

The Infatuation With Biotin Supplementation: Is There Truth Behind Its Rising Popularity? A Comparative Analysis of Clinical Efficacy versus Social Popularity

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ABSTRACT

Biotin, also known as Vitamin B₇ or vitamin H, is a water-soluble B vitamin that acts as an essential cofactor for several carboxylases involved in the cellular metabolism of fatty acids, amino acids, and gluconeogenesis. Although there exists an incredible amount of social media hype and market advertising touting its efficacy for the improvement of hair quantity and quality, biotin's efficacy for hair remains largely unsubstantiated in scientific literature. We reviewed all pertinent scientific literature regarding the efficacy of biotin supplementation for hair growth and quality improvement, and we also investigated its popularity in society defined as a function of market analytics. To date, there have been no clinical trials conducted to investigate the efficacy of biotin supplementation for the treatment of alopecia of any kind, nor has there been any randomized controlled trial to study its effect on hair quality and quantity in human subjects. Because of the lack of clinical evidence, its use to improve hair quantity or quality is not routinely recommended. However, societal infatuation with biotin supplementation is not only propagated by its glamorization in popular media, its popularity is vastly disproportionate to the insufficient clinical evidence supporting its efficacy in hair improvement. In other words, biotin supplements are quite "in vogue," without there being any real reason to be so.

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INTRODUCTION

Biotin, also known as Vitamin B₇ or vitamin H (the H comes from *Haar und Haut*, German for "hair and skin"), is a water-soluble B vitamin that acts as an essential cofactor for several carboxylases involved in the cellular metabolism of fatty acids, amino acids, and gluconeogenesis.^{1,2,3} Biotin is also an essential cofactor for mitochondrial carboxylases in hair roots.^{4,5} Although there exists a substantial amount of market advertising and social media publicity regarding the efficacy of biotin therapy for the improvement of hair quality, in reality the only human health condition for which there is strong evidence of biotin's therapeutic utility is for the treatment of biotin deficiency.¹⁻⁶ Biotin deficiency may be acquired, in which case the most common causes are: 1) a lack of sufficient biotin in parenteral nutrition, 2) gastrointestinal abnormalities including malabsorptive disorders, 3) excessive intake of raw egg whites (raw egg whites contain avidin, a protein that binds biotin and renders it useless; cooking egg whites denatures avidin while biotin remains functional) and 4) chronic anticonvulsant therapy.^{1,3,4} Biotin deficiency may also be inherited, in which case the most common causes are: 1) an inherited deficiency in holocarboxylase synthetase (an enzyme required to attach biotin onto biotin-dependent carboxylases; neonatal-onset of symptoms) and 2) an inherited deficiency in biotinidase (an enzyme required in releasing biotin from foods and biotin-related

peptides; juvenile onset of symptoms).^{1,4,5} In industrialized countries such as the United States, true biotin deficiencies remain rare because the production of biotin from intestinal bacteria remain sufficient to meet the body's daily requirements.^{2,3} For that reason, statutory agencies such as those in the United States do not prescribe a recommended daily intake of biotin.^{2,2}

A Review of the Scientific Literature

In the mid-1980s, routine biotin supplementation for hair improvement was supported by both the pediatric and dermatologic communities. In fact, an article published in *The Journal of the American Academy of Dermatology* stated "It is a general recommendation that any child with unexplained hair loss, rash or candidiasis receive a trial of biotin therapy."¹⁸

However, to date, there have been no clinical trials conducted to evaluate the efficacy of biotin supplementation for any type of alopecia, and currently, its use to improve hair quantity or quality is not routinely recommended.⁷ The initial literature investigating the efficacy of biotin for hair dates back to a study in 1965 in which 46 women were treated with an unknown dose of biotin and observed for "effects on hair roots." The authors concluded that biotin supplementation produced no change in the "state of the hair roots" in any of the 46 women.⁸ In the 1980s,

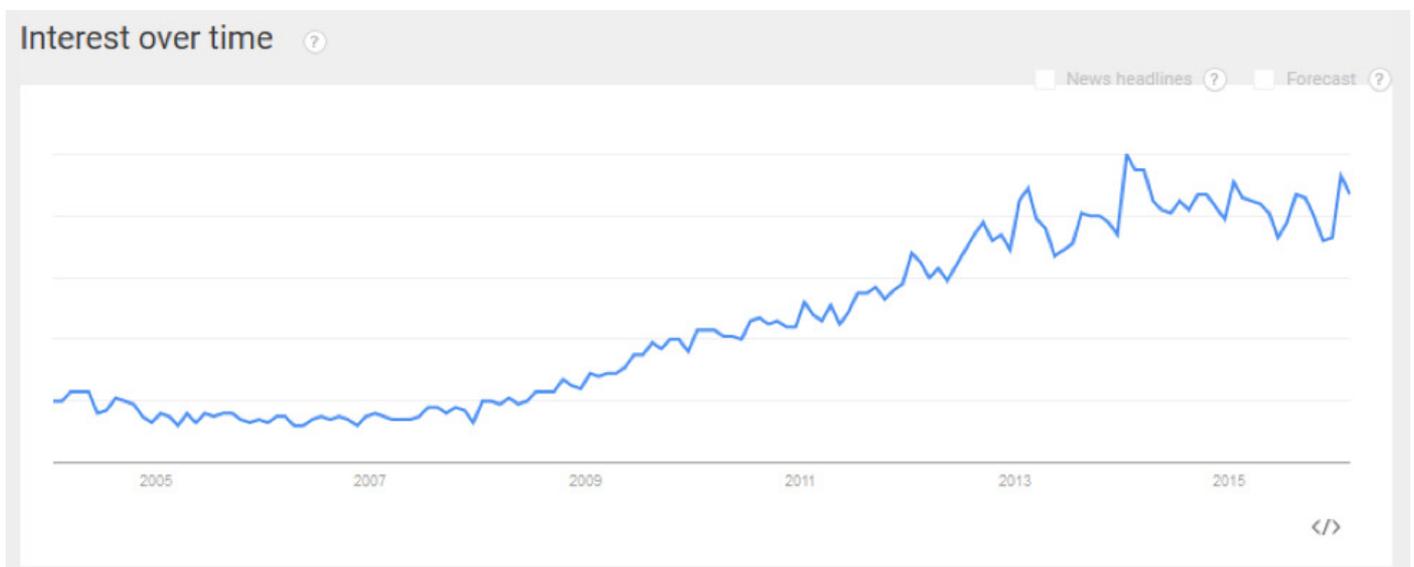
animal studies investigating the efficacy of biotin supplementation on hair quality and quantity were published; in one notable study, 119 dogs with poor coat quality consisting of symptoms including dull coat, brittle hair, and loss of hair due to unknown factors were treated with 5 mg biotin/10 kg body weight/day for 3 to 5 weeks. The study produced notable results; 60% of treated dogs demonstrated complete resolution of all hair and coat symptoms, 31% showed at least partial improvement in hair quality and/or quantity, and only 9% showed no change.⁹ These results initially suggested that biotin supplementation may help to treat alopecia or at least improve hair quality in humans as well, however this has yet to be substantiated.^{4,7} In addition, recent research investigating the potential benefits of biotin supplementation at the molecular level has failed to demonstrate any improvement on hair growth or development. Biotin supplementation appears to have no effect on the proliferation and expression of differentiation specific keratins K1 and K10 in cultures of outer root sheath cells^{4,10} and biotin concentrations likewise do not effect the expression of keratin K16, involucrin, and filaggrin as well.^{4,10}

However, not all is grim for biotin's ability to improve hair quality and quantity, and supplementation may be beneficial for certain patients. It is well known that chronic anticonvulsant therapy with valproic acid can result in a diffuse, nonscarring alopecia.^{1,11,12,13,14} Valproic acid is a well-established treatment for a wide variety of neurological and psychiatric disorders including various types of seizures and mood disorders.^{11,14} The pathophysiology underlying the alopecia is thought to be related to an acquired biotin deficiency (both relative and absolute) and this has been corroborated in both animal and human studies.^{1,4,12,13,15,17} In a

recently published animal study, alopecia from valproic acid was reversed with biotin supplementation.¹⁵ In this study, rats were randomly divided into 4 groups: control, valproic acid (600mg/kg/day) without biotin, valproic acid with biotin supplemented at 6mg/kg/day and valproic acid with biotin supplemented at 0.6mg/kg/day. Alopecia was seen in 40% of the valproic acid group without biotin supplementation, but only 13.3% in either of the biotin supplemented groups.¹⁵ Serum biotin levels in the valproic acid only group were significantly lower than levels seen in the control group, indicating that valproic acid decreases biotin levels, and there were significant decreases in the levels of serum and liver tissue biotinidase in all of the study groups compared with the control group.¹⁵

Another recently published study investigated serum concentrations of biotin and biotinidase activity in 20 children treated with valproic acid and compared them to age and sex matched controls. Hair loss was observed in 3 patients treated with valproic acid and the alopecia disappeared in all 3 patients after oral administration of biotin for 3 months at 10 mg/day.¹² Surprisingly, the authors found no significant differences in the serum levels of biotin and biotinidase activity between patients taking valproic acid and the control group.¹² Though apparently conflicting with previous animal studies, serum biotin level measurements in human subjects are notoriously unreliable,¹ and that measurement of urinary excretion of biotin and its metabolites are a better predictor of deficiency or excess.¹ In another study, the mean biotinidase activity was assessed in 32 pediatric patients treated with valproic acid and found to be decreased in the first three months of valproic acid use, with a gradual return to baseline after 6 months.¹⁶ Similarly, in a different study involving 75 pediatric

FIGURE 1. Numbers on trend graph represent relative search interest as trended over years. Keyword interest is relative to the highest point on the chart, defined as '100'.²⁷



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patients treated with valproic acid, biotinidase activity was found to be significantly reduced as compared with controls ($P < 0.001$).¹⁷ A strong inverse correlation was observed between biotinidase enzyme activity and serum valproic acid levels with the activity of the enzyme.¹⁷ In subjects treated with valproic acid, 18% demonstrated alopecia, which was once again improved with biotin supplementation at a dose of 10 mg/day.¹⁷ The findings above suggest that valproic acid may cause alopecia through an acquired deficiency in biotin secondary to a reduction in biotinidase activity, which may account for the utility of biotin therapy in reversing this type of medication-induced alopecia.

Biotin supplementation has also been shown to improve hair quality in patients with uncombable hair syndrome.^{6,18-21} Uncombable hair syndrome, a rare autosomal dominant condition with incomplete penetrance, is characterized by dry, frizzy, unruly straw-colored or silvery blond hair that is extremely difficult to manage.^{6,18} Although difficult to quantify, there have been several reports demonstrating the efficacy of biotin supplementation on improving hair quality and growth rate in these subset of patients.¹⁸⁻²¹ In one notable study, oral biotin supplementation at 0.9mg/day (given as 0.3 mg three times a day), produced significant improvement in hair strength, combability and growth rate after 4 months.¹⁸

Apart from the aforementioned conditions including: 1) medication-induced alopecia (namely valproic acid) and 2) uncombable

hair syndrome, there is no scientific evidence validating biotin's clinical efficacy in the improvement of hair quality or quantity. Given the above, its use is not routinely recommended.⁷

The Infatuation With Biotin

The U.S. nutritional supplement industry is estimated to be worth a staggering \$35 billion in 2016, and the global nutritional supplement industry is estimated to be worth an astronomical \$104 billion dollars.²²⁻²⁴ Loosely defined as "Vitamins, Minerals and Supplements," this broad category, in which biotin supplements are included, is a leading global economic consumer market retail industry. Despite the clear lack of scientific evidence supporting biotin's use for hair growth or improvement in hair quality, its growing popularity in society is remarkable. From articles such as *The Vitamin My Hairdresser Suggested I Try. And, Wow, He Was Totally Right*²⁵ and *Two Easy Ways to Get Longer, Stronger, Shinier Hair in Time for Your Wedding*²⁶ to so-called "expert advice" touting its use based on popularity by current-day supermodels,²⁷ biotin's glamorization in popular media, particularly within high-end fashion and beauty magazines, has garnered the attention of many, despite its questionable track-record of efficacy.

Utilizing search engine optimization analytics, we investigated biotin's popularity based on keyword volumes searched on the popular search engine Google. (Figures 1-2). We investigated both the relative interest over time and the global geographic

FIGURE 2. Numbers on regional map represent search volume relative to the highest point on the map, defined as 100. Unsurprisingly, the United States had the highest search interest for "biotin" + "hair".²⁸

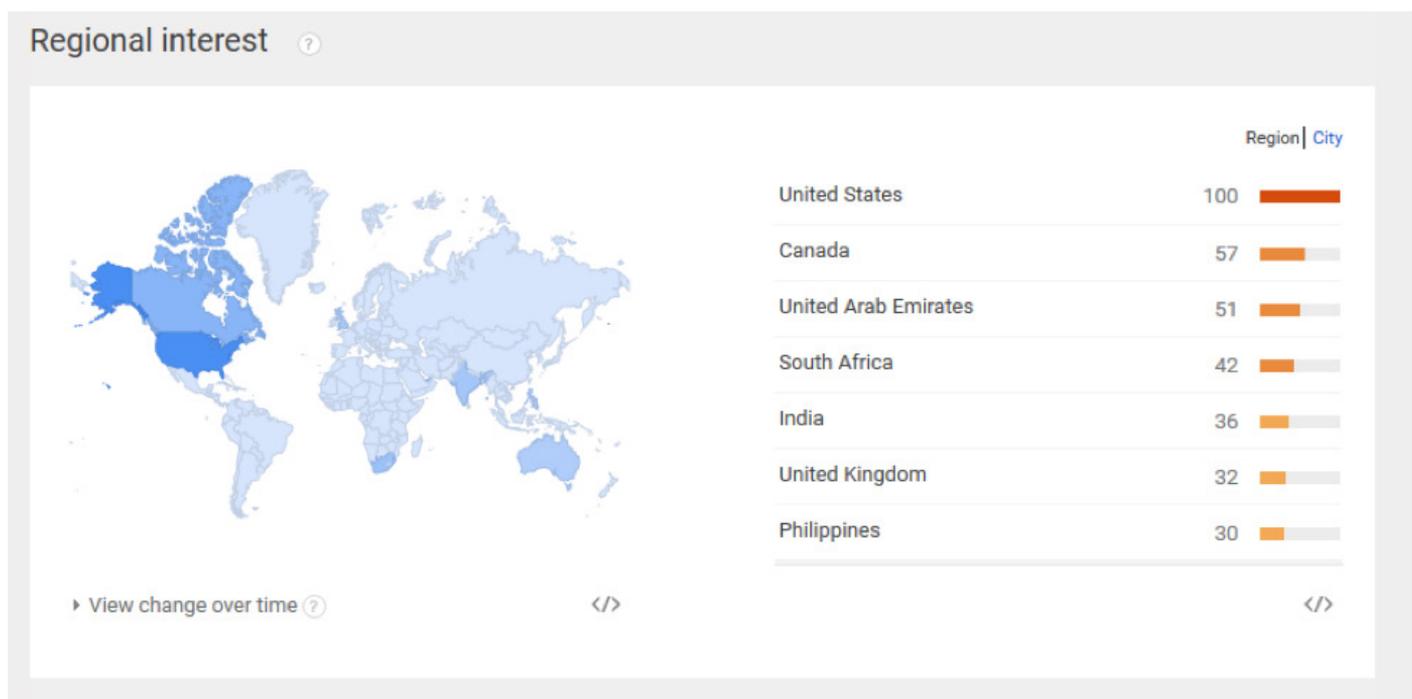
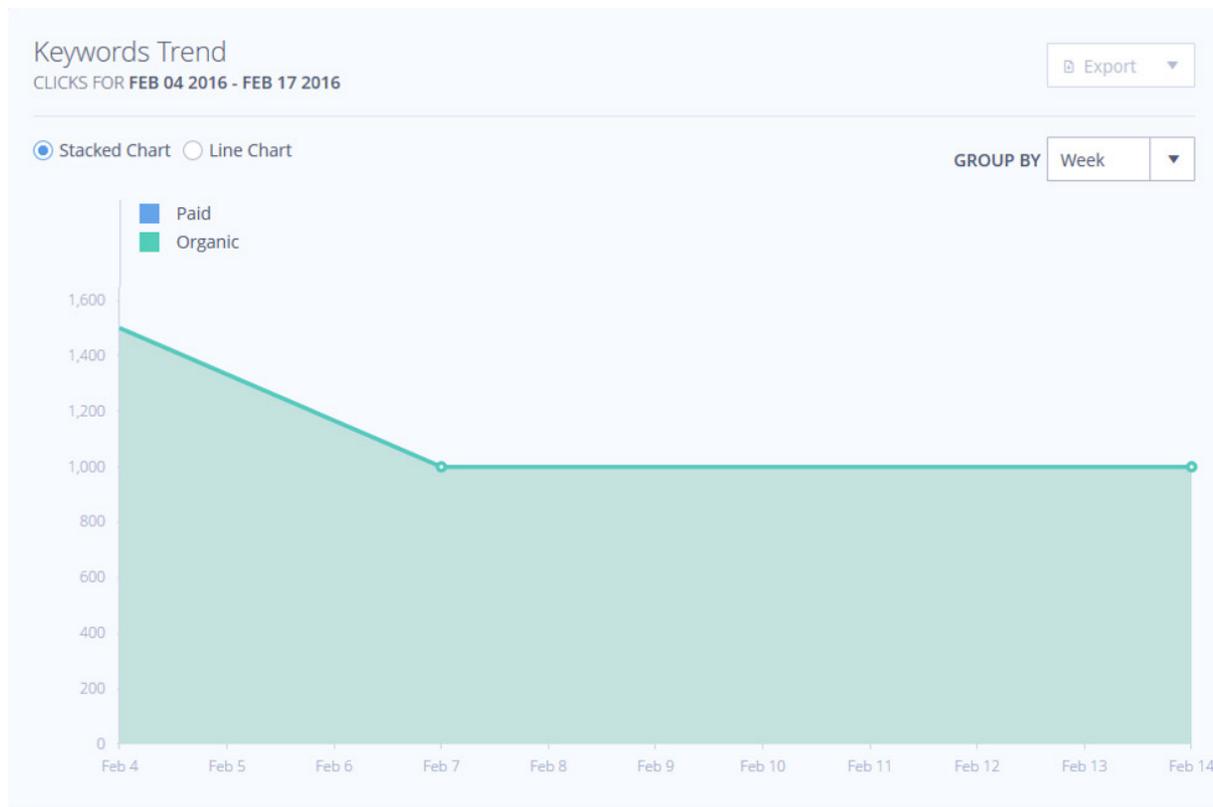


FIGURE 3. The graph above depicts the average number of keyword searches per day for “biotin” + “hair” performed through the Google.com domain. This does not include other search engines such as Bing, or Yahoo. On average, the combination of “biotin” + “hair” is searched over 1100 times a day on Google alone.²⁹



distribution of keyword interest for the keywords “biotin” + “hair” (inclusive) that were searched on Google. In addition, we looked at absolute keyword search volumes for “biotin” + “hair” searched through the Google domain (Figure 3). The results are impressive; there was a clearly-defined progressive increase in search interest for “biotin” + “hair” searched on Google each consecutive year for nearly a decade, which dates back almost as far as when data first started to be recorded (Figure 1). Unsurprisingly, the United States also had the highest search interest for “biotin” + “hair” when analyzed based on global geographic search interest distribution (Figure 2). In terms of absolute keyword search volumes, we surveyed an average one week sampling of the average number of keyword searches per day for “biotin” + “hair” performed through the Google.com domain alone; this did not include other search engines such as Bing, or Yahoo. On average, the combination of “biotin” + “hair” is searched over 1,100 times a day on Google alone.

What does this all mean? It signifies that societal infatuation with biotin supplementation is not only propagated by its glamorization in popular media, its popularity is vastly disproportionate to the scant clinical evidence supporting its efficacy in hair improvement. In other words, biotin supplements are

quite “in vogue,” without there being any significant convincing data to be so.

To Support or To Refute?

The analyses presented above illustrate the unmistakable discord between societal popularity and scientific evidence; infatuation with biotin supplementation is not only propagated by its glamorization in media, its popularity is vastly disproportionate to the scant clinical evidence supporting its efficacy in hair improvement. The authors do not recommend the routine use of biotin supplementation until randomized clinical trials for hair loss demonstrate its efficacy. Clinical trials investigating biotin’s efficacy for the treatment of the most common forms of hair loss such as pattern hair loss (PHL) and chronic telogen effluvium (CTE) of unknown etiology should be performed before any recommendation can be made. In addition, it is unlikely that immune-mediated hair loss such as alopecia areata or cicatricial alopecias would benefit from biotin supplementation. It may be argued that biotin is relatively benign and fairly inexpensive, therefore, “why not recommend it anyway”? However, as physicians, evidence-based practice is paramount, and recommendations should be based on sound scientific data. Although this paper outlines rare circumstances where

there may be benefit to biotin supplementation in the treatment of medication-induced and genetic forms of alopecia, to date, there is not enough evidence to support its use for the most common forms of hair loss.

DISCLOSURES

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REFERENCES

- Schaefer J, Stephanie M., and Chad M. Hivnor. "Nutritional Disorders." *Dermatology*. By Jean L. Bologna, Joseph L. Jorizzo, and Julie V. Schaffer. 3rd ed. Vol. 1. S.I.: Elsevier Saunders, 2012. 742-47. Print.
- Otten, JJ, Hellwig, JP and Meyers, LD., ed. (2006). *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. The National Academies Press. ISBN 0-309-10091-7.
- Scheinfeld, Noah S. "Biotin Deficiency." *Medscape*. WebMD, 31 Jan. 2016. Web. 11 Mar. 2016. <http%3A%2F%2Fmedicine.medscape.com%2Farticle%2F984803-overview>.
- Famenini S, Goh C. Evidence for supplemental treatments in androgenetic alopecia. *J Drugs Dermatol*. 2014 Jul;13(7):809-12.
- Zempleni J, Hassan YI, Wijeratne SS. Biotin and biotinidase deficiency. *Expert Rev Endocrinol Metab*. 2008;3(6):715-724
- Calderon P, Otberg N, Shapiro J. Uncombable hair syndrome. *J Am Acad Dermatol*. 2009 Sep;61(3):512-5. doi: 10.1016/j.jaad.2009.01.006.
- Rogers NE, Avram MR. Medical treatments for male and female pattern hair loss. *J Am Acad Dermatol* 2008;59:547-56.
- Pawlowski, A., Kostanecki, W. Effect of biotin on hair roots and sebum excretion in women with diffuse alopecia. *Pol Med J*. 1965;5:447-452.
- Frigg M, Schulze J, Volker L. Clinical Study on the effect of biotin on skin conditions in dogs. *Schweiz Arch Tierheilk*. 1989. 131:621-625.
- Limat A, Suormala T, Hunziker T, et al. Proliferation and differentiation of cultured human follicular keratinocytes are not influenced by biotin. *Arch Dermatol Res*. 1996;288(1):31-8.
- Mercke Y, Sheng H, Khan T, Lippmann S. Hair loss in psychopharmacology. *Ann Clin Psychiatry*. 2000;12:35-42.
- Castro-Gago M, Pérez-Gay L, Gómez-Lado C, et al. The influence of valproic acid and carbamazepine treatment on serum biotin and zinc levels and on biotinidase activity. *J Child Neurol*. 2011;26(12):1522-4.
- Schulpis KH, Georgala S, Papakonstantinou ED, et al. The effect of isotretinoin on biotinidase activity. *Skin Pharmacol Appl Skin Physiol*. 1999;12(1-2):28-33
- Ramakrishnappa SK, Belhekar MN. Serum drug level-related sodium valproate-induced hair loss. *Indian J Pharmacol*. 2013 Mar-Apr; 45(2): 187-188. doi: 10.4103/0253-7613.108315
- Arsilan M, Vurucu S, Balamtekin N, et al. The effects of biotin supplementation on serum and liver tissue biotinidase enzyme activity and alopecia in rats which were administrated to valproic acid. *Brain Dev*. 2009 ;31(6):405-10.
- Yilmaz Y, Tasdemir HA, Paksu MS. The influence of valproic acid treatment on hair and serum zinc levels and serum biotinidase activity. *Eur J Paediatr Neurol*. 2009;13(5):439-43.
- Schulpis KH, Karikas GA, Tjamouranis J, et al. Low serum biotinidase activity in children with valproic acid monotherapy. *Epilepsia*. 2001;42(10):1359-62.
- Shelley W, Shelley E. Uncombable hair syndrome: observations on response to biotin and occurrence in siblings with ectodermal dysplasia. *J Am Acad Dermatol*. 1985;13: 97-102
- Boccaletti V, Zendi E, Giordano G, Gnetti L, De Panfilis G. Familial Uncombable Hair Syndrome: Ultrastructural Hair Study and Response to Biotin. *Pediatr Dermatol*. 2007;24(3):E14-6.
- U. Blume-Peytavi, N. Mandt. Hair shaft abnormalities. S.M. Hordinsky M, R. Scher (Eds.), *Atlas of hair and nails*, Churchill Livingstone, Philadelphia (2000), pp. 105-119.
- Whiting DA. Hair shaft defects. E.A. Olsen (Ed.), *Disorders of hair growth: diagnosis and treatment*, McGraw-Hill, Barcelona (2003), pp. 123-175.
- Baird. "Retail Sales of Vitamins & Nutritional Supplements in The United States from 2000 to 2017 (in Billion U.S. Dollars)*." Statista - The Statistics Portal. Statista. March 2012. Web. 11 Mar 2016.
- Lariviere, David. "Nutritional Supplements Flexing Muscles As Growth Industry." *Forbes*. Forbes Magazine, 18 Apr. 2013. Web. 11 Mar. 2016.
- Thomas, Addie. "Global Nutrition and Supplements Market: History, Industry Growth, and Future Trends by PMR." *GlobeNewswire News Room*. Persistence Market Research; Nasdaq GlobeNewsWire, 27 Jan. 2015. Web. 11 Mar. 2016.
- Petronis, Lexi. "The Vitamin My Hairdresser Suggested I Try. And, Wow, He Was Totally Right." *Glamour*. Conde Nast, 11 Mar. 2013. Web. 23 Feb. 2016.
- Fusaro, Kim. "Two Easy Ways to Get Longer, Stronger, Shinier Hair in Time for Your Wedding." *Glamour*. Conde Nast, 31 Aug. 2015. Web. 23 Feb. 2016.
- Macon, Alexandra. "Taking the Long View: The Power of Pretty Waist-Slimming Hair." *Vogue*. Condé Nast, 12 Apr. 2013. Web. 23 Feb. 2016.
- Google Trends - Web Search Interest - Worldwide, 2004 - Present." *Google Trends*. Google Analytics; Google, 23 Feb. 2016. Web. 23 Feb. 2016.
- Search Engine Optimization - Keyword Trend: "Biotin Hair"" *Google Keywords*. Jumpshot Marketing Analytics, 23 Feb. 2016. Web. 23 Feb. 2016.

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