratio (inverse) and copper and Cu/Zn ratio (positive), confirming the internal biochemical consistency of the dataset.

Additionally, expected physiological correlations among lipid parameters—such as total cholesterol with LDL and triglycerides—validate the reliability and biological plausibility of the lipid profile data.

[Figure 1] Heat map illustrating Spearman's rank correlation coefficients (ρ) between demographic variables, psoriasis severity (PASI score), serum zinc, serum copper, Cu/Zn ratio, and lipid profile parameters in patients with psoriasis (n = 50). Each cell represents the correlation coefficient, with color intensity indicating the strength and direction of association. Yellow shades indicate strong positive correlations, dark purple shades indicate strong negative correlations, and green-blue shades indicate weak or no correlation. Values within cells represent Spearman's ρ. A p-value <0.05 was considered statistically significant.

The heat map demonstrates the overall correlation pattern among demographic variables, disease severity, serum trace elements, and lipid profile parameters in patients with psoriasis. A moderate negative correlation between PASI score and serum copper levels (ρ = −0.31) is evident, suggesting a decline in copper levels with increasing disease severity. In contrast, PASI score shows minimal association with lipid profile parameters, indicating

that disease severity is largely independent of dyslipidemia.

Strong internal correlations are observed between trace elements and the Cu/Zn ratio, with zinc showing a strong inverse correlation ($\rho = -0.66$) and copper showing a strong positive correlation ($\rho = 0.75$), confirming the validity of Cu/Zn ratio as an indicator of trace element balance. Lipid parameters demonstrate expected physiological clustering, particularly between total cholesterol and LDL ($\rho = 0.66$) and triglycerides ($\rho = 0.55$), supporting the internal consistency of lipid profile measurements.

Overall, The heat map visually reinforces that trace element imbalance and lipid abnormalities coexist but function as largely independent metabolic processes in psoriasis, with serum copper showing a potential inverse relationship with disease severity.

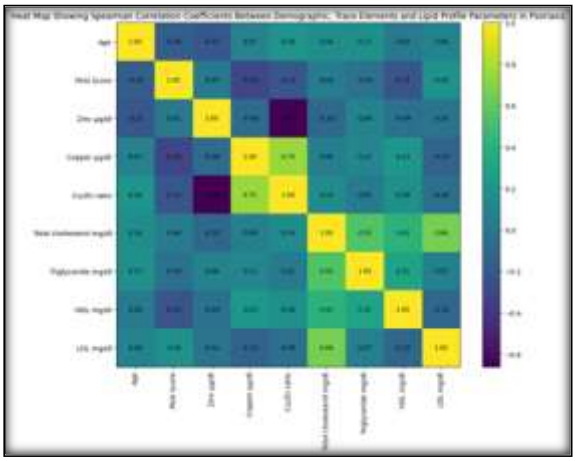

Figure 1: Correlation heat map of disease severity, trace elements, and lipid profile parameters in psoriasis

DISCUSSION

Psoriasis is increasingly recognized as a chronic systemic inflammatory disorder with metabolic and oxidative implications beyond the skin. Alterations in trace elements and lipid metabolism have been proposed to contribute to disease pathogenesis and associated cardiovascular risk. The present study evaluated serum zinc, copper, Cu/Zn ratio, and lipid profile parameters in patients with psoriasis and examined their relationship with disease severity.

Trace Elements in Psoriasis: In the present study, serum zinc levels demonstrated wide inter-individual variability and did not show a significant correlation with disease severity or lipid profile parameters. This finding suggests that zinc deficiency is not universal in psoriasis and may depend on disease phenotype, nutritional status, or redistribution of zinc from serum to hyperproliferative epidermis.

Previous studies have reported conflicting results. Sheikh et al. observed significantly reduced serum zinc levels in psoriatic patients compared with healthy controls, attributing this to increased epidermal turnover and loss through desquamation.[17] Similarly, Al-Wasiti et al. demonstrated significantly lower serum zinc levels in psoriasis, particularly in generalized plaque psoriasis, supporting the role of zinc depletion in oxidative stress and impaired antioxidant defense [18] In contrast, other studies have reported normal zinc levels or lack of association with disease severity, highlighting heterogeneity in zinc metabolism across different populations.[19] The absence of a zinc–severity correlation in the present study may be explained by the predominance of mild disease and the absence of direct oxidative stress markers.

Serum Copper and Disease Severity: A notable finding of the present study was the significant negative correlation between serum copper levels and PASI score, indicating declining copper levels with increasing disease severity. This observation contrasts with several earlier reports describing elevated serum copper levels in psoriasis. Sheikh et al. reported significantly higher serum copper levels in psoriatic patients compared with controls, attributing this increase to elevated ceruloplasmin, an acute-phase reactant upregulated during inflammation.[17] Similarly, Al-Wasiti et al. demonstrated increased serum copper levels in psoriasis patients and linked this to heightened oxidative stress and inflammatory activity.[18] The inverse association observed in the present study may indicate enhanced utilization of copper in antioxidant defense mechanisms during severe disease. Differences in disease severity distribution, nutritional status, and study design may also account for the variability in reported copper levels across studies.

Cu/Zn Ratio and Oxidative Balance: The Cu/Zn ratio showed strong internal correlations with individual trace elements but did not demonstrate a significant association with disease severity or lipid parameters. Although previous studies have proposed the Cu/Zn ratio as a marker of oxidative stress and inflammatory imbalance in psoriasis, particularly in severe disease.[20] the present findings suggest that while the ratio reliably reflects trace element balance, it may not independently predict disease severity in cohorts with predominance of mild psoriasis.

Lipid Profile Abnormalities and Disease Severity: In the present study, lipid parameters showed expected internal correlations; however, no significant association was observed between lipid profile components and PASI score or trace element levels. These findings suggest that dyslipidemia may occur as a parallel metabolic abnormality rather than being directly driven by cutaneous disease severity or trace element imbalance. This contrasts with the findings of Gupta et al,[21] who reported significantly elevated total cholesterol, triglycerides, LDL-C, and VLDL-C with decreasing HDL-C in moderate to severe psoriasis and demonstrated a positive correlation between lipid parameters and disease severity. The discrepancy may be attributed to differences in disease severity distribution, inclusion of moderate–severe cases, assessment of VLDL-C, and adjustment for confounding cardiovascular risk factors.

Other population-based studies have similarly reported inconsistent associations between psoriasis severity and dyslipidemia, supporting the view that lipid abnormalities may represent an independent comorbidity rather than a direct marker of disease activity.[22]

Oxidative Stress and Integrated Pathogenesis: Oxidative stress has been widely implicated in the pathogenesis of psoriasis. Al-Wasiti et al. demonstrated elevated malondialdehyde levels with reduced antioxidant enzymes and vitamins, along with altered zinc and copper levels, emphasizing oxidative imbalance as a central mechanism in psoriasis progression.[18] Although oxidative stress markers were not assessed in the present study, the observed trace element alterations indirectly support the involvement of oxidative pathways in disease severity.

Clinical Implications: The present findings reinforce the concept that psoriasis should be regarded as an immunometabolic disorder with complex interactions between inflammation, oxidative stress, and metabolic abnormalities. The lack of direct association between trace elements and lipid parameters suggests that cardiovascular risk assessment in psoriasis should be performed independently of trace element evaluation.

Strengths and Limitations: The strengths of the present study include simultaneous evaluation of trace elements, lipid profile, and disease severity, providing an integrated metabolic assessment. Limitations include a relatively small sample size, predominance of mild disease, and lack of oxidative stress marker analysis, which may limit broader applicability.

CONCLUSION

In conclusion, the present study demonstrates that serum copper levels decline with increasing psoriasis severity, while serum zinc, Cu/Zn ratio, and lipid profile parameters show no significant association with disease severity. Dyslipidemia appears to coexist independently of trace element imbalance. These findings highlight the importance of comprehensive metabolic and cardiovascular risk assessment in patients with psoriasis and underscore the need for larger prospective studies incorporating oxidative stress markers.

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