

# Biotin for Hair Loss: Teasing Out the Evidence

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**OBJECTIVE:** Biotin has widespread popularity as a hair supplement. We sought to review the literature regarding biotin's efficacy as a hair supplement. **METHODS:** We conducted a literature search of PubMed for articles specifically studying the use of oral biotin for hair growth or quality. Case reports and case series were excluded. **RESULTS:** Three studies met our inclusion criteria. The first study was the highest quality, with a double-blind and placebo-controlled study design, but their results found no difference between the biotin and placebo groups for hair growth. The other two studies investigated specific patient populations (patients on isotretinoin and female patients post-sleeve gastrectomy). Both studies were susceptible to multiple potential biases and neither had striking results in favor of biotin. **LIMITATIONS:** Our review is limited by lack of available studies. **CONCLUSION:** Given the widespread popularity of biotin as a hair supplement, one would presume that this claim must be grounded in strong evidence; however, there is a large discrepancy between the public's perception of its efficacy and the scientific literature. The utility of biotin as a hair supplement is not supported by high-quality studies. **KEYWORDS:** Biotin, vitamin B-7, vitamin H, supplement, hair loss, alopecia

Biotin is vitamin B7, also known as vitamin H from the German words "Haar und Haut," which mean "hair and skin." Biotin has long been glamorized as a hair supplement, but the scientific evidence supporting this claim has been surprisingly lacking.<sup>1</sup> Biotin is an essential cofactor for five mammalian carboxylase enzymes involved in gluconeogenesis, fatty acid synthesis, and amino acid catabolism.<sup>2,3</sup> Mammals cannot synthesize biotin, however deficiency is thought to be rare in industrialized countries since it is available in a wide range of foods (namely meat, fish, eggs, nuts, dairy, and some vegetables) and is produced by intestinal flora.<sup>4,5</sup> A balanced Western diet provides 35–70mcg of biotin daily, which exceeds the daily adequate intake of 30mcg.<sup>4,6–8</sup> Biotin deficiency can be either acquired or inherited. Acquired forms can be seen with pregnant and breastfeeding women, alcoholism, smoking, malabsorption, malnutrition, total parenteral nutrition, excessive consumption of raw egg whites, prolonged antibiotic use altering the gut microbiota, and associated with various medications including valproic acid and isotretinoin.<sup>2,5,9,10</sup> Inherited deficiencies are due to a genetic mutation in either biotinidase or holocarboxylase, both involved in the biotin cycle.

## METHODS

In this review, we sought to delve deeper into the existing high-quality scientific evidence regarding biotin for hair loss by conducting a literature review using PubMed on June 6th, 2023, for the following search terms: biotin AND (hair OR alopecia). There were 330 results. Results were narrowed by relevance, those available in English, and those accessible

through the authors' institutional library (Figure 1). Relevance was defined as human studies evaluating the use of biotin monotherapy for improving hair growth or quality. With the purpose of isolating high-quality evidence, case reports and case series were excluded.

## RESULTS

Only three studies met our criteria (Table 1). One double-blind, placebo-controlled study was identified dating back to 1966.<sup>11</sup> In this study on female participants with diffuse alopecia, 28 patients took 10mg of biotin daily compared to 18 patients given placebo. After four weeks, both groups improved from baseline and there was no significant difference in hair growth or sebum excretion between the groups. In the second study, Aksac et al<sup>12</sup> had 60 patients taking isotretinoin and 30 of them were also given biotin 10 mg daily.<sup>12</sup> Using trichoscopy, both groups displayed a decrease in the terminal hair density while on isotretinoin therapy; however, the biotin group showed a significant shift toward anagen hairs compared to baseline. In the final study, Sen et al<sup>13</sup> investigated the efficacy of biotin for hair loss after sleeve gastrectomy. Of 112 female patients with self-reported hair loss post-sleeve gastrectomy, 22 were biotin-deficient. Of these biotin-deficient patients, 23 percent reported subjective improvement in hair loss with 1mg of biotin daily. Interestingly, 38 percent of biotin-sufficient patients reported improvement in hair loss as well. No other case-control studies, cohort studies, nor controlled clinical trials specifically investigating the efficacy of biotin for improving hair growth or quality were identified.

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### DISCUSSION

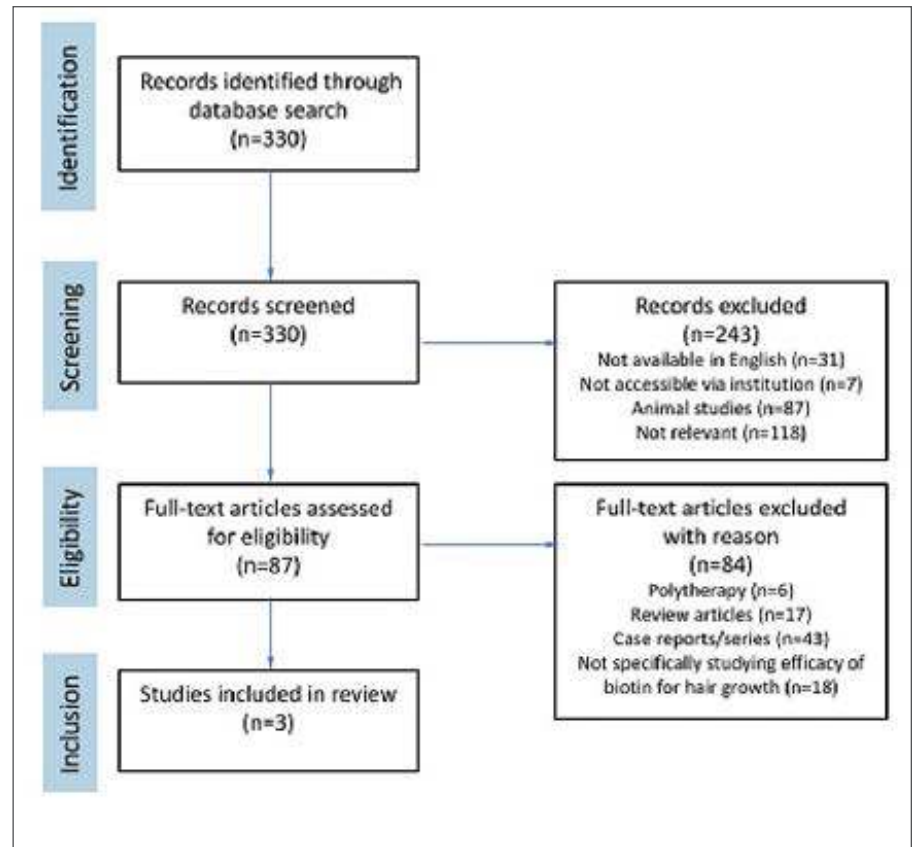
The study by Pawlowski et al<sup>11</sup> is almost 60 years old and did not support the use of biotin for diffuse female alopecia. The study on biotin's utility in isotretinoin-associated alopecia as well as the study on sleeve gastrectomy patients focused on niche patient populations and, therefore, are not generalizable.<sup>12,13</sup> These studies were not blinded, and therefore the results may have been affected by observer bias; regardless, the results were not remarkably supportive of biotin. The level of evidence for the sleeve gastrectomy study in particular is especially low because it relied on subjective perception of hair loss.

Given the dearth of publications that met our complete search criteria, we will touch on noteworthy articles that resulted from our initial search terms, including numerous case reports and small case series, as well as studies investigating serum biotin levels in various causes of alopecia. Of the reported cases, the majority were pediatric cases, and all patients had an underlying pathology to explain their poor hair growth.

Biotin supplementation has been utilized in many pediatric hair conditions. Doses ranging from 300mcg three times daily to 5,000mcg daily have shown improvement of hair thickness and combability at 3 to 4 months in cases of uncombable hair syndrome, even with normal baseline biotin levels.<sup>14,15</sup> A retrospective chart analysis of 25 patients with short anagen syndrome demonstrated that biotin alone or with topical minoxidil produced clinical improvement in the length and diameter of hair shafts.<sup>16</sup>

Additionally, there are ample case reports of patients with inherited biotin-deficiency due to defective biotinidase or holocarboxylase enzymes that display subjective improvement of alopecia after biotin supplementation.<sup>1,17</sup> Likewise, many cases of alopecia from acquired causes of biotin deficiency have shown improvement with biotin supplementation, including malnutrition from formula, parenteral nutrition, or surgical resection of bowel.<sup>18–21</sup>

Biotin-responsive alopecia has been seen with a few medications, as seen with the isotretinoin trial mentioned above. Accordingly, Schulpis et al<sup>22</sup> discovered that isotretinoin-associated telogen effluvium has significantly diminished biotinidase activity compared to controls. Alopecia in the setting of valproic



**FIGURE 1.** Summary of review conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines

acid has also shown subjective improvement with 10mg of daily biotin administration.<sup>23,24</sup> The exact mechanism is unclear since one study of 20 children on valproic acid showed no significant difference in serum biotin level or biotinidase activity compared to controls, yet another study did show a dose-related reduction of biotinidase activity with valproic acid; nonetheless, the biotin-responsiveness of alopecia in both studies suggests some interference of the biotin cycle.<sup>23,24</sup>

Biotin has been studied in polytherapy regimens for hair loss. In a compounded topical formulation with minoxidil, finasteride, and caffeine citrate, biotin has promoted normal hair growth in androgenetic alopecia.<sup>25</sup> Similarly, in an intradermal mesotherapy preparation with minoxidil, finasteride, and D-panthenol, biotin produced significant improvement in hair density and thickness.<sup>26</sup> In children with alopecia areata, oral biotin with concurrent oral zinc and topical clobetasol administration produced complete hair regrowth in 3 of 9 pediatric patients compared to none of the

nine children that received systemic steroids.<sup>27</sup> Intramuscular biotin and dexpanthenol injections improved total hair density and decreased hair fall count compared to baseline in a study of 50 patients with diffuse pattern hair loss.<sup>28</sup> Of course, studies on polytherapy formulations do not give any true insight on the impact of biotin in producing the result.

A few studies have evaluated serum biotin concentrations in patients with hair loss and yielded conflicting results. On one side, Trueb et al<sup>29</sup> reported a remarkable 38 percent of 541 female patients (9–92 years old) complaining of hair loss were biotin-deficient (<100 ng/L), and 89 percent of these biotin-deficient individuals had no identifiable risk factors for biotin deficiency. On the other side, Rahman et al<sup>30</sup> found no difference in biotin levels between 60 patients with telogen effluvium and 20 controls. In androgenetic alopecia, 60 male patients had biotin levels significantly lower than 60 controls, though neither group had any individuals that were truly biotin-deficient.<sup>9</sup> The gender differences and type of alopecia may

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**TABLE 1.** Summary of the three studies that met our inclusion criteria

STUDY	POPULATION	DOSE	DESIGN	RESULTS
Pawlowski et al 1966 <sup>11</sup>	Females with diffuse pattern hair loss	10mg daily x 4 weeks	Double-blinded, placebo controlled; Group 1: 28 patients took biotin; Group 2: 18 patients took placebo	Both groups improved from baseline. No significant difference in hair growth or sebum production between groups.
Aksac et al 2021 <sup>12</sup>	Patients taking isotretinoin	10mg daily x 4 months	Group 1: 30 patients took isotretinoin and biotin; Group 2: 30 patients took isotretinoin only	Using trichoscopy, both groups had a decrease in terminal hair density. Group 1 had a significant shift toward anagen hairs compared to baseline.
Sen et al 2021 <sup>13</sup>	Females with hair loss after sleeve gastrectomy	1mg daily	Group 1: 22 biotin-deficient patients took biotin x 3 months; Group 2: 29 biotin-sufficient patients took biotin x 2.5 months on average	23 percent of Group 1 reported remarkable decline in hair loss. 38 percent of Group 2 reported remarkable decline in hair loss. There was no significant difference between groups.

**TABLE 2.** Laboratory tests susceptible to biotin interference<sup>38,39</sup>

POSITIVE INTERFERENCE (FALSELY ELEVATED)	NEGATIVE INTERFERENCE (FALSELY DIMINISHED)
Aldosterone	ACTH, FSH, HGH, LH, PTH, SHBG, TSH
Androstenedione	AFP
Anti-HAV Total	Anti-CCP
Anti-TSH receptor	Anti-HAV IgM
Anti-TPO	Anti-HBc IgM & HBsAg
Anti-Thyroglobulin (both)	Anti-HCV
Cortisol	Calcitonin & Procalcitonin
Cyclosporine	Cancer Ags (125, 15-3, 19-9, CEA, HE4, PSA)
DHEAS	Cardiac biomarkers (Troponin, CK-MB, Myoglobin)
Digoxin	EPO
Estradiol	Ferritin
Folate	Gastrin
FT3, FT4, T3, T4	HIV 1/2 Ag/Ab [41]
Progesterone	Insulin, IGF-1, C-peptide
Testosterone [40]	IgE
Vitamin B12	NT-proBNP
Vitamin D Total	Prolactin
17-OH-progesterone	Qualitative hCG [42]
25-Hydroxyvitamin D	

help explain the discrepant outcomes. Plus, serum biotin levels are thought to be unreliable; instead, measuring urine metabolites is considered a more precise measure of biotin deficiency.<sup>1,5,9,29,31</sup> More studies are needed to corroborate these findings.

Some authors have investigated public perception of biotin efficacy for hair loss. John et al<sup>32</sup> analyzed Amazon.com reviews for biotin products revealing 27.2 percent of reviewers stated it was helpful for their hair. That same group performed an anonymous survey of

dermatology patients where 27.4 percent of 152 biotin users reported subjective improvement in hair and nails.<sup>33</sup>

Overall, existing low-grade evidence only supports that biotin may improve hair growth or quality in the following settings: uncombable hair syndrome, short anagen syndrome, biotinidase and holocarboxylase deficiency, insufficient biotin intake (formula, parenteral nutrition, surgical bowel resection), and medications (isotretinoin and valproic acid). There have been no studies demonstrating biotin supplementation to be beneficial for hair growth in healthy individuals.

It is well-known that patients who are biotin-deficient can display alopecia.<sup>5</sup> From this, one can surmise that biotin must play a significant role in hair growth. Residing on a fallacious rationale, the media extrapolated that excess supplementation of this vitamin would be useful for hair growth and started marketing biotin as an essential hair supplement. Herein lies a large discrepancy between the public's perception of biotin's efficacy for hair loss and the current scientific literature. As we can see above, the current literature does not support biotin's use in adults with sufficient levels of biotin. Nonetheless, use of this vitamin by the public is pervasive. In 2016, 29 percent of the population was found to take a biotin-containing supplement.<sup>34</sup> In another study of 1,944 emergency room visits at Mayo Clinic, 7.7 percent of patients knowingly reported taking biotin.<sup>35</sup> The survey by John et al<sup>33</sup> exhibited that 33.7 percent of dermatology patients reported current or past biotin use, and 28.8 percent of them were recommended to start biotin by a physician. Despite insufficient evidence, physicians continue to recommend biotin for hair concerns. A national survey of 147 physicians found that 43.9 percent

recommended biotin to patients, and of these, 59 percent recommended it for hair disorders.<sup>36</sup> Though, Trueb et al<sup>29</sup> did raise the possibility that a substantial proportion of the hair loss community may be biotin-deficient, and thus, warrants further investigation into possible biotin deficiency in alopecia patients.

**FDA warning.** Being a water-soluble vitamin, biotin toxicity is essentially unheard of; however, biotin supplementation does not come without risk. Elevated serum biotin levels can interact with various laboratory immunoassays that could lead to a missed diagnosis, needless workups, undue distress, or fatal consequences. For instance, a death has been reported where biotin interference of a troponin test led to the missed diagnosis of a heart attack.<sup>37</sup>

Many immunoassays rely on a streptavidin-biotin interaction. Interference from excess serum biotin may induce both false-positive and false-negative laboratory results based on the assay design. Competitive assays result in positive interference, meaning lab results are falsely elevated, and sandwich (non-competitive) assays can have negative interference, meaning lab results are falsely diminished.<sup>38</sup> Table 2 displays a list of laboratory tests that may have false-positive or false-negative results due to biotin interference. There are many reports of biochemical Graves' disease in euthyroid individuals due to biotin interference, one almost leading to an unnecessary thyroidectomy.<sup>43-50</sup> Another notable interference is with qualitative urine hCG tests, which may pose a problem since biotin is often a component of prenatal vitamins.<sup>42</sup>

In 2017, the Food and Drug Administration (FDA) released a safety communication to spread awareness that biotin can seriously interfere with certain lab tests.<sup>37</sup> In 2019, they issued another statement reminding the public,

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healthcare providers, lab personnel, and lab test developers about such lab interference with particular concern about interference with troponin laboratory tests.<sup>51</sup> They also published a list of troponin lab tests that are subject to biotin interference that was last updated June 2022.<sup>52</sup>

Fortunately, high doses of biotin are required in order to pass most thresholds for interference and biotin is eliminated quickly.<sup>38,50</sup> Each individual immunoassay has its own threshold, some being more sensitive to interference than others. It is concerning that troponin is one of the affected tests that has a low threshold for interference.<sup>50</sup> Biotin's serum concentration depends on the dose, duration of treatment, time of last dose, and the patient's renal function. Microgram (mcg) doses have a half-life of around 1.8 h, while 100–300 mg doses have a half-life ranging from 7.8–18.8 hours.<sup>50</sup> Standard microgram doses (30–60 mcg daily) often found in multivitamins are believed not to interfere with streptavidin-biotin assays.<sup>50</sup> Milligram doses (5–10 mg daily) can be found in over the counter supplements marketed for hair, skin, and nail growth, and can cause biotin interference, particularly in more sensitive assays like troponin.<sup>50</sup> As a reminder, the recommended daily intake for biotin is 30mcg daily, meaning that these products contain >10,000 percent adequate intake. High-dose biotin therapy (100–300 mg daily), used for treatment of multiple sclerosis, produced significant interference in all tested assays.<sup>50</sup> Cessation of biotin therapy is recommended at least two days prior to blood tests, and up to a week may be needed for high-dose therapy, especially for sensitive tests.<sup>50,53</sup> In reality, at least an 8-hour washout is likely sufficient for patients who have consumed 5–10 mg of biotin or less.<sup>38</sup>

Despite these FDA warnings, many consumers and even physicians are unaware of biotin's potential laboratory interference. The John et al. survey showed that only 6.6 percent of biotin users were aware of the FDA warning and only 4 percent were informed of potential laboratory interference by their physician.<sup>33</sup> Waqas et al.<sup>36</sup> published a national survey of physicians revealing that 19.5 percent were unaware of any laboratory interference.

There are many safeguards that can be instituted to prevent the unwanted implications of biotin laboratory interference.

Increased public and physician awareness will help mitigate potential errors. It is important for physicians to inquire about biotin supplementation in all patients since 54.6 percent of users have been shown to self-prescribe.<sup>33</sup> Physicians should educate patients about such laboratory interference and recommend for patients to discontinue biotin two days prior to scheduled laboratory work. If the patient does not have sufficient notice for a blood test as in the case of an emergency, then the laboratory should be notified that the patient is taking biotin.<sup>54</sup> Surprisingly, biotin product labels are not mandated to mention the FDA warning, but biotin manufacturers should also be responsible for educating the public about this.<sup>32,55</sup> The onus is also on laboratories and assay manufacturers to update immunoassays recognizing the fact that much of the public is taking biotin. For laboratory tests subject to biotin interference, serum biotin concentration could be reported with the test results with an explanation as to whether it's above the interference threshold.<sup>56</sup> Alternatively, biotin could be removed from the serum prior to the assay to prevent interference.<sup>57,58</sup> Lastly, it is vital for providers to have an open discussion with patients about the risks and scarcity of evidence supporting biotin's use for hair loss in the first place.

## CONCLUSION

Biotin is not an enemy here; misinformation is. The glorification of its uncertain efficacy for hair loss combined with the lack of awareness about laboratory interference poses a potential hazard. For those concerned about inadequate biotin consumption, it can be innocuously administered in microgram doses to ensure sufficient intake while being subthreshold for laboratory interference; however, excessive daily doses are inadvisable. Our review displays that the widespread marketing of biotin for hair loss in healthy individuals is unsubstantiated. The current literature comprised of low-quality studies merely shows that biotin may be useful in patients who are biotin-deficient or in pediatric patients with an underlying hair pathology. It does not support superfluous administration in individuals with sufficient biotin. In order to appropriately justify or dispel biotin's popularity as a hair supplement, randomized-controlled studies on biotin monotherapy for improving hair growth or

quality in the target population (i.e., healthy individuals with self-perceived hair loss) are especially needed.

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