

# Hair Integrity and Health with Dieting

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## Abstract

A significant number of individuals desire strong and healthy hair, particularly as they age. The rate of hair growth is detected by genetic factors, age, gender, and hormonal levels. Nutrient shortage, such as anorexia, anemia, or zinc deficiency, and hormonal imbalances, for example menopause, thyroid illness, or polycystic ovaries, can cause a reduction in it. A healthy diet is characterized by the consumption of macronutrients in optimal proportions to meet the body's energy and physiological requirements, without excessive intake. It should also provide adequate micronutrients and hydration to fulfill the body's physiological needs. Macronutrients, such as carbs, proteins, and lipids, supply the energy needed for the cellular functions essential for daily functioning. Micronutrients, such as minerals and vitamins, are necessary in relatively small quantities for regular development, metabolism, growth, and physiological functioning. Patients with hair loss should undergo screening through medical history, food history, & physical examination to identify potential risk factors for nutritional insufficiency. If necessary, laboratory tests may be conducted. It is evident that cases with dietary inadequacies should address and correct those deficiencies.

**Keywords:** Hair follicle, Supplementation, Macronutrients, Micronutrients, Physiologic functioning.

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## Introduction

Specifically, hair has a delayed response to any form of stimulation. Generally, the appearance of healthy hair indicates both good overall health and effective hair-care routines. Studies have shown that proper nutrition has a crucial role in promoting healthy hair growth. On the other hand, several deficiencies have been discovered to be correlated with loss of hair (1). It is crucial to note that the follicle cells require specific vitamins & minerals to

support optimal growth of hair (2). B-group vitamins play a crucial role in maintaining healthy hair, with biotin being particularly essential. When the body is at risk, it reorganizes its activities, giving precedence to the key organs but not considering hair follicles as important. Although not all cases of hair growth problems stem from malnutrition, it can serve as a significant indicator in the diagnostic process (3). Omega-3 fatty acids, vitamin B12, protein, and iron\_nutrients abundant in fish\_help prevent scalp dryness & maintain dull hair color. Dark green vegetables are rich in vitamins C&A, which promote sebum production and act as a natural hair conditioner. Legumes are a good source of protein, which helps stimulate hair development. They also contain zinc, iron, & biotin. Biotin serves to stimulate specific enzymes that facilitate the breakdown of carbon dioxide, as well as proteins, lipids, and carbs during metabolism. Inadequate consumption of biotin can result in hair fragility and may contribute to hair loss, (3). To prevent a biotin shortage, people can obtain biotin from sources such as liver, cereal-grain products, soy flour, egg yolk, & yeast. Nuts are rich in selenium & hence play a crucial role in maintaining a healthy scalp. Some nuts include alpha-linoleic acid and zinc, which can help improve hair condition & reduce hair shedding that may result from zinc deficiency. Inadequate protein intake or consumption of low-quality protein can lead to hair weakness & fragility, eventually causing loss of hair color. Low-fat dairy products are excellent providers of calcium, which is an important element for promoting hair growth (4).

## Hair follicles

Hair follicles exhibit variations in size & shape based on their location, while maintaining the same fundamental structural components. The hair shaft is formed by rapidly dividing matrix cells located in the hair bulb, along with melanocytes spread everywhere, which are responsible for providing color to the hair. The process of differentiation & upward movement play a role in the growth of the hair shaft, which is made up of intermediate filaments & proteins in its cortex. The dermal papilla, located at the base of the hair follicle, regulates the quantity of matrix cells & , consequently, the dimensions of the hair (3).

Hair growth is a continuous process that may be divided into four distinct phases: catagen (regression), anagen (growth), telogen (rest), & exogen (shedding). Each hair follicle undergoes a distinct cycle, with individual

follicles having between ten and thirty cycles throughout a person's lifetime. Although the average person typically has more than hundred thousand hairs on their scalp, it is common for them to shed between 100 to 150 telogen hairs per day. In healthy conditions, the density & total quantity of hair strands stay mostly stable since some hairs are in the anagen phase while others are resting or shedding (3).

Anagen, the most extended phase of the hair cycle, typically lasts from 2 to 8 years for scalp hair. Anagen is distinguished by the generation of a whole hair shaft originating from hair follicles. The catagen phase is the period of transition between the telogen phase & the anagen phase, and it typically lasts for approximately 2 weeks. During the catagen phase, the hair follicles undergo regression & separate from the dermal papilla, which is a group of mesenchymal cells within the hair follicles. This process leads to the death of epithelial cells in the bulb of the follicle (5).

After the catagen phase, the dermal papilla moves up towards the bulge of the hair follicle. When the dermal papilla fails to reach the bulge throughout the catagen phase, the cycle of hair follicle growth stops, leading to hair loss. The telogen resting period ensues, with a duration of approximately two to three months. Around nine percent of all hair on the scalp is in the telogen phase, while forty to fifty percent of all hair on the trunk is in the same phase (3).

During the period of hair inactivity, fresh hair starts to form at the root of the hair follicle, gradually displacing the old hair. Nevertheless, if the anagen phase transitions into the resting phase prematurely, it can lead to an excessive shedding & thinning of hair, which is referred to as telogen effluvium (TE). On the other hand, decreasing the percentage of hair follicles in the telogen phase helps control hair loss. Finally, exogen refers to the end of telogen & the beginning of anagen. Throughout this phase, the growth of new hair causes it to push the old hair out, leading to its eventual shedding (6).

## Diet

Non-communicable diseases (NCDs), including cardiovascular illness, cancer, diabetes, obesity, chronic respiratory diseases, & cognitive impairment, are major contributors to mortality & disability worldwide. These illnesses impact both developed & developing countries (7).

While hereditary and environmental variables are known to contribute to the risk of non-communicable diseases (NCDs), it is important to note that modifiable lifestyle-related factors can have a significant impact at the level of the person (8).

Dietary choices can raise the risk of developing hypercholesterolemia, obesity / overweight, hypertension, & inflammation. These factors, in turn, elevate the risk of illnesses that are related to significant mortality & morbidity, such as cardiovascular disorders, diabetes, & cancer. The significant increase in chronic non-communicable diseases can be attributed to global dietary patterns that are progressively using Western features. These patterns are distinguished by excessive consumption of fatty & processed meats, refined grains, saturated fats, salt, & sugars, while lacking fresh vegetables & fruits (9).

The WHO Global Action Plan for the Prevention & Control of Non-communicable Disorders acknowledges the significant role of diet in determining illness risk. As part of its efforts to reduce behavioral risk factors, the plan involves strategies to address unhealthy diet patterns. These strategies are implemented among initiatives targeting physical inactivity, tobacco use, & harmful alcohol use (10).

The World Health Organization suggests several dietary modifications, which include maintaining a balanced caloric intake, restricting the consumption of saturated & trans-unsaturated fats while favoring unsaturated fats, boosting the consumption of vegetables & fruits, & limiting the intake of sugar & salt.

Several dietary goals are found in regional diets like the Mediterranean diet or are involved into evidence-based diets aimed at lowering the risk of diseases, like the Dietary Approaches to Stop Hypertension (DASH) or Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diets. (11).

## Effect of the Mediterranean Diet on hair

The Mediterranean diet & soy products high in isoflavones provide nutrients with anti-inflammatory properties that can potentially enhance hair health and stimulate growth in people who have androgenetic alopecia. Research has demonstrated that the gluten-free diet can promote hair growth for cases with alopecia areata (AA) who also have celiac illness. However, no impact on hair growth was observed with a lactose-free diet

An investigation conducted by Pham et al. in 2020 indicated that consuming fish with high levels of mercury may lead to the development of alopecia areata & TE (telogen effluvium). Additionally, the investigation found that consuming significant amounts of buckwheat & millet groats relate to the occurrence of frontal fibrosing alopecia (FFA). (12).

Dietary fats modulate immune cell functionality and contribute to the maintenance of skin health. Hao et al. demonstrate that mice models experience hair loss when fed high-fat diets including fish oil, but not when fed diets containing cocoa butter. Hao et al. (2022) have determined that the expression of E-FABP in skin macrophages is crucial for facilitating the impacts generated by the fish oil. (13).

A diet that contains high levels of antioxidants, anti-inflammatory substances, or estrogen-like compounds - which are characteristics of the Mediterranean diet - may help hinder hair loss.

Plant-based diets are high in phytochemicals, including carotenoids & polyphenols, which have anti-inflammatory & antioxidant properties. These properties assist in lowering the creation of reactive oxygen species in dermal papilla cells, resulting in a decrease in the secretion of transforming growth factor  $\beta$ 1 & promoting hair growth.

Certain polyphenols, such as flavonoids like myricetin & apigenin, possess estrogenic properties that can hinder the activity of  $5\alpha$ -reductase (14).

Proteins are the primary constituents of hair. A cross-sectional investigation discovered significant protein consumption deficiencies in Indian



cases with AGA (androgenetic alopecia), alopecia areata (AA), & telogen effluvium (TE). This finding provides support for the need of protein as a crucial nutrient for maintaining healthy hair. When examining the protein level of key Indian food products, it was found that fish, including tuna, codfish, & salmon, had the highest protein content per portion. While fish is commonly consumed in the Mediterranean diet, it is important to exercise caution due to the potential risk of mercury poisoning. Two cases had hair loss (alopecia) because of high amounts of tuna & other fish with high mercury content in their diet (15).

### **Low carbohydrate diets**

Common side effects of low carbohydrate diets involve reduced appetite, headaches, bad breath, muscle spasms, overall fatigue, and alopecia. (16).

### **Hair Loss from Diet: (2)**

- Significant hair loss has been related to rapid weight loss, particularly in patients who underwent weight\_ loss surgeries . These surgical procedures might lead to sudden or delayed hair loss following weight loss.
- A highly restrictive diet, whether it be low in calories or limited in certain foods or nutrients, can potentially impact hair development. A decrease in calories & nutrients can have a significant influence on various physiological systems.
- Iron, protein, & vitamin D are important nutrients that can contribute to the health of hair.
- Further investigation is required to establish a definitive connection among diet & hair loss. However, consuming a well-balanced diet that includes foods rich in those nutrients may potentially stimulate hair growth and enhance your general state of health.

### **Nutrients have direct role in promoting hair growth**

Unsaturated fatty acids have been found to hinder the function of five

alpha reductases, with gamma linolenic acid (an omega six fatty acid) exhibiting the strongest inhibitory effect. Vitamin D3 decreases levels of androgen & insulin resistance, controls hair cycles, & directly affects the dermal papilla cells.

Zinc functions as an immunomodulator, inhibiting the catagen stage, preventing follicle regression, & facilitating recovery from telogen. Copper facilitates the process of distinguishing and multiplying cutaneous papilla cells.

Arachidonic acid enhances the production of growth factors in the dermal papilla cells, stimulates the division of matrix keratinocytes, & triggers the formation of new blood vessels & the elongation of hair. Nutrients are known to directly influence hair development. (17).

### Role of iron is supported by other vitamins & minerals

Hair follicles are recognized as a primary source & storage for ferritin, a protein that is used in cases of insufficiency (18).

Iron deficiency may disrupt the hair growth cycle , as ferritin is preserved & directed to maintaining normal serum ferritin levels in the blood. Therefore, laboratory testing indicate that the ferritin levels are within the normal range, even when there is a simultaneous deficiency & hair loss.

The process of iron absorption, binding, transport, and activation for the production of red blood cells (erythropoiesis) requires the presence of vitamin A, vitamin C, amino acids, beta carotene, zinc, & copper , (19)

The presence of these accessory nutrients' inadequacies results in inadequate use of the iron resources that are available, manifesting as non\_iron deficiency anemia & hair loss, while having seemingly normal levels of iron or ferritin. The presence of iron is necessary for the process of converting stored thyroid hormone T3 into active T4, (20).

### Nutrients support stem cell function

Stem cells are responsive to the presence or absence of nutrients, as well

as hormones & factors that are triggered by nutrition, such as insulin, IGF (insulin-like growth factor), amino acids, & steroid hormones.

The hairless scalp has hair follicle stem cells but does not have hair follicle progenitor cells. Nutrition facilitates the growth & preservation of the stem/progenitor cell population. Nutrient treatment enhances the efficacy of traditional hair treatment by supporting and stimulating hair development , (21).

### Diet and hair loss

Many individuals frequently ask about using vitamins, minerals, & nutrition to prevent or treat skin issues, namely hair loss. Responding to these queries is often difficult due to the enormous and conflicting amount of material available on this subject.

The most recent discoveries support new recommendations depend on evidence for preventing and treating psoriasis, atopic dermatitis, skin cancer & acne. These results additionally highlight the need for continued investigations , (22).

Individuals with hair loss frequently ask whether dietary supplements might aid in the restoration of hair growth or the prevention of more hair loss. In fact, many people initiate the consumption of dietary supplements without seeking professional advice, in the expectation that these supplements will help.

The unregulated supplement industry takes advantage of the susceptibility of this people. The metabolic activity of hair follicles is high in the body. Hair development can be affected by malnutrition in terms of calories, protein, & micronutrients. However, the association between these factors is intricate , (2).

Both the structure & growth of hair can be affected by a lack of essential nutrients. Acute telogen effluvium (TE) is a recognized consequence of abrupt weight loss or reduced protein consumption, which might impact hair development , (23).



## **Factors Increasing Hair Loss**

### **Nutritional Deficiencies**

Optimal nutrition is crucial for maintaining a healthy balance between anagen & telogen phases of hair growth. Insufficient caloric intake or nutritional deficiencies can have detrimental effects on the structure, growth, & pigmentation of hair. In addition, telogen effluvium can occur because of sudden weight loss or inadequate protein consumption, and widespread hair loss may be an initial indication of a nutritional shortage.

Various nutritional components were assessed for their impact on the growth & structure of hair, involving a range of minerals & vitamins, as well as fatty acids & protein. The usefulness of nutritional supplementation for hair loss, particularly in those who aren't deficient, is still unknown. Over-supplementation of some nutrients may lead to increased toxicity & potentially contribute to hair loss , (2).

### **Amino Acids and Protein**

Alopecia subtypes frequently exhibited a lack of crucial amino acids, specifically leucine, histidine, & valine (24).

Protein deficiency, as seen in conditions like kwashiorkor & marasmus, can lead to hair alterations characterized by hair thinning & hair loss, (25).

### **Fatty Acids**

Inadequate parenteral nutrition and malabsorption problems, such as cystic fibrosis, can lead to a deficit of the polyunsaturated essential fatty acids linoleic acid (an omega six fatty acid) & alpha-linolenic acid (an omega three fatty acid).

Changes in hair consist of alopecia (loss of scalp hair) & hypopigmentation (lightening of hair), including the eyebrows. Unsaturated fatty acids can affect androgen function by inhibiting 5 $\alpha$ -reductase, which is like how the medication finasteride works. Moreover, the omega six fatty acid

known as arachidonic acid may stimulate hair development by increasing the rate at which hair follicles multiply , (16).

Furthermore, research has indicated that a lack of omega-three and omega-six fatty acids may have a role in causing more hair follicles to be in the telogen phase, leading to alopecia. Arachidonic acid, which is an omega-six fatty acid, was demonstrated to enhance the expression of growth factors associated with hair growth, including fibroblast growth factor (FGF)-7 & FGF-10, in murine models (16).

Furthermore, the addition of arachidonic acid supplementation resulted in an extended growth phase of hair follicles and stimulated the elongation of hair elongation. Moreover, unsaturated fatty acids have the potential to hinder the action of five-alpha-reductase & alter the functioning of androgens in a manner comparable to finasteride (1).

Supplementing fatty acids decreased hair loss in rhesus macaques that participate in self-grooming. Furthermore, a single case report (26) shown that the administration of topical linoleic acid effectively reversed scalp dermatitis, alopecia, & depigmentation of hair.

## Vitamins

Micronutrients, such as vitamins, influence the regular cycle of hair follicles and promote the replacement of matrix cells in the bulbs of hair follicles. In addition, studies using mouse models have shown that dietary supplementation of vitamin A leads to a higher percentage of hair follicles in the anagen phase.

Nevertheless, an overabundance of vitamin supplementation has demonstrated adverse effects on hair characteristics (2).

## Vitamin A

Vitamin A enhances the concentration of beta-catenin & WNT7A in the nucleus of the hair follicle bulge, with the extent of increase being depending on the dosage. These findings indicate that the impact of vitamin A in the diet

on the initiation of hair growth and the activation of stem cells is mediated by an upregulation of WNT signaling ,(27).

## B Vitamins

Biotin (vitamin B7), Niacin (vitamin B3), & folic acid (vitamin B9), which are part of the B vitamins, have been related to hair loss. For example, alopecia is a common clinical discovering related to deficient niacin, in addition to the well-documented pellagra characteristic of niacin deficiency ,(2).

**Biotin** is a substance that helps carboxylation enzymes function properly. It may be found in protein-rich foods. Biotin was studied extensively for its impact on hair, & it is commonly included in supplements & serums that aim to improve hair health (1). Severe alopecia (infantile)& dermatitis & scant or missing eyebrows, scalp, & eyelash hair (infantile) are linked to genetic biotin deficiency. In the same way, acquired biotin insufficiency is identified by hair loss and brittle nails.

## Vitamin D

Vitamin D is a crucial nutrient in the body that performs several tasks. The fat-soluble vitamin can be ingested orally, obtained from dietary supplements and foods, or generated internally by the body through a photochemical process triggered by sun exposure on the skin (28).

Upon activation, vitamin D facilitates the absorption of calcium in the gastrointestinal tract, regulates bone mineralization by controlling calcium & levels of phosphate, & performs additional immunomodulatory roles.

While the precise correlation between vitamin D & hair loss isn't fully comprehended, a prevailing view proposes that the presence of the vitamin D receptor (VDR) is necessary for a regular hair growth cycle, involving the beginning of the growth phase known as anagen , (25). The expression of VDR was detected in mesodermal dermal papilla cells & epidermal keratinocytes, which are both components of a hair follicle.

## Vitamin E

Vitamin E is hypothesized to enhance hair count by reason of its antioxidant properties & its ability to suppress lipid peroxidation. However, there is a lack of research supporting the potential advantages of supplementation. However, an excessive amount of vitamin E might elevate the likelihood of bleeding and reduce the production of thyroid hormones, which ironically may contribute to hair loss.

Supplementation, in this case, resulted in negative impacts on hair characteristics in cases who consumed around thirty times the recommended daily amount. (29).

## Minerals

Iron, zinc, & selenium are minerals that were related to the regulation of the hair growth cycle. Iron deficiency is the most frequent dietary deficiency worldwide, & it has a role in the development of TE (2).

The potential influence of iron on the hair cycle arises from its role as a cofactor for the rate-limiting enzyme involved in DNA synthesis. Some researchers have found that cases with chronic AGA, TE, & AA have low levels of serum ferritin, which is the storage form of iron. nevertheless, other investigations have not established any connection between these conditions & low serum ferritin levels, (1).

The precise way in which iron affects hair growth is currently unknown. However, it is worth noting that hair follicle matrix cells are among the fastest dividing cells in the body. “ID” Iron deficiency may contribute to hair loss by acting as a cofactor for ribonucleotide reductase, which is the enzyme responsible for reducing the rate of DNA synthesis. Furthermore, researchers have discovered several genes within the human hair follicle, & it is possible that certain genes are influenced by iron levels, (1).

Vegans and vegetarians have an increased susceptibility to iron deficiency “ID” due to their greater dietary iron needs, which are estimated to be 1.8 times more than those of meat eaters. Non-heme iron, which is present

in plants, has a reduced potential to be taken by the body compared to heme iron, which is found in meat and fish , (1).

Zinc, a crucial component of several metalloenzymes that control protein synthesis & cellular division, was correlated with telogen effluvium & fragile hair in individuals with zinc deficiency (1). Zinc is a vital mineral that is necessary for the functioning of numerous enzymes & various transcription factors that control gene expression.

Although the precise mechanism of action remains unclear one potential explanation revolves around zinc's function as a vital constituent of certain metalloenzymes that play a crucial role in protein synthesis and cell division. Another potential factor is the involvement of zinc in the Hedgehog signaling pathway, which plays a crucial role in the regulation of hair follicle development. Zinc deficiency can lead to hair changes such as telogen effluvium & brittle hair , (30).

Selenium, a mineral that has a role in protecting against oxidative damage & the development of hair follicles, has been linked to reduced hair growth & hair loss in rats & mice with selenium deficiency. Supplementing selenium in persons who are deficient has been found to result in the development of hair and improvement of alopecia.

Selenium poisoning can cause widespread hair loss, along with additional symptoms for example skin lesions that form blistering, gastrointestinal pain, & memory issues ,(1).

## Niacin

Pellagra, caused by a lack of niacin, leads to the commonly observed combination of photosensitive skin inflammation, diarrhea, & dementia. Alopecia is a commonly observed clinical sign. (1).

## Complex carbohydrates

Complex carbs are essential for the conversion of protein into hair cells. They supply the necessary energy as hair is the 2<sup>nd</sup> most rapidly growing



cellular structure in the body. Hair isn't physiologically prioritized by the body & a prolonged absence of carbs might cause the body to convert stored proteins, such muscle, into energy. This can lead to hair loss. (31)

## Conclusion

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It is possible that diet is only one of numerous factors that contribute to loss of hair, & it may not be the primary factor in a particular form of loss of hair. Hair loss may also be associated with marijuana. Hair growth & hair structure may be adversely affected by nutritional deficiencies. Acute telogen effluvium, a well-known consequence of sudden weight loss or diminished intake of protein, & the diffuse alopecia observed in niacin deficiency are among the effects on hair growth. Additional research with an extended follow-up period is required to enhance the absorption of topical hair treatments to achieve superior outcomes. It is advised that future research be conducted utilizing water-soluble drugs, as alcohol is known to cause dry hair. Additional research is required to enhance the selectivity of systemic hair therapy. Additional research regarding the integration of a nutritious diet with medications to address hair loss

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