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Research Article

# Clinico-Epidemiological Study of Acquired Alopecia in Females: Correlation with Anemia and Thyroid Dysfunction

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## ABSTRACT

**Background:** Acquired alopecia in females is a common dermatological complaint; it has a multifactorial etiology. Thyroid dysfunctions and nutritional deficiencies are important factors for this condition. However, their role across alopecia subtypes remains unknown. The current study was designed to evaluate the prevalence of anemia, iron deficiency, and thyroid dysfunction among women with acquired alopecia and to correlate these parameters with alopecia severity.

**Methods:** The prospective observational study was done on 50 female patients aged 17-49 years with acquired alopecia presenting to our hospital. Detailed history, physical examination, hematological investigations, thyroid functioning test, and serum ferritin tests were performed on all cases. Sinclair grade regarding female pattern hair loss (FPHL) and SALT score regarding alopecia areata (AA) were used to evaluate functional correlations with the severity of alopecia.

**Results**: Most frequent subtype of acquired alopecia was Telogen effluvium (44%), followed by FPHL (32%), AA (18%), and cicatricial alopecia (6%). 56% of the cases in the study were found to have anemia, with most of the cases having mild anemia. Iron deficiency was detected in 64% of cases and was most marked in TE cases (81.8%). Serum ferritin showed a significant inverse correlation with alopecia severity ($\rho = -0.52$, $p=0.02$). Thyroid dysfunction was observed in 28%, with subclinical hypothyroidism being the most common abnormality. A vegetarian diet independently increased the risk of iron deficiency (aOR 4.85, $p=0.02$).

**Conclusion**: Nutritional deficiencies, especially iron deficiency, and thyroid dysfunction are common in female alopecia, with ferritin correlating strongly with disease severity. Routine screening and timely correction of these abnormalities should be integral to management, particularly in telogen effluvium and FPHL.

***Keywords***: *Alopecia, Telogen Effluvium, Female Pattern Hair Loss, Anemia, Iron Deficiency, Thyroid Dysfunction.*

## INTRODUCTION

Hair is a crucial part of physical and psychological health, especially in females. Hair disorders, and in particular alopecia, have a high cosmetic, social, and emotional impact. Alopecia is the loss of scalp or body hair, and it can be broadly classified as either congenital or acquired. Among them, acquired alopecia is more widespread and represents a common reason for dermatological visits all over the world (1). The etiology of acquired alopecia is multifactorial and includes genetic, hormonal, nutritional, autoimmune, and environmental factors. It is observed that the burden of acquired alopecia in females is on the rise, and partly it is caused by more awareness, lifestyle changes related to stress, and nutritional deficiencies. Women are particularly at risk because hair loss in women has not been as socially acceptable as in men and

usually causes depression, anxiety, and decreased quality of life (2,3). Women do not present patterns of alopecia in the same way as men, and diffuse, patchy, or generalized shedding is more common. The most common acquired alopecia among women are telogen effluvium, alopecia areata, androgenetic alopecia, and scarring alopecias (4). Hair loss has always been associated with nutritional deficiencies, especially anemia, due to iron deficiency. Iron is an important factor affecting the growth and multiplication of hair follicle matrix cells, and a lack of it may affect the growth and multiplication of hair (5). A number of studies have shown that diffuse hair loss in women is strongly associated with low levels of serum ferritin (6). As there is a strong prevalence of nutritional anemia in developing nations and particularly in reproductive-aged women, this aspect deserves close consideration in patients with alopecia (7). Similarly, another systemic disorder that is closely related to alopecia is thyroid dysfunction. Diffuse thinning or patches of alopecia areata can be caused either by hypothyroidism or hyperthyroidism. The metabolism and differentiation of keratinocytes are regulated by thyroid hormones, whose imbalance may result in the weakening of hair and reduced growth (8,9). Telogen effluvium has been specifically attributed to hypothyroidism, whilst diffuse hair thinning is commonly associated with hyperthyroidism (10). Given the increased incidence of thyroid disorders in women, it is of great clinical significance to assess the thyroid functionality in alopecia patients. Although anemia and thyroid dysfunction have been reported to be related to alopecia, the prevalence and strength of the relationship vary in different populations. This difference can be attributed to genetic, dietary, and environmental differences. Particularly, Indian studies have cited a high rate of nutritional anemia and thyroid dysfunction in women that could predispose women to increased rates of alopecia (11). Nevertheless, there is limited comprehensive clinico-epidemiological information that specifically describes female patients in our area. Thus, the study aimed to determine the clinico-epidemiological profile of acquired alopecia in females and to examine the relationship between acquired alopecia and anemia and thyroid functioning. This is important not only in effective diagnosis but also in the application of suitable corrective actions, including nutritional supplementation or hormonal therapy, to enhance treatment outcomes and quality of life in afflicted women.

**Materials and Methods**

This cross-sectional observational study was conducted in the Department of Dermatology in coordination with the Department of General Medicine, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Telangana. The Institutional Ethics Committee approved the study protocol. Patient confidentiality was maintained as per the Declaration of Helsinki for human research. Written consent was obtained from all the participants after explaining the nature of the study in the vernacular language, and assent with guardian consent for ages 15–17 was obtained.

*Inclusion criteria*

1. Females aged 15 or above
2. Acquired hair loss (new or worsening) within the last 12 months
3. Ready to undergo the investigations
4. Willing to participate by signing informed consent

*Exclusion criteria*

1. Congenital alopecia
2. Pregnancy/Lactation
3. Postpartum period <6 months
4. Chemotherapy/radiotherapy
5. Systemic illnesses causing cicatricial alopecia
6. Surgery or hemorrhage in the previous 3 months

*Sample size and sampling:* A total of 50 consecutive female patients eligible as per the inclusion and exclusion criteria were included in the study. The method of sample collection was a convenience sampling method.

*Clinical assessment*: A structured proforma captured demographics (age, menstrual and obstetric history, diet, drug history, hair-care practices, family history), onset/duration, shedding pattern, and triggers (stress, illness, weight loss). Dermatological examination included scalp mapping, hair-pull test, wash test (when feasible), trichoscopy, and scalp photography. Alopecia was classified as:

1. Telogen effluvium (TE)
2. Female pattern hair loss (FPHL) (graded by Sinclair/Ludwig scale)
3. Alopecia areata (AA) (severity by SALT score)
4. Cicatricial alopecia (clinical ± biopsy when indicated).
5. Coexistent dandruff/seborrheic dermatitis and thyroid signs were recorded.

*Laboratory investigations*: Complete blood count (automated analyzer), peripheral smear when indicated; hemoglobin (Hb) classified per WHO for non-pregnant women (mild 11–11.9 g/dL, moderate 8–10.9 g/dL, severe <8 g/dL). Iron studies: Serum ferritin (chemiluminescence); iron deficiency defined as ferritin <30 ng/mL (or <50 ng/mL if inflammatory markers are elevated). Optional: serum iron, TIBC, transferrin saturation. Thyroid profile: TSH and free T4 (and free T3 if needed).

Thyroid status categorized as:

1. Euthyroid: TSH 0.4–4.0 mIU/L with normal FT4

2. Subclinical hypothyroid: TSH >4.0 with normal FT4
3. Overt hypothyroid: TSH >4.0 with low FT4
4. Subclinical hyperthyroid: TSH <0.4 with normal FT4
5. Overt hyperthyroid: TSH <0.4 with high FT4. Optional anti-TPO antibodies were measured when autoimmune thyroid disease was suspected.

*Outcomes*: Primary outcomes were (1) prevalence of anemia and iron deficiency and (2) prevalence of thyroid dysfunction across alopecia subtypes. Secondary outcomes included correlations of Hb/ferritin/TSH with alopecia severity scores (SALT for AA; Sinclair/Ludwig grade for FPHL) and duration.
*Statistical analysis:* All the available data were uploaded to an MS Excel spreadsheet and analyzed by SPSS version 26 in Windows format. The Continuous variables were represented as mean ± SD (or median [IQR]); categorical variables as frequency and percentage. Group comparison was done by use of the T-test, the Mann-Whitney U test for two groups, and the Kruskal–Wallis test for ≥3 groups. Correlations were measured by Spearman coefficients. The values of p (<0.05) were considered significant.

**Results**
The sample size of the study was 50 women with acquired alopecia with a mean age of 32.5 ± 8.7 years (the range 17-49 years). Table 1 shows the demographic profile of the cases included in the study. The majority of cases were aged 25-49 (76%), which is the common age of onset of alopecia in women. The average BMI was 23.1 ± 3.4 kg/m$^2$, indicating that it was within the normal range; hence, obesity was not a significant confounding factor in this cohort. Food habits were dominated by vegetarianism (56%), which is pertinent because vegetarianism is linked to nutritional deficiencies (iron). Most (84%) were premenopausal, so hormonal transitions were less represented. The median duration of alopecia was 7 months, which indicates it is of recent onset. An analysis of subtype distribution showed that telogen effluvium (44%), female pattern hair loss (32%), alopecia areata (18%), and cicatricial alopecia (6%) were the most prevalent subtypes. This distribution is very common as per global trends, with TE and FPHL being the most common in an outpatient dermatology facility.

The prevalence of anemia and Iron deficiency is depicted in Table 2. A critical analysis of the table shows that anemia was found in 56% of cases with alopecia, indicating its high burden in alopecia cases. It occurred most frequently in telogen effluvium (68.2%), then in FPHL (50%), and alopecia areata (44.4%), although there was no significant overall difference in prevalence (p=0.41), the severity distribution was significant (p=0.04). Mild anemia was most frequent, whereas moderate anemia was also significant, particularly in TE cases (22.7%). Iron deficiency, defined by low serum ferritin, was found to be even more prevalent (64%) in cases. TE had the highest prevalence (81.8%), while cicatricial alopecia had the lowest (33.3%). Median ferritin levels were significantly lower in TE (18 ng/mL) compared to other subtypes (p=0.02).
The prevalence of thyroid dysfunctions and alopecia subtypes is given in Table 3. Abnormal thyroid functions were found to exist in 28% of cases with no significant differences between subtypes (p=0.92). Subclinical hypothyroidism was the most frequent abnormality (16%), followed by overt hypothyroidism (6%), subclinical hyperthyroidism (4%), and overt hyperthyroidism (2%). Telogen effluvium and FPHL contributed to 10% of cases each of the thyroid abnormalities. Alopecia areata and cicatricial alopecia showed similar proportions (33.3%). Anti-TPO antibodies of autoimmune thyroiditis were present in 22.5% of cases, and a higher rate of them was in FPHL and AA cases compared to TE cases. Although the difference was not statistically significant. Overall, thyroid dysfunctions were found to present in one-third of cases; therefore, routine thyroid screening in females with alopecia is required.

Correlation of Laboratory Parameters with Alopecia Severity and Duration is depicted in Table 4. A critical analysis of the table shows that ferritin was the only laboratory marker significantly associated with alopecia severity. In addition, FPHL, serum ferritin negatively correlated with Sinclair grade ($\rho$ = -0.52, p=0.02), which shows that lower ferritin levels were linked to more advanced disease. Hemoglobin level analysis showed a weak negative correlation (-0.18), although not statistically significant (p=0.41). This shows that ferritin may be a more sensitive marker than Hb for alopecia severity. Thyroid-stimulating hormone (TSH) showed a mild positive correlation ($\rho$ = 0.31), although it did not reach the level of significance. This underscores the role of iron metabolism in hair loss progression, while thyroid dysfunction may have a contributory but less direct effect.

Multivariable Logistic Regression for Factors Associated with Iron Deficiency is given in Table 5. Analysis of the table showed that a vegetarian diet was the strongest independent predictor of iron deficiency (aOR 4.85, 95% CI: 1.32–17.84 and p=0.02). This could be due to decreased bioavailability of iron, which is lower in vegetarian diets. Alopecia subtype did not significantly predict iron deficiency after adjustment, although alopecia areata showed a near-significant inverse association (aOR 0.18, p=0.053), suggesting a potentially different etiopathogenesis. Age and menopausal status were not significant predictors. Overall, nutritional factors, particularly a vegetarian diet, appeared more influential than demographic or clinical variables in determining iron deficiency among women with alopecia.

| **Table 1: Baseline Characteristics of the Study Participants (N=50)** | |
|---|---|
| *Characteristic* | *Value* |
| Age (years) Mean ± SD | 32.5 ± 8.7 |
| Range | 17 - 49 |
| *Age Groups, n (%)* | |
| 15-24 years | 12 (24.0%) |
| 25-34 years | 18 (36.0%) |
| 35-49 years | 20 (40.0%) |
| Body Mass Index (kg/m$^2$), Mean ± SD | 23.1 ± 3.4 |
| *Dietary Pattern, n (%)* | |
| Vegetarian | 28 (56.0%) |
| Non-vegetarian | 22 (44.0%) |
| *Menopausal Status, n (%)* | |
| Premenopausal | 42 (84.0%) |
| Postmenopausal | 8 (16.0%) |
| Duration of Alopecia (months), Median [IQR] | 7 [4 - 10] |
| Alopecia Subtype, n (%) Telogen Effluvium (TE) | 22 (44.0%) |
| Female Pattern Hair Loss (FPHL) | 16 (32.0%) |
| *Alopecia Subtype, n (%)* | |
| Telogen Effluvium (TE) | 22 (44.0%) |
| Female Pattern Hair Loss (FPHL) | 16 (32.0%) |
| Alopecia Areata (AA) | 9 (18.0%) |
| Cicatricial Alopecia | 3 (6.0%) |

| **Table 2: Prevalence of Anemia and Iron Deficiency among Alopecia Subtypes** | | | | | | |
|---|---|---|---|---|---|---|
| *Parameter* | *Overall (N=50)* | *TE (n=22)* | *FPHL (n=16)* | *AA (n=9)* | *Cicatricial (n=3)* | *P value* |
| Anemia (Hb <12 g/dL), n (%) | 28 (56.0%) | 15 (68.2%) | 8 (50.0%) | 4 (44.4%) | 1 (33.3%) | 0.41 |
| Severity of Anemia, n (%) | | | | | | |
| Mild (11-11.9 g/dL) | 18 (36.0%) | 9 (40.9%) | 6 (37.5%) | 3 (33.3%) | 0 (0.0%) | 0.04* |
| Moderate (8.0-10.9 g/dL) | 9 (18.0%) | 5 (22.7%) | 2 (12.5%) | 1 (11.1%) | 1 (33.3%) | |
| Severe (<8 g/dL) | 1 (2.0%) | 1 (4.5%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | |
| Iron Deficiency (Ferritin <30 ng/mL), n (%) | 32 (64.0%) | 18 (81.8%) | 9 (56.3%) | 4 (444%) | 1 (33.3%) | |
| Median Ferritin (ng/mL) [IQR] | 24 [12 - 38] | 18 [10 - 28] | 29 [18 - 42] | 35 [22 - 48] | 41 [32 - 50] | 0.02* |
| *TE= Telogen Effluvium; FPHL=Female pattern Hair Loss; AA =Alopecia Areata; P value Kruskal-Walli's test* **Significant* | | | | | | |

| Table 3: Prevalence of Thyroid Dysfunction among Alopecia Subtypes | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Thyroid Status* | *Overall (N=50)* | *TE (n=22)* | *FPHL (n=16)* | *AA (n=9)* | *AA (n=9)* | *Cicatricial (n=3)* | *p - value* |
| Euthyroid, n (%) | 36 (72.0%) | 17 (77.3%) | 11 (68.8%) | 6 (66.7%) | 6 (66.7%) | 2 (66.7%) | 0.89 |
| Any Thyroid Dysfunction, n (%) | 14 (28.0%) | 5 (22.7%) | 5 (31.3%) | 3 (33.3%) | 3 (33.3%) | 1 (33.3%) | 0.92 |
| Subclinical Hypothyroid | 8 (16.0%) | 3 (13.6%) | 3 (18.8%) | 2 (22.2%) | 2 (22.2%) | 0 (0.0%) | |
| Overt Hypothyroid | 3 (6.0%) | 1 (4.5%) | 1 (6.3%) | 1 (11.1%) | 1 (11.1%) | 0 (0.0%) | |
| Subclinical Hyperthyroid | 2 (4.0%) | 1 (4.5%) | 1 (6.3%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | |
| Overt Hyperthyroid | 1 (2.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (33.3%) | |
| Positive Anti-TPO Antibodies n (96) | 9/40 (22.5%) | 3/18 (16.7%) | 4/14 (28.696) | 2/7 (28.6%) | 2/7 (28.6%) | 0/1 (0.0%) | 0.72 |

| Table 4: Correlation of Laboratory Parameters with Alopecia Severity and Duration | | |
|---|---|---|
| Parameter | *Alopecia Severity (FPHL: Sinclair Grade)* | *Alopecia Severity (AA: SALT Score)* |
| | Spearman's ρ | p-value |
| Hemoglobin (g/dL) | -0.18 | 0.41 |
| Serum Ferritin (ng/mL) | -0.52* | 0.02* |
| TSH (mlU/L) | 0.31 | 0.11 |
| *Correlation analysis was performed only for the FPHL (n=16) and AA (n=9) subgroups for severity scores. Correlation with duration was performed for all participants (N=50). Statistically significant correlation is marked (*)* | | |

| Table 5: Multivariable Logistic Regression for Factors Associated with Iron Deficiency | | | |
|---|---|---|---|
| Variable | Adjusted Odds Ratio (aOR) | 95% Confidence Interval | P value |
| Alopecia Subtype (Ref: Telogen Effluvium) Female Pattern Hair Loss | 0.32 | 0.07 - 1.42 | 0.13 |
| Alopecia Areata | 0.18 | 0.03 - 1.02 | 0.053 |
| Cicatricial Alopecia | 0.11 | 0.01 - 1.62 | 0.10 |
| Age (per 5-year increase) | 1.15 | 0.82 - 1.62 | 0.41 |
| Vegetarian Diet (Ref: Non-vegetarian) | 4.85 | 1.32 – 17.84 | 0.02* |
| Premenopausal Status (Ref: Postmenopausal) | 2.1 | 0.35 - 12.56 | 0.41 |
| *Model adjusted for all variables listed. The outcome is Iron Deficiency (Ferritin <30ng/mL). Statistically significant association is marked (*)* | | | |

**DISCUSSION**

The current study was designed to evaluate the prevalence of anemia, iron deficiency, and thyroid dysfunction among females with acquired alopecia. The objective was to explore the correlation of the disease with severity. The study findings indicate that there is a high burden of nutritional and endocrine abnormalities in patients with acquired alopecia, particularly with subtype telogen effluvium (TE). The demographic characteristics of the patients show that the mean age of the cohort was 32.5 years. Other studies in this field have shown that alopecia is common in the fourth decade, and it is this group which have the primary concern due to cosmetic and psychological issues. The predominance of premenopausal females in this study shows that menstrual blood loss and dietary insufficiencies could be the factors contributing to iron deficiency [12]. In this study, we found a higher proportion of cases who were strict vegetarians. It has been shown that vegetarian diets are often associated with lower bioavailability of iron and are independently linked to iron deficiency in multivariate analysis of other studies [13]. The strong association of TE with both anemia and iron deficiency is related to its pathophysiology, in which systemic stressors or nutritional deficiencies disrupt the normal hair cycle, initiating diffuse

shedding [14]. In this study, we found much lower median ferritin levels in TE compared to other subtypes, which confirms our hypothesis that iron deficiency is a determining factor in this disease [12, 15]. Interestingly, female pattern hair loss (FPHL) and alopecia areata (AA) also showed significant levels of iron deficiency, but less pronounced than the TE subtype. This implies that iron can affect the general hair growth condition in addition to the already known role with TE [16].

This interpretation is further supported by correlation analysis, as serum ferritin has a significant negative correlation with disease severity in FPHL. Reduced levels of ferritin were associated with increased Sinclair grades, which suggested that persistent iron deficiency might contribute to the increased miniaturization and hair thinning in genetically susceptible patients [15]. Hemoglobin, however, did not substantially correlate with severity, and ferritin was possibly more clinically important in the context of alopecia, as it is an early and sensitive indicator of iron status [14]. In 28% of patients in this study, thyroid dysfunction was observed, of which subclinical hypothyroidism was the most common abnormality. This distribution is not subtype-specific but is consistent with the established effect of thyroid hormones on the hair follicle cycling [17]. The presence of positive anti-TPO antibodies in almost a quarter of patients under testing raises the suspicion of an autoimmune component, especially in such diseases as AA and FPHL, where autoimmune or inflammatory processes may be involved [18]. Even though subtype relationships were not statistically significant, the comparatively high prevalence merits regular thyroid screening in women with alopecia.

The assessment of factors by logistic regression analysis showed that diet is a key modifiable factor. Vegetarian patients have nearly five times higher odds of developing iron deficiency, which is independent of age, menopausal status, or alopecia subtypes. These findings signify the importance of dietary counselling and possible supplementation if required for management [13]. Alopecia areata showed a lower tendency for association with iron deficiency, but it did not reach the level of statistical significance, suggesting that factors beyond nutritional status, such as autoimmunity, may play a significant role in pathogenesis [18]. Overall, our study shows that the interrelationship of nutritional and endocrine factors, such as thyroid dysfunctions, plays a role in acquired alopecia in females. Therefore, screening for anemia, iron deficiency, and thyroid dysfunctions should be incorporated into routine evaluation, especially in TE and FPHL cases where the abnormalities are found to be significant. Targeted correction of these deficiencies could lead to a better prognosis and improved quality of life.

## CONCLUSION

Within the limitations of the current study, we found a significant association of nutritional deficiency and endocrine factors for acquired alopecia in females. The common subtype that emerged from our study was Telogen effluvium, which was found to have a strong link with anemia and iron deficiency. Thyroid dysfunction, in particular subclinical hypothyroidism, was also prevalent across subtypes. Serum ferritin had a stronger correlation with alopecia severity as compared to hemoglobin, defining its clinical utility in the evaluation of alopecia. A vegetarian diet was independently associated with increased risk of iron deficiency, showing the role of nutritional supplementation if required. Routine screening of iron status and thyroid function must be included for the overall evaluation of female alopecia and its management.

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