Food Habits, Daily Routine and Hair Loss — A Focused Review

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Abstract

Hair loss is a common clinical concern with multifactorial etiology involving genetic, hormonal, nutritional, and lifestyle factors. Increasing evidence suggests that nutritional status and lifestyle behaviors play an important role in maintaining normal hair follicle function and regulating the hair growth cycle. This review examines the current evidence linking micronutrient status, dietary patterns, and lifestyle factors with hair health and common hair loss disorders.

Hair follicles are highly metabolically active structures that require an adequate supply of proteins, vitamins, minerals, and energy to sustain normal growth. Deficiencies in key micronutrients such as iron, vitamin D, zinc, vitamin B12, and essential fatty acids have been associated with several forms of hair loss, particularly telogen effluvium and diffuse hair shedding. At the same time, excessive intake of certain micronutrients, including vitamin A and zinc, may also contribute to hair loss, highlighting the importance of balanced nutritional intake rather than excessive supplementation.

Lifestyle factors such as sleep quality, psychological stress, physical activity, smoking, and hair care practices may further influence follicular health through mechanisms involving hormonal regulation, oxidative stress, inflammation, and vascular function. In addition, restrictive dieting, rapid weight loss, and chronic metabolic disturbances can disrupt follicular cycling and precipitate hair shedding.

Despite growing interest in nutritional and lifestyle interventions for hair loss, the current evidence base remains limited. Few large randomized controlled trials have evaluated micronutrient supplementation, and controlled dietary intervention studies assessing hair outcomes are scarce. Further research is needed to clarify the mechanistic pathways linking lifestyle factors with follicular biology and to establish evidence based clinical guidelines. A comprehensive approach that prioritizes nutritional adequacy, healthy lifestyle behaviors, and individualized clinical assessment remains essential for supporting hair health.

Keywords: hair loss, food, lifestyle, nutrition

1. Introduction

Hair growth is regulated by a highly coordinated cyclic process consisting of the anagen (active growth), catagen (regression), and telogen (resting) phases, governed by tightly controlled epithelial–mesenchymal interactions within the hair follicle microenvironment. During anagen, matrix keratinocytes proliferate rapidly under the influence of dermal papilla signaling pathways including Wnt/β-catenin, Sonic hedgehog, and fibroblast growth factor cascades, which collectively sustain follicular elongation and hair shaft production. Catagen represents a brief apoptotic phase characterized by programmed regression of the lower follicle, while telogen is a quiescent stage preceding the shedding of the hair shaft and initiation of a new growth cycle. Dysregulation of these signaling pathways—particularly premature transition from anagen to telogen—leads to diffuse hair shedding, a clinical hallmark of telogen effluvium (TE).[2,8] In genetically predisposed individuals, enhanced follicular sensitivity to androgens, especially dihydrotestosterone (DHT), contributes to progressive follicular miniaturization observed in androgenetic alopecia (AGA) through modulation of androgen receptor signaling, altered prostaglandin balance, and suppression of growth-promoting pathways such as Wnt/β-catenin.[11]

Beyond endocrine and genetic determinants, emerging evidence highlights the significant influence of nutritional status and lifestyle factors on follicular homeostasis. Nutrient availability directly affects rapidly dividing matrix keratinocytes by regulating mitochondrial energy metabolism, keratin synthesis, and cellular proliferation. Deficiencies in essential micronutrients can impair DNA synthesis, alter redox balance, and increase oxidative stress within the follicular microenvironment. In addition, systemic inflammation, metabolic dysregulation, and neuroendocrine stress responses may disrupt follicular cycling by modulating cytokine signaling, cortisol levels, and perifollicular vascular supply.[1,3] Increasing evidence suggests that dietary quality, micronutrient sufficiency, circadian rhythm integrity, and psychosocial stress collectively influence hair follicle biology through mechanisms involving oxidative stress regulation, immune modulation, and hormonal homeostasis. Accordingly, this review evaluates the current evidence linking dietary patterns and daily lifestyle practices to hair loss and highlights their clinical implications in maintaining optimal hair follicle function.

2. Methods

A structured narrative review was conducted to synthesize current evidence on the relationship between dietary habits, lifestyle factors, and hair loss. Relevant peer reviewed literature published between 2010 and 2025 was identified through electronic database searches primarily using PubMed, along with articles published in major dermatology and clinical nutrition journals. The search strategy included combinations of keywords such as “hair loss”, “alopecia”, “telogen effluvium”, “androgenetic alopecia”, “nutrition”, “micronutrients”, “dietary patterns”, “sleep”, “stress”, and “metabolic health”. Boolean search operators were applied to refine the results and ensure retrieval of studies relevant to the objectives of this review.

Priority was given to high quality sources including systematic reviews, meta analyses, consensus guidelines, randomized clinical trials, and observational studies examining the association between nutritional status and hair follicle biology. Particular emphasis was placed on studies evaluating the role of micronutrients such as iron, zinc, vitamin D, biotin, and essential fatty acids in hair growth, follicular cycling, and keratin synthesis. In addition, literature exploring broader dietary patterns, metabolic health, circadian rhythm disturbances, and psychosocial stress in relation to hair loss was also considered in order to provide a comprehensive understanding of modifiable lifestyle influences.

Articles were screened for relevance based on their focus on hair physiology, mechanisms affecting follicular cycling, and clinical implications in conditions such as telogen effluvium and androgenetic alopecia. Studies lacking mechanistic insight or not directly related to hair biology were excluded. The selected literature was critically evaluated and organized thematically to highlight emerging mechanisms linking nutrition and lifestyle factors with hair follicle function and hair loss.[1,2,3,4,8]

3. Types of Hair Loss Relevant to Nutrition and Routine

Telogen Effluvium (TE)

Telogen effluvium is a non scarring form of diffuse hair loss characterized by an abnormal shift of hair follicles from the anagen growth phase into the telogen resting phase. Under normal conditions most scalp follicles remain in the anagen phase, while only a small proportion enter telogen. In TE this balance is disrupted, leading to synchronized entry of a larger number of follicles into the telogen phase and subsequent hair shedding after a delay of about two to three months.[2,8]

This condition is commonly triggered by systemic stressors that affect the metabolic activity of rapidly dividing follicular matrix cells. Factors such as acute illness, surgical stress, hormonal changes, and significant nutritional deficiencies can interfere with normal follicular cycling. Deficiencies of nutrients such as iron, zinc, and protein may impair keratin synthesis and cellular proliferation within the follicle. Rapid weight loss, restrictive dieting, and severe psychological stress may also contribute through metabolic and neuroendocrine pathways. Although TE is usually reversible once the underlying trigger is corrected, persistent metabolic or nutritional stress may prolong shedding.[2,8]

Androgenetic Alopecia (AGA)

Androgenetic alopecia is the most common form of patterned hair loss and is characterized by progressive follicular miniaturization in genetically predisposed individuals. The condition is largely mediated by increased follicular sensitivity to dihydrotestosterone, which shortens the anagen phase and gradually transforms terminal follicles into smaller vellus like follicles producing thinner hair shafts.[11]

Recent evidence indicates that metabolic and inflammatory factors may further influence disease progression. Conditions such as obesity, insulin resistance, and metabolic syndrome may contribute to chronic low grade inflammation, oxidative stress, and impaired scalp microcirculation. Pro inflammatory dietary patterns may exacerbate these mechanisms, thereby accelerating follicular miniaturization and worsening hair thinning in susceptible individuals.[3,4]

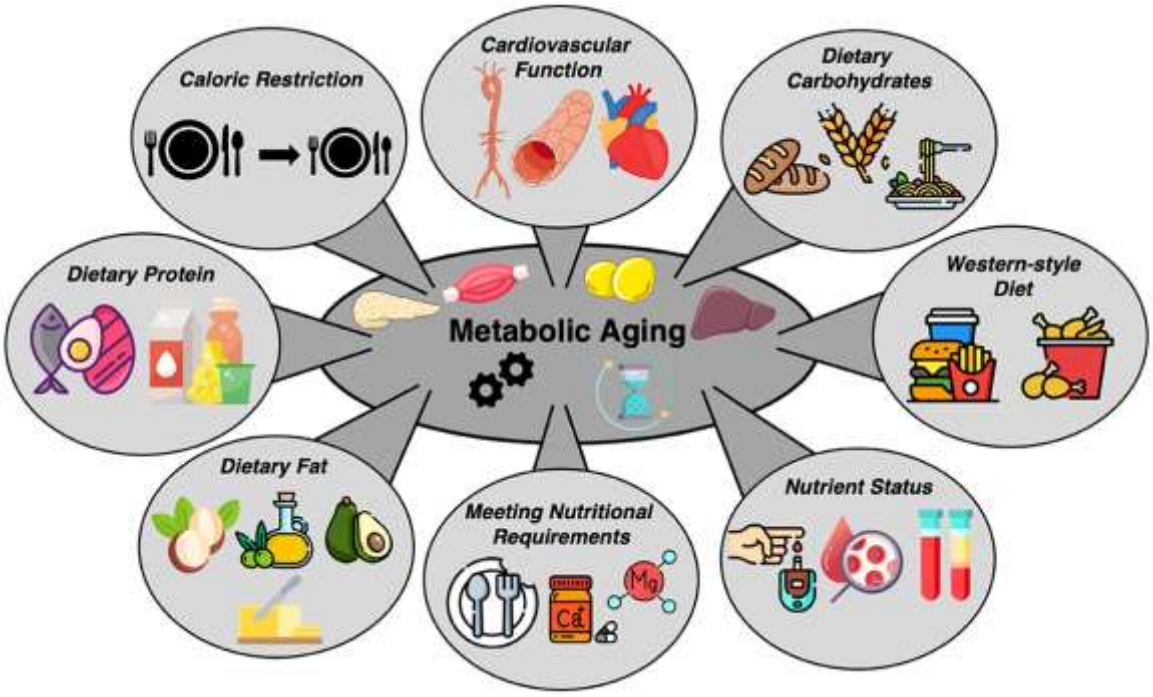

Figure no.1 : lifestyle and nutrition factors affecting hair loss

4. Macronutrients and Hair Health

4.1 **Protein**

Hair shafts consist primarily of keratin, a sulfur rich structural protein that provides strength, elasticity, and structural integrity to the hair fiber. Keratin is synthesized within the hair follicle matrix by rapidly proliferating keratinocytes, making adequate protein availability essential for normal hair growth and follicular function. Because hair follicles are among the most metabolically active tissues in the body, they require a continuous supply of amino acids to sustain cellular proliferation and hair shaft production.

Severe or prolonged protein deficiency, such as that observed during crash dieting, restrictive eating patterns, malnutrition, or significant caloric restriction, can disrupt the normal hair growth cycle. In such conditions the body prioritizes essential physiological processes over hair production, leading to shortening of the anagen growth phase and premature transition of follicles into the telogen resting phase. This shift in follicular cycling may precipitate telogen effluvium characterized by diffuse hair shedding several weeks or months after the nutritional insult.[1,8]

Adequate intake of essential amino acids is therefore necessary to support matrix cell proliferation and keratin synthesis within the follicle. Sulfur containing amino acids such as cysteine and methionine play a particularly important role because they contribute to the formation of disulfide bonds that stabilize keratin structure and maintain hair shaft strength. Insufficient availability of these amino acids may impair keratin production, weaken hair fibers, and compromise follicular growth activity.

Clinical evaluation of patients presenting with diffuse hair loss should therefore include careful assessment of dietary protein intake and overall nutritional status. Identifying inadequate protein consumption can help guide appropriate nutritional interventions aimed at restoring normal follicular cycling and supporting healthy hair growth.[1]

4.2 Fats

Omega 3 and omega 6 fatty acids play an important role in maintaining cellular membrane integrity and regulating inflammatory signaling within the body. These essential fatty acids are key structural components of phospholipid membranes and are involved in the synthesis of bioactive lipid mediators that influence immune responses, vascular function, and cellular communication. Within the hair follicle environment, adequate availability of these fatty acids supports normal follicular metabolism and contributes to maintaining the structural stability of follicular cells.

Omega 3 fatty acids are generally associated with anti inflammatory effects through the production of lipid mediators that reduce inflammatory cytokine activity, while omega 6 fatty acids participate in pathways that regulate both pro inflammatory and anti inflammatory responses. A balanced intake of these fatty acids is therefore essential for maintaining physiological inflammatory control. Diets that are deficient in essential fatty acids or excessively enriched in saturated fats and highly processed foods may disrupt this balance and promote a pro inflammatory state. Such dietary patterns may contribute to increased oxidative stress, altered lipid metabolism, and inflammatory activity within the scalp microenvironment.[1,4]

Chronic low grade inflammation and oxidative stress are recognized contributors to impaired follicular function and may influence hair growth dynamics by affecting dermal papilla signaling and follicular vascular supply. As a result, inadequate intake of essential fatty acids may indirectly contribute to hair thinning or increased shedding in susceptible individuals. Although supplementation with omega 3 or omega 6 fatty acids may benefit individuals with documented dietary deficiencies or poor nutritional status, current clinical evidence does not support indiscriminate supplementation in individuals who already maintain a balanced and nutritionally adequate diet.[1]

4.3 Carbohydrates and Glycaemic Load

High glycaemic load diets are known to influence metabolic homeostasis by promoting rapid fluctuations in blood glucose levels and stimulating excessive insulin secretion. Repeated exposure to such dietary patterns may contribute to the development of insulin resistance, a metabolic condition characterized by reduced cellular responsiveness to insulin signaling. Insulin resistance is frequently accompanied by systemic inflammation, oxidative stress, and hormonal dysregulation, all of which may negatively influence hair follicle physiology and normal hair cycling. Elevated insulin levels can also increase androgen activity through alterations in sex hormone binding globulin levels and enhanced androgen production, thereby creating a hormonal environment that may favor follicular miniaturization in susceptible individuals.

Observational studies increasingly suggest that dietary patterns characterized by high consumption of refined carbohydrates, sugars, and ultra processed foods are associated with a greater prevalence and severity of androgenetic alopecia.[3,4] These pro inflammatory diets may promote chronic low grade inflammation and metabolic disturbances that impair dermal papilla function and alter follicular signaling pathways involved in the regulation of the hair growth cycle. In addition, increased oxidative stress generated by such dietary habits may further compromise the microenvironment surrounding the hair follicle.

Conversely, dietary patterns with a lower glycaemic load may support improved metabolic balance and reduced inflammatory activity. Diets emphasizing whole grains, dietary fiber, legumes, fruits, vegetables, and minimally processed carbohydrate sources are associated with improved glycaemic control and better insulin sensitivity. Such dietary approaches may therefore be advisable for individuals experiencing hair thinning, particularly for patients who present with metabolic risk factors such as obesity, insulin resistance, or features of metabolic syndrome.

5. Key Micronutrients: Evidence and Practical Considerations

5.1 Iron and Ferritin

Iron deficiency remains one of the most consistently reported nutritional abnormalities in women presenting with diffuse hair loss. Adequate iron availability is essential for several physiological processes including oxygen transport, cellular energy metabolism, and DNA synthesis, all of which are critical for the rapidly proliferating cells of the hair follicle matrix. Because hair follicles are metabolically active structures requiring continuous cellular division and protein synthesis, reduced iron stores may impair follicular metabolism and disrupt the normal hair growth cycle. As a result, iron deficiency has frequently been implicated as an important contributing factor in patients experiencing diffuse hair shedding.[1,10]

Clinical observations have shown that low serum ferritin levels, which reflect depleted iron stores, are often associated with increased hair shedding in individuals with telogen effluvium. Insufficient iron availability may compromise cellular proliferation within the hair bulb and shorten the duration of the anagen growth phase, leading to a higher proportion of follicles entering the telogen phase prematurely. This disruption of the normal follicular cycle can manifest as noticeable hair thinning and excessive daily hair shedding. Several clinical studies have also reported that correction of iron deficiency through appropriate supplementation or dietary improvement may lead to gradual reduction in hair shedding and improvement in hair density in affected individuals.[1]

Given this association, routine laboratory evaluation is commonly recommended in patients presenting with unexplained diffuse hair loss. Assessment of hemoglobin levels along with serum ferritin concentration provides useful information regarding systemic iron status and helps identify individuals who may benefit from targeted nutritional intervention. Early detection and correction of iron deficiency can therefore play an important role in restoring normal follicular function and supporting healthy hair growth.

5.2 Vitamin D

Vitamin D receptors are widely expressed in several skin structures including keratinocytes, dermal papilla cells, and hair follicle epithelial cells, indicating an important regulatory role in maintaining normal follicular biology. Activation of vitamin D receptors participates in signaling pathways that influence keratinocyte differentiation, cellular proliferation, and immune regulation within the follicular environment. These receptors are particularly important for maintaining the integrity of the hair growth cycle, as they contribute to the initiation and maintenance of the anagen phase. Disruption of vitamin D signaling has therefore been suggested to interfere with normal follicular cycling and may contribute to abnormal hair shedding or impaired hair regeneration.

Several observational studies have reported reduced serum vitamin D levels in patients presenting with both telogen effluvium and androgenetic alopecia, suggesting a potential association between vitamin D deficiency and hair loss disorders.[7,10] Low vitamin D status may influence hair follicle function through multiple mechanisms including impaired keratinocyte activity, altered immune responses, and increased inflammatory signaling within the scalp microenvironment. In addition, vitamin D plays a role in maintaining epidermal barrier function and regulating local immune responses, both of which may indirectly influence follicular health and hair growth dynamics.

Preliminary interventional studies have indicated that vitamin D supplementation in individuals with documented deficiency may lead to modest improvement in hair shedding and follicular activity. Some small clinical investigations have reported partial improvement in hair density or reduction in shedding following correction of vitamin D deficiency.[7] However, despite these encouraging findings, robust randomized controlled trials with larger patient populations and longer follow up durations remain limited. Further well designed clinical research is therefore required to clarify the precise therapeutic role of vitamin D supplementation in the management of hair loss disorders.

5.3 Zinc, Selenium, Copper and Other Trace Elements

Trace elements such as zinc and copper play important roles in maintaining normal hair follicle physiology through their involvement in multiple biochemical and cellular processes. These micronutrients participate in protein synthesis, enzymatic reactions, cellular proliferation, and antioxidant defense mechanisms that are essential for the proper functioning of rapidly dividing follicular matrix cells. Zinc is particularly important for DNA and RNA synthesis, regulation of cell division, and stabilization of protein structures, all of which contribute to normal keratin production within the hair shaft. Copper also contributes to several enzymatic pathways and is involved in processes such as melanin synthesis, connective tissue formation, and maintenance of follicular structural integrity.

Disturbances in the balance of these trace elements have been observed in certain populations experiencing hair loss. Zinc deficiency, for example, has been associated with impaired keratinocyte proliferation and disruption of the normal hair growth cycle, potentially leading to increased shedding or weakened hair fibers. Conversely, excessive intake of zinc through supplementation may interfere with copper absorption in the gastrointestinal tract, resulting in secondary copper depletion. Such imbalances may disrupt enzymatic activity and cellular metabolism within the follicle, thereby contributing to abnormal follicular function and hair thinning.[1,3]

Because both deficiency and excess of trace elements can negatively affect hair follicle health, careful clinical evaluation is important when assessing patients with unexplained hair loss. Laboratory testing that evaluates serum zinc and copper levels can help identify underlying micronutrient imbalances and guide appropriate nutritional interventions. Targeted correction of identified deficiencies or imbalances is generally considered more appropriate than empirical high dose supplementation, which may inadvertently create additional nutritional disturbances and fail to address the underlying cause of hair loss.

5.4 B-Vitamins and Biotin (Vitamin B7)

Biotin, also known as vitamin B7, is a water soluble vitamin that functions as an essential cofactor for several carboxylase enzymes involved in fatty acid metabolism, amino acid metabolism, and energy production. Through these biochemical roles, biotin contributes to normal cellular growth and supports the synthesis of keratin, the primary structural protein of hair shafts. In states of true biotin deficiency, individuals may develop dermatological manifestations such as brittle hair, hair thinning, and increased hair shedding, reflecting impaired keratin structure and reduced follicular function.[5] However, clinically significant biotin deficiency is considered uncommon in the general population because the vitamin is widely available in many foods and can also be synthesized by intestinal microbiota.

Despite the widespread marketing of biotin supplements for hair health, current scientific evidence supporting routine supplementation in individuals without documented deficiency remains limited. Most individuals with normal nutritional status are able to meet their biotin requirements through a balanced diet, and additional supplementation has not consistently demonstrated significant improvement in hair growth or reduction in hair

loss in well nourished populations.[6] As a result, indiscriminate use of biotin supplements for cosmetic hair concerns is not strongly supported by clinical evidence.

An additional concern associated with high dose biotin supplementation is its potential to interfere with certain laboratory diagnostic assays. Excess circulating biotin may disrupt immunoassay based laboratory tests, leading to falsely abnormal results in measurements such as thyroid hormone levels or cardiac biomarkers. This interference may occasionally result in incorrect clinical interpretation or misdiagnosis if supplement use is not recognized during medical evaluation.[12] For these reasons, routine high dose biotin supplementation should be approached with caution, and its use should ideally be guided by clinical assessment and evidence of deficiency.

5.5 Vitamin A and Antioxidants (Vitamins C and E)

Both deficiency and excess of vitamin A have been associated with disturbances in normal hair follicle function and may contribute to hair loss in susceptible individuals. Vitamin A plays an important physiological role in epithelial cell differentiation, sebaceous gland activity, and regulation of keratinocyte proliferation within the skin and hair follicle environment. Adequate levels of this vitamin are necessary for maintaining normal follicular development and supporting the integrity of hair producing cells. However, imbalance in vitamin A status can disrupt this delicate regulatory process. Deficiency may impair epithelial maintenance and follicular health, while excessive intake, particularly through high dose supplementation, has been linked to increased hair shedding and telogen effluvium due to toxic effects on rapidly dividing follicular cells.[1]

Antioxidant vitamins also contribute to maintaining a healthy follicular microenvironment by protecting cells from oxidative stress and supporting metabolic processes necessary for hair growth. Vitamin C is particularly important because it enhances intestinal absorption of dietary iron by converting ferric iron to its more bioavailable ferrous form. Since iron deficiency is a recognized contributor to diffuse hair loss, adequate vitamin C intake indirectly supports hair follicle function by improving iron availability. In addition, vitamin C functions as a potent antioxidant that helps neutralize reactive oxygen species, thereby protecting follicular cells from oxidative damage and supporting normal cellular metabolism.

Given the potential risks associated with both nutrient deficiencies and excessive supplementation, clinical management should prioritize balanced dietary intake rather than reliance on pharmacological megadoses of vitamins. Emphasis on a nutritionally adequate diet rich in fruits, vegetables, and whole foods can help maintain appropriate micronutrient levels while minimizing the risk of toxicity or nutrient imbalance.

6. Specific Diets, Weight Loss and Hair Loss

Crash diets and very low calorie dietary regimens are frequently associated with the onset of telogen effluvium within several weeks to months following the period of nutritional restriction. Rapid reductions in caloric intake place significant metabolic stress on the body and can disrupt the availability of nutrients required for normal hair follicle activity. Because hair follicles are highly metabolically active and depend on a continuous supply of energy, amino acids, and micronutrients, sudden nutritional deprivation may trigger a protective physiological response in which the body conserves resources by shifting a greater proportion of follicles from the anagen growth phase into the telogen resting phase. This premature transition ultimately results in diffuse hair shedding that becomes clinically apparent after the typical delay associated with the hair growth cycle.[2,8]

Vegetarian and vegan dietary patterns can support overall health when appropriately balanced; however, when these diets are poorly planned they may increase the risk of certain micronutrient deficiencies that are relevant to hair follicle function. Nutrients such as iron, vitamin B12, zinc, and high quality protein are sometimes less readily available in restrictive plant based diets, particularly when dietary diversity is limited. Inadequate intake of these nutrients may impair cellular proliferation within the follicular matrix, disrupt keratin synthesis, and contribute to diffuse hair shedding in susceptible individuals.[1] For this reason, individuals following restrictive dietary patterns may benefit from appropriate nutritional counseling and periodic laboratory evaluation to ensure adequate micronutrient status.

Broader dietary patterns also appear to influence hair health. Observational evidence suggests that Western style diets characterized by high intake of processed foods, refined carbohydrates, and saturated fats may be associated with an increased risk or greater severity of androgenetic alopecia. In contrast, Mediterranean style dietary patterns rich in fruits, vegetables, whole grains, antioxidants, and healthy fats such as olive oil may help reduce systemic inflammation and oxidative stress, thereby potentially exerting protective effects on hair follicle function.[3,4]

7. Daily Routine and Lifestyle Factors

7.1 Sleep

Adequate sleep is an essential component of systemic physiological regulation and plays an important role in maintaining normal hair follicle function. Poor sleep quality and chronic sleep deprivation have been associated with increased severity of hair shedding and worsening of hair loss conditions in a observational study.[9] Sleep disruption may influence hair biology through activation of the hypothalamic pituitary adrenal axis, resulting in elevated cortisol levels and prolonged physiological stress responses. Persistently elevated cortisol can interfere with normal cellular proliferation and may promote inflammatory signaling within the scalp microenvironment.

In addition, sleep deprivation has been linked to increased production of neuroinflammatory mediators and oxidative stress, which may disrupt the delicate signaling pathways that regulate follicular cycling. Insufficient sleep may also impair tissue repair processes and cellular regeneration, both of which are necessary for maintaining the activity of rapidly dividing hair follicle matrix cells. Because the hair growth cycle is sensitive to systemic physiological stress, disturbances in sleep patterns may contribute to premature transition of follicles from the anagen phase into the telogen phase. For these reasons, improving sleep quality through regular sleep schedules, reduced exposure to late night stimulants, and maintenance of healthy circadian rhythms may represent a useful supportive strategy in the management of hair loss disorders.[9]

7.2 Psychological Stress

Psychological stress is widely recognized as an important trigger for telogen effluvium and may also exacerbate other hair loss conditions such as androgenetic alopecia and alopecia areata. Stress related hair shedding typically occurs after a period of intense emotional or psychological strain, during which systemic stress signaling pathways become activated. These responses involve neuroendocrine mediators that can influence hair follicle biology and disrupt normal follicular cycling.[2,8]

One of the principal mechanisms involves activation of the hypothalamic pituitary adrenal axis, which leads to increased cortisol secretion and altered immune responses. Elevated stress hormones may influence dermal papilla signaling and impair the proliferation of hair matrix keratinocytes. In addition, neuropeptides such as substance P and various pro inflammatory cytokines may accumulate within the follicular microenvironment

during periods of stress. These mediators can promote local inflammation, alter follicular immune privilege, and contribute to premature termination of the anagen phase.

Because psychological stress can significantly influence the course of hair loss disorders, addressing emotional wellbeing is an important component of comprehensive management. Interventions aimed at reducing stress, including cognitive behavioral therapy, mindfulness based practices, relaxation techniques, and regular physical activity, may help restore physiological balance and support recovery of normal hair growth patterns.[2,8]

7.3 Exercise and Metabolic Health

Regular physical activity plays a beneficial role in maintaining metabolic health and may indirectly support healthy hair growth. Moderate exercise has been shown to improve insulin sensitivity, enhance cardiovascular function, and reduce systemic inflammation. These physiological benefits can contribute to a healthier scalp environment by improving blood circulation and supporting nutrient delivery to hair follicles. Improved metabolic regulation may also reduce the hormonal and inflammatory disturbances that are sometimes associated with androgenetic alopecia.[3,4]

However, excessive endurance training or extremely intense exercise without adequate nutritional support may produce adverse effects. Prolonged physical exertion combined with insufficient caloric intake can lead to a state known as relative energy deficiency, in which the body lacks sufficient energy to support normal physiological processes. Under such conditions the body may conserve resources by suppressing non essential functions including hair growth. This metabolic imbalance may result in increased hair shedding due to premature transition of follicles into the telogen phase. Therefore, while regular exercise is generally beneficial, maintaining balanced training routines along with adequate nutritional intake is essential for supporting both systemic health and normal follicular activity.[3,4]

7.4 Smoking, Alcohol and Environmental Toxins

Lifestyle factors such as smoking and excessive alcohol consumption can also influence hair health through multiple biological mechanisms. Cigarette smoke contains numerous toxic compounds that contribute to oxidative stress, vascular dysfunction, and chronic low grade inflammation. These processes may impair microcirculation within the scalp and reduce the delivery of oxygen and nutrients to the hair follicle. Over time, this vascular compromise and oxidative damage may contribute to follicular weakening and progressive hair thinning.[4]

Excessive alcohol consumption may further compound these effects by interfering with nutrient absorption and contributing to deficiencies of vitamins and minerals that are important for hair follicle metabolism. Alcohol related metabolic disturbances can also increase oxidative stress and inflammatory signaling, potentially affecting follicular function. In addition to these factors, environmental toxins and pollutants may contribute to oxidative damage and inflammation within the scalp environment. Because many of these influences are modifiable, counseling patients regarding smoking cessation, moderation of alcohol intake, and reduction of environmental exposures may be beneficial as part of a comprehensive hair health strategy.[4]

7.5 Hair Care Practices (Mechanical and Chemical Trauma)

In addition to systemic and nutritional factors, certain hair care practices can directly contribute to hair damage and hair loss. Mechanical stress resulting from tight hairstyles, excessive tension, or frequent pulling of hair strands may lead to traction alopecia. This condition occurs when persistent mechanical force damages the hair follicle and surrounding tissues, potentially leading to inflammation and progressive follicular weakening. If the mechanical stress continues for prolonged periods, the resulting follicular injury may become irreversible.[8]

Chemical treatments can also contribute to hair damage when used excessively or improperly. Frequent application of hair dyes, bleaching agents, chemical straightening treatments, or harsh styling products may weaken the hair shaft and disrupt the structural integrity of keratin fibers. Aggressive grooming practices such as excessive brushing, high heat styling, or repeated manipulation of wet hair may further increase the risk of shaft breakage and follicular stress. Because these factors are largely modifiable, early identification and correction of damaging hair care practices is important for preventing long term follicular injury and preserving hair density.[8]

8. Clinical Approach and Practical Recommendations

8.1 Assessment

Evaluation of patients presenting with hair loss should begin with a comprehensive clinical assessment that considers both medical and lifestyle related factors. A detailed dietary history is essential to identify potential deficiencies in protein, micronutrients, or overall caloric intake. Clinicians should also inquire about recent weight loss, restrictive dieting practices, acute illness, or significant physiological stressors that may precipitate hair shedding.

Laboratory investigations may be useful when nutritional or endocrine abnormalities are suspected. Commonly recommended tests include complete blood count, serum ferritin levels, thyroid stimulating hormone, vitamin D, vitamin B12, and selected trace elements when clinically indicated.[1,10] These tests can help identify underlying deficiencies or metabolic disturbances that may contribute to abnormal hair shedding.

In addition to laboratory evaluation, a thorough lifestyle review should include assessment of sleep patterns, psychological stress levels, physical activity, smoking habits, and alcohol consumption. Understanding these factors allows clinicians to identify modifiable contributors to hair loss and develop a more comprehensive management plan. In most cases, targeted investigations based on clinical history and examination are preferable to indiscriminate testing, which may lead to unnecessary interventions.

8.2 Interventions

Management strategies should focus on correcting underlying nutritional deficiencies and optimizing overall lifestyle habits that support hair follicle health. When laboratory evaluation confirms deficiencies such as low iron stores, vitamin D insufficiency, or vitamin B12 deficiency, appropriate supplementation under medical supervision may help restore normal follicular function and reduce hair shedding.[1,7]

Dietary counseling is often an important component of treatment. Patients should be encouraged to consume balanced meals that include adequate protein sources, essential fatty acids, and a variety of micronutrient rich foods. Emphasis on whole foods such as fruits, vegetables, whole grains, legumes, nuts, and healthy fats is consistent with Mediterranean style dietary patterns, which have been associated with reduced systemic inflammation and improved metabolic health.[3,4]

Lifestyle modification may also contribute to improved outcomes. Strategies aimed at optimizing sleep quality, managing psychological stress, and maintaining balanced exercise routines may help restore normal physiological regulation of hair growth.[9] In addition, clinicians should address harmful grooming practices or chemical hair treatments that may contribute to mechanical damage or traction related hair loss.[8]

8.3 Supplements — A Cautious Perspective

Dietary supplements are frequently marketed for hair growth; however, their use should be approached with caution. Supplementation may provide benefits in individuals with confirmed nutritional deficiencies, but routine use in the absence of documented deficiencies may offer limited benefit. In some cases excessive intake

of certain micronutrients may even produce adverse effects. For example, high doses of biotin, zinc, or vitamin A have been associated with potential metabolic disturbances or interference with laboratory testing.[1,6,12]

For this reason, clinical decisions regarding supplementation should ideally be guided by laboratory findings and individualized patient assessment. Addressing nutritional deficiencies, improving lifestyle habits, and correcting modifiable risk factors often represent more effective long term strategies for supporting hair health. In cases of persistent, severe, or unexplained hair loss, referral to a dermatology specialist may be appropriate for further diagnostic evaluation and management.

9. Research Gaps and Future Directions

9. Limitations of Current Evidence

Despite growing interest in the relationship between nutrition, lifestyle factors, and hair health, the current body of evidence has several important limitations. These gaps should be considered when interpreting existing research and when applying findings to clinical practice.

First, there is a **limited number of large scale randomized controlled trials evaluating micronutrient supplementation in populations with hair loss**.[1,3] Much of the available literature consists of observational studies, small clinical trials, or studies conducted in individuals with confirmed deficiencies. As a result, it remains difficult to determine whether supplementation provides meaningful benefits for individuals who do not have clear nutritional deficits. More robust clinical trials are needed to establish efficacy, optimal dosing, and long term safety of commonly marketed hair related supplements.

Second, there is **insufficient mechanistic evidence linking circadian rhythm disruption directly to hair follicle biology**.[9] Although sleep deprivation and circadian misalignment have been associated with systemic inflammation, hormonal dysregulation, and increased oxidative stress, the precise molecular pathways through which these processes affect the hair follicle remain incompletely understood. Future research exploring circadian regulation of follicular stem cells, keratinocyte proliferation, and anagen maintenance may help clarify these relationships.

Third, there is a **lack of controlled dietary intervention studies that directly assess hair related outcomes**.[4] Many existing studies examine broader metabolic or dermatological endpoints rather than hair growth parameters specifically. As a result, the impact of dietary patterns such as Mediterranean, plant based, or high protein diets on hair density, hair cycle dynamics, and shedding rates remains inadequately characterized. Well designed dietary intervention trials with standardized hair assessment methods would help strengthen the evidence base in this area.

Addressing these research gaps will be essential for developing clearer clinical guidelines and evidence based recommendations regarding nutrition and lifestyle interventions for the prevention and management of hair loss.

10. Conclusion

Hair growth is a complex biological process influenced by multiple systemic and local factors. Emerging evidence highlights the important role of nutrition and lifestyle behaviors in maintaining healthy follicular function and supporting normal hair growth cycles. Because hair follicles are among the most metabolically active structures in the body, they are particularly sensitive to deficiencies in energy, protein, and essential micronutrients.

Current research suggests that deficiencies in nutrients such as iron, vitamin D, zinc, vitamin B12, and essential fatty acids may contribute to various forms of hair loss, especially diffuse shedding conditions such as telogen effluvium. However, the relationship between micronutrients and hair health is not solely limited to deficiency states. Excessive intake of certain nutrients, including vitamin A or high dose supplementation without medical indication, may also negatively affect hair growth. For this reason, maintaining balanced nutritional intake through a diverse and adequate diet remains a key principle in clinical management.

Lifestyle factors also play an important role in hair health. Chronic psychological stress, poor sleep quality, metabolic imbalance, smoking, and damaging hair care practices may disrupt normal follicular cycling through mechanisms involving hormonal dysregulation, inflammation, oxidative stress, and impaired microcirculation. Addressing these modifiable factors can therefore be an important component of a comprehensive treatment strategy.

Although interest in nutritional and lifestyle approaches to hair loss continues to grow, current scientific evidence remains limited by a lack of large randomized trials and controlled dietary studies. Future research should aim to clarify mechanistic pathways and evaluate targeted interventions. In clinical practice, an individualized, holistic approach that combines nutritional optimization, healthy lifestyle habits, and appropriate medical evaluation offers the most practical strategy for supporting long term hair health.

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