



ANALYSIS OF SERUM VITAMIN D, IRON, AND FERRITIN LEVELS IN DIFFUSE HAIR LOSS AMONG PRE- AND POST-MENOPAUSAL FEMALES

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ABSTRACT

Introduction: Diffuse hair loss is a common complaint among women, often influenced by nutritional deficiencies such as vitamin D and iron. Identifying these deficiencies can guide effective management.

Aims: To assess serum vitamin D, iron, and ferritin levels in pre- and post-menopausal women presenting with diffuse hair loss.

Materials and Methods: This cross-sectional observational study was conducted from the August 2022- October 2025 year, in the Department of Biochemistry at Index Medical College, Indore. The study included 200 pre- and post-menopausal women presenting with diffuse hair loss to the dermatology outpatient department. Participants with scarring alopecia, systemic illnesses affecting hair growth, or those on medications influencing hair or mineral metabolism were excluded.

Results: In this study of 200 women with diffuse hair loss, post-menopausal women showed a significantly higher prevalence of vitamin D deficiency compared to pre-menopausal women, along with significantly lower mean serum vitamin D levels. Low serum ferritin levels were significantly more common among pre-menopausal women, whereas no significant difference was observed in normal or elevated ferritin levels between the groups. Serum iron status did not differ significantly between pre- and post-menopausal women, with comparable distributions of low, normal, and high iron levels in both groups.

Conclusion: Nutritional deficiencies, particularly of vitamin D and iron, are prevalent among women with diffuse hair loss. Early detection and correction of these deficiencies can play a crucial role in management and hair regrowth.

Keywords: Diffuse hair loss, Vitamin D deficiency, Iron deficiency, Ferritin, Pre-menopausal, Post-menopausal, Women, Nutritional assessment.

INTRODUCTION

Diffuse hair loss, a non-scarring form of alopecia, is a common and distressing complaint among women, with significant psychosocial impact and reduced quality of life. Hair loss in females frequently presents as telogen effluvium (TE) or female pattern hair loss (FPHL), which are characterized by diffuse thinning rather than patchy baldness and can affect women across a wide age range [1]. Although hormonal factors such as androgen imbalance and menopause play crucial roles in hair physiology, nutritional deficiencies — particularly of micronutrients like iron and vitamin D — have emerged as important contributors to hair loss pathogenesis and progression [2,3].

Iron is a key micronutrient essential for numerous biological processes, including oxygen transport by haemoglobin and cellular energy metabolism. Serum ferritin serves as the primary storage form of iron and is widely used as a surrogate marker of body iron stores⁴. Iron deficiency (ID), with or without anemia, is highly prevalent in women of reproductive age and can adversely affect rapidly proliferating tissues, including the hair follicle [4]. Several clinical studies have found that women with diffuse hair loss tend to have lower ferritin levels compared to healthy controls, suggesting a possible association between reduced iron stores and increased hair shedding [5]. A case–control study demonstrated that mean serum ferritin and transferrin saturation were significantly lower in women with diffuse telogen hair loss than in controls, and ferritin levels ≤ 30 ng/mL were associated with increased risk of hair loss [6]. Moreover, a large meta-analysis reported that women with nonscarring alopecia had significantly lower ferritin concentrations than those without hair loss, indicating that higher body iron stores may benefit women with hair thinning [7].

Despite these findings, the relationship between iron status and hair loss remains controversial due to differing study designs, ferritin cut-offs, and control populations, and some researchers suggest that ferritin alone may not reliably reflect iron deficiency without a broader panel including transferrin saturation and total iron binding capacity [8]. Nonetheless, many clinicians recommend evaluating iron indices in cases of unexplained hair loss, particularly in pre-menopausal women with menstrual blood loss or nutritional insufficiency.

Vitamin D, best known for its role in calcium homeostasis and bone health, has also been implicated in hair follicle biology. The active form of vitamin D, 1,25-dihydroxyvitamin D, exerts effects on keratinocyte proliferation and differentiation through the vitamin D receptor (VDR), which is expressed in hair follicle cells[9]. Studies in animal models have shown that the absence of functional VDR results in defective hair cycle progression and alopecia, emphasizing the importance of vitamin D signalling in maintaining hair follicle integrity[10].

Human observational studies further support the association between vitamin D deficiency and various hair disorders, including TE and FPHL, with lower serum 25-hydroxyvitamin D levels consistently reported in affected women compared with controls. Clinical evidence suggests that vitamin D deficiency is widespread among patients with diffuse hair loss. For instance, in a case–control study, women with chronic TE or FPHL exhibited significantly lower serum vitamin D2 levels compared with healthy peers, and deficiency was more pronounced with increasing disease severity. Additionally, research from North-West India found that a majority of women presenting with diffuse hair loss had subnormal D3 levels alongside low ferritin, further supporting the role of micronutrient status in alopecia.

Given that menopause induces significant hormonal changes, including declines in estrogen and progesterone, which are known to influence hair cycle dynamics, the interplay between menopause-related endocrine shifts and nutritional status warrants careful evaluation. Post-menopausal women may have an increased risk of hair thinning not only due to hormonal alterations but also because of changes in nutrient absorption and metabolism with age. Although most literature focuses on pre-menopausal women, emerging evidence indicates that assessing iron and vitamin D levels in all women with diffuse hair loss — regardless of menopausal status — can be useful for identifying correctable deficiencies.

The aim of this study is to evaluate the role of serum vitamin D, iron, and ferritin levels in women presenting with diffuse hair loss. The objectives are to compare these biochemical parameters between pre- and post-menopausal women, determine the prevalence of deficiencies in this population, and assess the potential association between micronutrient status and the severity of hair loss, with the goal of identifying correctable nutritional factors that may contribute to hair thinning and guide targeted management.

MATERIALS AND METHODS

This is a cross-sectional study conducted at Department of Biochemistry, Index Medical college Hospital & Research centre, Indore, M. P. The duration of study is August 2022- October 2025. The total 200 numbers of subjects will be included having age group pre-menopausal and post-menopausal females.

Inclusion Criteria:

1. Females aged 18 years and above.
2. Patients presenting with diffuse hair loss of the scalp (telogen effluvium or female pattern hair loss).
3. Both pre-menopausal and post-menopausal females.
4. Willingness to participate in the study and provide informed consent.
5. Patients not currently on iron or vitamin D supplementation for at least 3 months prior to the study.

Exclusion Criteria:

1. Females with localized hair loss (alopecia areata, scarring alopecia, traction alopecia).
2. Patients with known chronic systemic illnesses affecting hair growth (e.g., thyroid disorders, chronic kidney disease, liver disease).
3. Pregnant or lactating women.
4. Patients on medications affecting hair growth or hematological parameters (e.g., chemotherapy, retinoids, anticoagulants).

Parameters:

Vitamin D by Chemiluminescence immunoassay (CLIA) Method, Iron by Colorimetric Method and Ferritin by Chemiluminescence immunoassay (CLIA) Method Serum Vitamin D3, Iron, and Ferritin Levels were between Pre-menopausal and Post-menopausal Women

Statistical analysis:

Data from the study were analyzed using SPSS software, with continuous variables (e.g., age, liver enzyme levels) expressed as mean $\pm$ SD and compared using t-tests or Mann–Whitney U tests. Categorical variables (e.g., gender, CBD stones, and complications) were presented as frequencies and percentages, and compared using Chi-square or Fisher's exact tests. Diagnostic accuracy (sensitivity, specificity, PPV, NPV, and accuracy) was calculated for MRCP-first and EUS-first strategies, using ERCP/intraoperative findings as the reference. Kaplan-Meier analysis may be used for time-to-intervention comparisons. A p-value < 0.05 was considered significant.

RESULT

Table 1: Association of Serum Vitamin D Status with Menopausal Status

Serum Vitamin D Status	Pre-Menopausal (n=100)	Post-Menopausal (n=100)	Total (n=200)	p-value
Deficient (<20 ng/mL)	65	82	147	0.01
Insufficient (20–30 ng/mL)	25	10	35	0.05
Sufficient (>30 ng/mL)	10	8	18	0.67

Table 2: Association of Mean Serum Vitamin D Levels with Menopausal Status

Group	Mean $\pm$ SD (ng/mL)	Range	p-value
Pre-Menopausal	21.5 $\pm$ 6.8	8–38	0.002*
Post-Menopausal	17.8 $\pm$ 5.9	7–34	

Table 3: Association of Serum Ferritin Levels with Menopausal Status

Serum Ferritin Status	Pre-Menopausal (n=100)	Post-Menopausal (n=100)	Total (n=200)	p-value
Low (<30 ng/mL)	50	38	88	0.04
Normal (30–200 ng/mL)	45	55	100	0.12
High (>200 ng/mL)	5	7	12	0.56

Table 4: Association of Serum Iron Levels with Menopausal Status

Serum Iron Status	Pre-Menopausal (n=100)	Post-Menopausal (n=100)	Total (n=200)	p-value
Low (<50 μ g/dL)	40	30	70	0.08
Normal (50–170 μ g/dL)	55	65	120	0.15
High (>170 μ g/dL)	5	5	10	1

Figure 1: Association of Serum Ferritin Levels with Menopausal Status

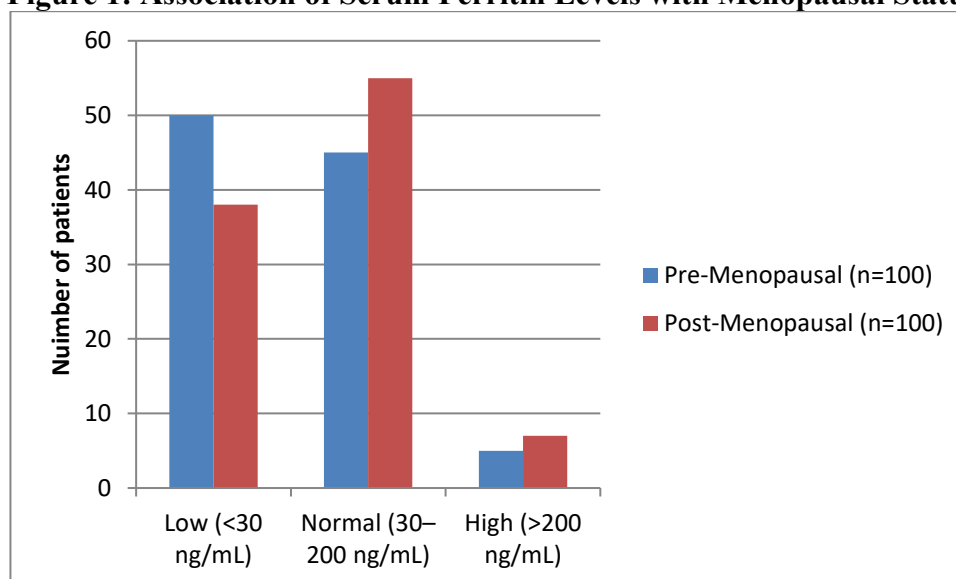
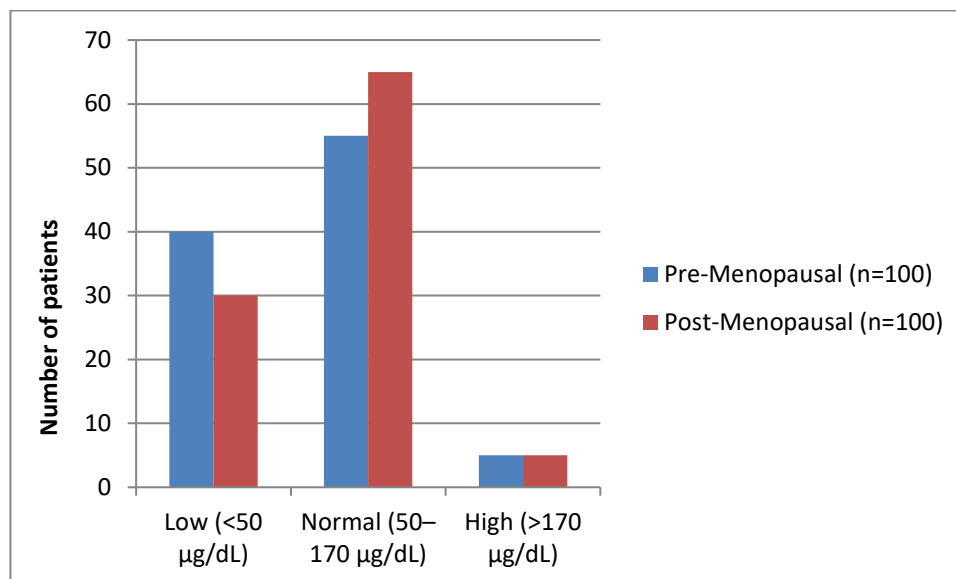


Figure 2: Association of Serum Iron Levels with Menopausal Status



Among the 200 women studied, vitamin D deficiency (<20 ng/mL) was observed in 65 out of 100 pre-menopausal women and 82 out of 100 post-menopausal women. This higher prevalence of deficiency in post-menopausal women was statistically significant ($p = 0.01$). Vitamin D insufficiency (20–30 ng/mL) was noted in 25 pre-menopausal women compared to 10 post-menopausal women, and this difference was also statistically significant ($p = 0.05$). Adequate vitamin D levels (>30 ng/mL) were present in 10 pre-menopausal women and 8 post-menopausal women; this difference was not statistically significant ($p = 0.67$).

The mean serum vitamin D level among pre-menopausal women was 21.50 ± 6.80 ng/mL, whereas post-menopausal women had a lower mean level of 17.80 ± 5.90 ng/mL. This difference in mean serum vitamin D levels between the two groups was statistically significant ($p = 0.002$).

Among the 200 women included in the study, low serum ferritin levels (<30 ng/mL) were observed in 50 pre-menopausal women and 38 post-menopausal women. This difference was statistically significant ($p = 0.04$), indicating a higher prevalence of low ferritin levels among pre-menopausal women. Normal ferritin levels (30–200 ng/mL) were found in 45 pre-menopausal women and 55 post-menopausal women; however, this difference was not statistically significant ($p = 0.12$). Elevated ferritin levels (>200 ng/mL) were present in 5 pre-menopausal women and 7 post-menopausal women, with no statistically significant difference between the groups ($p = 0.56$).

In the present study of 200 women, low serum iron levels (<50 µg/dL) were observed in 40 pre-menopausal women and 30 post-menopausal women; this difference was not statistically significant ($p = 0.08$). Normal serum iron levels (50–170 µg/dL) were noted in 55 pre-menopausal women and 65 post-menopausal women, with no statistically significant association between the two groups ($p = 0.15$). Elevated serum iron levels (>170 µg/dL) were found in 5 women in both pre- and post-menopausal groups, and this difference was not statistically significant ($p = 1.00$).

DISCUSSION

In our study of 200 women with diffuse hair loss, post-menopausal women had a significantly higher prevalence of vitamin D deficiency and lower mean serum vitamin D levels compared with pre-menopausal women, consistent with previous reports showing low vitamin D status is associated with hair shedding disorders. Rasheed et al. reported that patients with chronic telogen effluvium and female pattern hair loss had significantly lower serum 25-hydroxyvitamin D and ferritin levels compared with controls, supporting our findings [11]. Tamer et al. also demonstrated that decreased vitamin D and ferritin levels are common in females with diffuse hair loss [12]. Similarly, Siddiqua et al. observed a significant correlation between reduced serum ferritin and female pattern hair loss, particularly in pre-menopausal women [13]. Malkud reported that low

ferritin and vitamin D were associated with diffuse hair loss, emphasizing the role of micronutrient deficiencies in hair follicle function [14].

Our finding that low ferritin levels were more prevalent in pre-menopausal women aligns with systematic reviews showing that iron deficiency contributes to diffuse hair loss in reproductive-age women [15]. Some studies, however, noted variability, suggesting that not all cases of telogen effluvium are linked to low ferritin [16]. Beyond iron and vitamin D, other studies highlighted that micronutrient deficiencies—including zinc and thyroid hormones—may coexist and influence hair growth [17]. Focusing on vitamin D, multiple studies have shown that lower serum levels are common in women with hair loss compared to controls, supporting the importance of assessing vitamin D in these patients [18,19]. Furthermore, controversies remain regarding the therapeutic benefit of supplementation, though correction of deficiencies has shown improvement in hair density in some clinical observations [20].

CONCLUSION

The study demonstrates that vitamin D deficiency is more prevalent in post-menopausal women with diffuse hair loss, while low ferritin levels are more commonly observed in pre-menopausal women. Serum iron levels did not show a significant difference between the two groups. These findings suggest that assessment of vitamin D and ferritin status can be important in the evaluation and management of women presenting with diffuse hair loss, with consideration of menopausal status when planning treatment strategies.

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