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Association of Low Serum Ferritin Level with Non-Scarring Alopecia in Women from Punjab, Pakistan

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ABSTRACT

Hair loss in women is often linked to nutritional deficiencies, especially low serum ferritin. Reduced ferritin may impair hair growth and contribute to non-scarring alopecia, though existing studies show mixed results. **Objectives:** To determine the association between low serum ferritin levels and non-scarring alopecia in women from Punjab, Pakistan. **Methods:** This Case-control study was conducted at the Department of Dermatology, Allam Iqbal Memorial Teaching Hospital, Sialkot, from May 2025 to August 2025. A total of 102 women aged 18–55 years were enrolled, including 51 diagnosed with non-scarring alopecia and 51 age-matched controls with unrelated dermatological conditions. Venous blood samples were analyzed for hemoglobin, ESR, and serum ferritin using ELISA. Serum ferritin <15 ng/mL was categorized as low. Data were analyzed using SPSS v26 and DataTabs. Independent sample t-test compared mean values, chi-square tested categorical associations, and logistic regression determined the predictive value of serum ferritin. **Results:** The mean age of participants was 36.0 ± 10.8 years. Among cases, alopecia areata was most frequent (45.1%), followed by androgenetic alopecia (27.5%) and telogen effluvium (27.5%). Mean ferritin and hemoglobin levels were lower in cases, while ESR was slightly higher. Low ferritin was present in 41.2% of cases versus 19.6% of controls (χ^2 = 5.61, p=0.018). Logistic regression showed low ferritin significantly predicted alopecia (OR=2.87, 95% CI: 1.18–6.98, p=0.020). **Conclusions:** Low serum ferritin is significantly associated with non-scarring alopecia in women. Routine assessment of ferritin may help in identifying iron deficiency as a modifiable factor in patients presenting with hair loss.

INTRODUCTION

Hair loss is a common concern among women and can significantly affect psychological well-being and quality of life [1]. Various conditions under the non-scarring alopecia include telogen effluvium, androgenetic alopecia, and alopecia areata, which can be multifactorial in their causes, including hormonal imbalance, stress, genetics, and nutritional deficiencies [2, 3]. One of the most commonly known nutritional factors that causes diffuse hair loss in women is iron deficiency. Iron is an important constituent of several cellular and metabolic processes that support hair growth [4, 5]. DNA synthesis, energy metabolism, and oxygen transport in the hair follicle bulb are necessary in rapidly dividing cells. Ferritin is a protein that stores iron within a cell and controls the supply of iron to all essential enzymatic processes, including those in the synthesis of keratin. Normal levels of ferritin ensure the metabolic activity of the follicular cells and stimulate the anagen (growth) stage, whereas exhausted reserves may lead to an early transition to the telogen (resting) stage, leading to loss of hair [6, 7]. Serum ferritin is an effective indicator of the total body iron stores, and can be used to identify early iron deficiency before anemia develops. The connection between serum ferritin and various types of hair loss has already been studied in the past, but the results were not always similar. A number of studies have indicated that women who experience non-scarring alopecia have lower levels of ferritin compared to healthy controls, which may indicate that iron deficiency may have a role to play in the

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occurrence of hair loss. It has been suggested by other studies that this association is more pronounced in other conditions like alopecia areata and androgenetic alopecia but less pronounced in telogen effluvium [4, 8].

Despite increasing evidence linking iron deficiency to hair loss, the association between low serum ferritin and non-scarring alopecia remains inconsistent across different populations. Variations in diagnostic cut-offs, study designs, and nutritional backgrounds have produced conflicting findings, particularly regarding the strength of this relationship in women of reproductive age. Moreover, data from South Asian populations, where iron deficiency is highly prevalent, are limited and insufficient to guide evidence-based screening practices. Therefore, there is a need for region-specific research to clarify whether low serum ferritin is a significant contributing factor to non-scarring alopecia in women from Punjab, Pakistan. Although there is a lot of research on the topic globally, there is a dearth of information in South Asia, where iron deficiency and anemia are very high among women of reproductive age. This paper aimed to assess the relationship between low serum ferritin levels and non-scarring alopecia among women in Punjab, Pakistan. Through this relationship, the study will help to answer the question of whether ferritin deficiency is a major factor in the patterns of hair loss in this group of people and whether it will help in supporting the use of early laboratory screening and nutritional correction as part of clinical intervention. This study aimed to determine the association between low serum ferritin levels and non-scarring alopecia in women from Punjab, Pakistan.

METHODS

The case-control study was carried out in the department of dermatology, Allam Iqbal Memorial Teaching Hospital, Sialkot, after receiving the institutional research and ethics committee approval (Ref. No. 30/REC/KMSMC). The study was conducted from 2nd May, 2025 to 20th August, 2025. The WHO sample size calculator was used to determine the minimum sample size of 49 patients in each group (98 in total) with 80% statistical power, 5% significance level, and previously known proportions of low serum ferritin (63% in cases and 38% in controls) [8]. The sample size was adjusted to 51 participants per group to accommodate the potential attrition, non-response, or incomplete investigations, and the total of 102 participants ensured the maintenance of statistical power in the case of minor data loss. Non-probability consecutive sampling was used to enroll the participants. Women aged 18-55 years with non-scarring alopecia that was clinically verified were included in the case group. Conversely, the control group was a group of women who had no history of hair loss or iron deficiency and visited the same dermatology outpatient clinic because of other skin-related problems. To reduce confounding, controls were chosen to be similar to cases in terms of age (±3 years) and socioeconomic background, which was based on household income, education level, and occupation. The same consultant dermatologist (more than five years of experience) examined all the participants to ensure diagnostic consistency and minimize observer variation. The exclusion criteria were congenital or scarring alopecia, hair shaft disorder, acute inflammatory or systemic disease, abnormal thyroid activity, or erythrocyte sedimentation rate (ESR) ≥30 mm/h in the first hour. Postmenopausal women and those women who had taken vitamin B12, folic acid, iron, or multivitamin supplements in the last three months were also excluded. All participants signed informed consent in writing. Each subject was recorded with demographic information, such as age and name. In some cases, the alopecia subtype (androgenetic alopecia, alopecia areata, or telogen effluvium) and Ludwig stage were reported. Each of the participants was sampled by a trained phlebotomist who took 5 mL of venous blood. Of this, 3 ml of it was kept at –20°C to measure serum ferritin, and the rest 2 ml was referred to complete blood count. The enzyme-linked immunosorbent assay (ELISA) was used to determine serum ferritin by means of a sandwich-based Human Ferritin ELISA Kit (DRG Instruments GmbH, Germany) according to the manufacturer. A predesigned proforma was used to record all the information, and serum ferritin of less than 15 ng/mL was considered low. The data were entered and analyzed using SPSS version 26.0 and DataTabs. Numerical variables (age and serum ferritin) were summarized using mean ± standard deviation, whereas categorical variables (alopecia subtype, Ludwig stage and low serum ferritin status) were summarized using frequencies and percentages. The independent sample t-test was used to compare the mean ferritin in cases and controls, and the statistical significance was defined as $p \leq 0.050$. Odds ratios were calculated to determine the association between low serum ferritin and alopecia, with an odds ratio greater than one considered statistically significant.

RESULTS

The mean age of 102 participants was 36.0 ± 10.8 years. Among the cases, alopecia areata was the most frequent subtype, affecting 23 women (45.1%). Androgenetic alopecia and telogen effluvium were observed in 14 women each (27.5% each). In patients with androgenetic alopecia, distribution by Ludwig's classification showed stage I in 8 (57.1%), stage II in 5 (35.7%), and stage III in 1 (7.1%). The mean serum ferritin and hemoglobin levels were lower in cases than in controls, while ESR was slightly higher in cases (Table 1).

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Table 1: Comparison of Mean Serum Ferritin, Hemoglobin, and ESR Levels Between Women with Non-Scarring Alopecia (Cases) and Controls

Variables	Cases	Controls	t-test (DF, p-Value)
Serum Ferritin (ng/mL)	20.04 ± 15.17	29.04 ± 14.79	t (100) =-3.03, p=0.003
Serum Hb (g/dL)	12.16 ± 1.51	12.97 ± 1.05	t (100) =-3.14, p=0.002
ESR (mm/hr)	10.10 ± 4.85	9.00 ± 3.20	T (100) =1.36, p=0.178

Low serum ferritin (<15 ng/mL) was more frequent among cases compared with controls (Table 2).

Table 2: Distribution of Low Serum Ferritin Among Women with Non-Scarring Alopecia (Cases) and Controls With Corresponding Chi-Square Test Results

Low Ferritin	Cases	Controls	Total	χ^2 (DF, p-Value)
No	30 (29.4%)	41 (40.2%)	71 (69.6%)	χ^2=6.80, df=1, p=0.009
Yes	21 (20.6%)	10 (9.8%)	31 (30.4%)	

Low serum ferritin was observed in 30.4% of participants, with the highest proportion in the 36–45 age group (11.8%). No significant association was found between ferritin status and age group (χ^2=3.47, p=0.324) (Table 3).

Table 3: Distribution of Low Serum Ferritin Among Women with Non-Scarring Alopecia According to Age Groups

Age Group (years)	Normal Ferritin (No)	Low Ferritin (Yes)	Total	χ^2 (p-Value)
18–25	15 (14.71%)	9 (8.82%)	24 (23.53%)	χ^2=3.47, p=0.324
26–35	20 (19.61%)	5 (4.90%)	25 (24.51%)	
36–45	19 (18.63%)	12 (11.76%)	31 (30.39%)	
46–55	17 (16.67%)	5 (4.90%)	22 (21.57%)	
Total	71 (69.61%)	31 (30.39%)	102 (100%)	

Similarly, ferritin distribution did not differ significantly across Ludwig stages (χ^2=0.34, p=0.844) (Tables 3 and 4) (Table 4).

Table 4: Distribution of Low Serum Ferritin Among Women with Non-Scarring Alopecia According to Ludwig Stage

Ludwig Stage	Normal Ferritin (No)	Low Ferritin (Yes)	Total	χ^2 (p-Value)
I	6 (5.88%)	2 (1.96%)	8 (7.84%)	χ^2=0.34, p=0.844
II	4 (3.92%)	1 (0.98%)	5 (4.90%)	
III	1 (0.98%)	0 (0.00%)	1 (0.98%)	
Total	11 (10.78%)	3 (2.94%)	14 (13.72%)	

Binary logistic regression analysis revealed a statistically significant association between case status and low serum ferritin (χ^2=5.70, p=0.017). Women in the alopecia group were 2.87 times more likely to have low serum ferritin compared with controls (95% CI: 1.18–6.98, p=0.020) (Table 5).

Table 5: Binary Logistic Regression Analysis Between Case Status and Low Serum Ferritin

Variables	B (Co-efficient)	Standard Error (SE)	z-Value	p-Value	Odds Ratio (Exp(B))	95% Confidence Interval for OR
Constant	-1.41	0.35	4.00	<0.001	0.24	0.12 – 0.49
Label (Case)	1.05	0.45	2.33	0.020	2.87	1.18 – 6.98

DISCUSSION

The present study demonstrated a significant association between low serum ferritin and non-scarring alopecia in women. Participants with alopecia had lower ferritin and haemoglobin levels than controls, while erythrocyte sedimentation rate remained comparable. The prevalence of low ferritin (<15 ng/mL) was more than twice as high among cases, and logistic regression confirmed low ferritin as an independent predictor of alopecia (OR = 2.87, 95% CI 1.18–6.98, p=0.020). These findings indicate that iron depletion meaningfully increases the likelihood of hair loss. Iron is important in follicular metabolism and keratin production; low ferritin can cause anagen-telogen imbalance, leading to diffuse shedding. Our findings are consistent with those of Aslam *et al.*, who discovered significantly reduced ferritin in women with alopecia, and Chisti *et al.*, who found the same differences and stronger correlations between alopecia areata and androgenetic alopecia. These regional studies, along with ours, indicate that iron deficiency is a factor in follicular dysfunction among pre-menopausal women and that ferritin testing must be included in preliminary examination [4, 8]. Chen *et al.* conducted a meta-analysis of 23 studies demonstrating that micronutrient deficiencies, especially low vitamin D, are risk factors, whereas Chary and Salechaa et al. found simultaneous deficits in ferritin, vitamin B 12, and vitamin D [9-11]. These results are similar to our conclusion that hair loss is not usually caused by one deficiency; instead, iron deficiency is synergistic with other micronutrient deficiencies. Massive and retrospective studies reinforce this idea. According to Oner and Akdeniz, ferritin deficiency was found in 22 per cent of women versus 9 per cent of men, most often in telogen effluvium, and Abdaljawad *et al.* related low ferritin to more severe and prolonged paediatric alopecia areata. Mohammed *et al.* found ferritin to be one of a range of biochemical correlates of alopecia in both sexes, but Neupane and Kumar found sub-threshold ferritin in female pattern hair loss without statistical significance, demonstrating the sensitivity of different cut-offs to significance [12-15]. These observations are supplemented by studies that focus on methodological improvements. Jasim and Aledan suggested reticulocyte haemoglobin content as a more sensitive measure of iron deficiency in diffuse hair loss, whereas Sulaiman and Qurtas reported trichoscopy as a supplement to

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biochemical tests. The two methods put forward are that diagnosis can be refined by combining clinical and laboratory markers [16-17]. Saqib *et al.* and Suleri *et al.* studied the deficiency of vitamin D, both in high prevalence and in controls, which supports the multifactoriality of alopecia. The results of Farah *et al.* showed that the reduction of ferritin and haemoglobin was the highest in younger women, which confirms our finding that iron deficiency is especially prevalent before menopause [5, 18, 19]. The lack of homogeneity in the studies is in part due to varying ferritin thresholds. Only 9 percent of female pattern hair loss was found to have ferritin under 15 ng/mL but over 50 percent of patients had ferritin under 70 ng/mL, indicating that ferritin under 15 ng/mL could still be detrimental to hair cycling. Lin *et al.* proposed redefining iron deficiency for hair health as ferritin < 60 ng/mL, noting improved regrowth with supplementation, whereas Zhang *et al.* reiterated that ferritin is a sensitive yet context-dependent biomarker that must be interpreted alongside inflammatory markers [6, 20-21]. Regional studies also reinforce the value of ferritin assessment. Joshi *et al.* reported inadequate ferritin in more than three-quarters of Nepali women with alopecia, despite normal haemoglobin, confirming that anaemia alone cannot represent iron status. In contrast, de Queiroz *et al.* observed higher ferritin in alopecia areata, showing that ferritin behavior may vary by subtype or inflammation. Much of this heterogeneity was resolved by the meta-analysis of Treister-Goltzman *et al.* that involved more than 10,029 participants and showed that the pooled mean ferritin difference between women with and without alopecia was -18.5 ng/mL ($p < 0.01$) [1, 22-23]. The data suggest that low ferritin is a reliable correlate of non-scarring alopecia. The differences in studies are mainly due to the variation in the definitions of diagnosis, sample demographics and nutritional baselines. We use our results to generalize this evidence to a Pakistani cohort where iron deficiency is still common among women. Ferritin measurement is a simple, cheap clinical tool that could be used to inform early nutritional intervention. Future studies must combine ferritin with other complementary indices like reticulocyte haemoglobin, vitamin D, and zinc to come up with holistic nutritional profiles of patients who present with diffuse hair loss. There were some limitations of the study. Iron status was determined by serum ferritin alone without any other biochemical measurements of iron metabolism like serum iron, saturation of transferrin or total iron-binding capacity that would have given a more comprehensive picture of iron metabolism. Factors such as dietary intake, menstrual history, and deficiencies of micronutrients (zinc, vitamin D, and vitamin B12) were not taken into account. Longitudinal designs should be employed in future studies to investigate the impact of iron supplementation on hair regrowth among various types of alopecia and a wider nutritional profiling should be undertaken.

This study has certain limitations, including a relatively small sample size and its single-center design, which may limit generalizability. Iron status was assessed solely through serum ferritin without evaluating additional iron indices or other micronutrients that may influence hair growth. Dietary factors, menstrual history, and inflammatory markers were not comprehensively analyzed. Future multicenter studies with larger cohorts and longitudinal follow-up are recommended to assess the impact of iron supplementation and to explore combined micronutrient profiling for a more comprehensive understanding of non-scarring alopecia.

CONCLUSIONS

In conclusion, low serum ferritin is significantly correlated with non-scarring alopecia in women. Alopecic patients had lower mean ferritin and hemoglobin levels than the controls, and low ferritin was more prevalent in cases. The low serum ferritin was affirmed as an independent predictor using logistic regression analysis, with the affected women having almost twice the probability of alopecia than those with normal ferritin. These results indicate that ferritin level testing can be used to identify iron deficiency in women with alopecia early and can be used to facilitate the use of appropriate management measures to enhance clinical outcomes.

Authors' Contribution

Conceptualization: ZS
Methodology: KL, ZS
Formal analysis: KL, SR
Writing and Drafting: BB, SR
Review and Editing: BB, SR, KL, ZS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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