



---

## A Comprehensive Systematic Review of the Association Between Vitamin D Deficiency and Alopecia Areata

Salsabilla Gina Rania<sup>1\*</sup>, Nanda Khirana Bangsawan Puteri<sup>2</sup>

Universitas Airlangga, Indonesia<sup>1</sup>

Universitas Sumatera Utara, Indonesia<sup>2</sup>

Email: salsabillariana@gmail.com\*

---

### Keywords:

Alopecia areata;  
vitamin D;  
deficiency;  
risk factor;  
immune system

---

### Abstract

Alopecia areata (AA) is a non-scarring hair loss disorder commonly considered an autoimmune condition in which the immune system attacks the hair follicle during the anagen phase. Vitamin D is a fat-soluble hormone primarily known for regulating calcium homeostasis via the vitamin D receptor (VDR), which is expressed in various cells including immune cells and hair follicles. This systematic review aims to examine the association between vitamin D deficiency and alopecia areata. The study followed the PRISMA 2020 guidelines. A literature search was conducted using databases including PubMed, SagePub, and ScienceDirect for articles published between 2014 and 2024. Review articles, duplicates, and incomplete studies were excluded. Results: From 1,751 initially identified articles, only eight studies met the inclusion criteria after a three-step screening process. All eight full-text articles were analyzed in depth. Vitamin D levels demonstrate an inverse relationship with the severity, extent, and pattern of alopecia areata. Thus, vitamin D deficiency may serve as a contributing factor in the pathogenesis of AA or may exacerbate the existing condition.

---

## INTRODUCTION

Alopecia areata (AA) is a disease of the immune system in which T cells attack specific tissues, particularly the hair follicle. The true cause remains unclear, but mounting evidence suggests that the immune system targets the hair follicle and disrupts its normal function. Histologically, AA is characterized by a dense infiltrate of lymphocytes surrounding and infiltrating the affected hair follicles. Macrophages and Langerhans cells are also observed in the perifollicular and intrafollicular regions. As an autoimmune disease, AA shares a notable association with other autoimmune conditions that exhibit low vitamin D levels, such as rheumatoid arthritis, diabetes mellitus, and multiple sclerosis. It is therefore plausible that vitamin D plays a role in AA pathogenesis, although this relationship remains incompletely understood (Erpolat et al., 2017).

AA is a common chronic condition that causes non-scarring hair loss and can present across a broad clinical spectrum. Some patients experience only localized patches of hair loss. In more advanced cases, there may be near-total or total loss of hair on the scalp and face, a condition known as *alopecia totalis*. In the most severe form, all hair on the scalp and body is lost, which is referred to as *alopecia universalis* (Darwish et al., 2017; Putterman & Castelo-Soccio, 2018).

The etiology of AA remains incompletely elucidated; however, several contributing factors have been proposed, including genetic predisposition, autoimmune dysregulation, and environmental influences. The autoimmune hypothesis is supported by several lines of

evidence: AA frequently co-occurs with other autoimmune diseases, autoantibodies have been detected in affected patients, and inflammatory lymphocytic infiltrates are consistently observed within and around affected hair follicles. Furthermore, hair regrowth following immunosuppressive therapy provides additional support for immune system involvement in AA pathogenesis. Vitamin D is a secosteroid hormone that plays a critical role in calcium homeostasis and skeletal health. It is derived from three primary sources: endogenous cutaneous synthesis following UVB light exposure, dietary intake, and supplementation (Bakry et al., 2016; Rajabi et al., 2018).

AA is one of the most prevalent autoimmune diseases in humans. In the United States, the prevalence is approximately 20.2 per 100,000 individuals, with a lifetime risk of approximately 1.7%. These figures underscore the considerable burden of AA, which is broadly comparable to other autoimmune diseases such as type 1 diabetes mellitus and rheumatoid arthritis — all of which share the hallmark of T cell-mediated, organ-specific autoimmune destruction. A retrospective analysis spanning two decades (1990–2009) indicated a gradual increase in AA incidence, consistent with broader trends observed in other autoimmune conditions. This suggests that the global burden of AA may continue to rise, although the precise drivers of this trend remain to be determined (Gilhar et al., 2016).

The hair follicle is highly responsive to hormonal signaling, including that of vitamin D, which plays essential roles in calcium metabolism, immunomodulation, and cellular proliferation and differentiation. The biologically active form of vitamin D, 1,25-dihydroxyvitamin D<sub>3</sub> [1,25(OH)<sub>2</sub>D<sub>3</sub>], exerts its effects by binding to the vitamin D receptor (VDR) in the nucleus of target cells, where it functions as a transcription factor regulating the expression of vitamin D-responsive genes. VDR expression has been identified in multiple compartments of the hair follicle, including the outer root sheath (ORS), the hair bulb, and the sebaceous gland. Within these structures, VDR contributes to the regulation of epidermal proliferation and differentiation. Emerging evidence also suggests that VDR plays an indispensable role in the normal hair cycle, particularly in the initiation of the anagen phase (Fawzi et al., 2016).

The novelty of this systematic review lies in its comprehensive qualitative synthesis of eight recent studies (2017–2024), incorporating detailed extraction of data on Severity of Alopecia Tool (SALT) scores, disease patterns, and serum vitamin D levels. Unlike prior meta-analyses that focused exclusively on mean differences in vitamin D levels, this review systematically examines the correlation between vitamin D status and specific clinical parameters of AA, including disease severity, extent, and pattern. Additionally, this review explores the potential mechanistic links between vitamin D deficiency and AA pathogenesis, with particular emphasis on VDR expression, immune privilege collapse, and oxidative stress. The objective of this study is to systematically review and qualitatively synthesize the available evidence on the association between vitamin D deficiency and the severity, extent, and pattern of alopecia areata. The theoretical contribution of this review is to advance the understanding of vitamin D's immunomodulatory role in AA pathogenesis, while its practical contribution is to provide clinicians with evidence-based guidance for considering vitamin D assessment and supplementation in the management of AA patients. Ultimately, this review aims to inform clinical practice and direct future research in this field.

## **RESEARCH METHODS**

### **Protocol**

By follow the guideline from PRISMA 2020, the author try to make sure that this study already meets the standard requirement. This step is important so the result and conclusion from the study can be more accurate, even if still have some limitation in the process.

### **Criteria for Eligibility**

For this literature review, the study try to compare and also see the relation between vitamin D deficiency and patient with alopecia areata. This can be done by looking many previous research that discuss about this topic. The main purpose of this writing is to show how important and relevant this problem is, based on the findings from different studies.

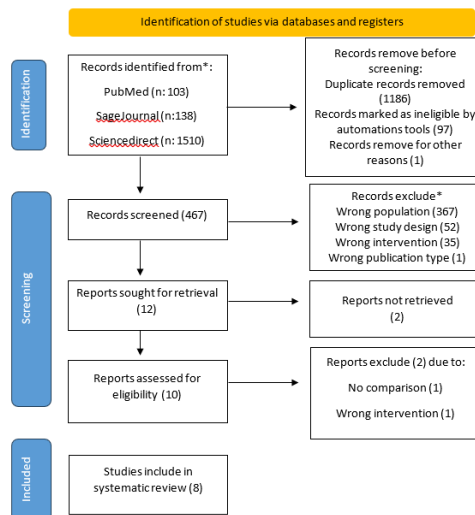
To be included in this study, some requirement must be followed. First, the article must be written in English and must discuss about the association of vitamin D deficiency in alopecia areata patient. Both conditions need to be fulfilled so the paper can be accepted. Second, the selected studies are taken from publication after 2014 until the time considered relevant for this review. Some types of article are not included, such as editorial paper, article without DOI, review article that already published before, and also duplicate or same paper that already exist in journal.

### **Search Strategy**

In this study, the researcher use keyword like "association of vitamin D deficiency in patients with alopecia areata" to search the data. The searching process was done using some database such as PubMed, SagePub, and Sciencedirect. The words that used in searching include combination like ("Alopecia" or "alopecia areata" or "risk factor") and also ("etiology" or "vitamin D") and ("vitamin D deficiency" or "effect of vitamin D"). These keywords combination is used to find the relevant article that discuss about the relation between vitamin D and alopecia areata, even if sometimes the result can be too broad or not all directly related.

### **Data retrieval**

After reading the title and abstract from each study, the writer checks to see if the study already matches with the inclusion criteria or not. Then, the writer choose which previous research can be used as source for this article and select only the relevant one. After reviewing many studies that show similar pattern or trend, the conclusion starts to be made based on those findings. All article that included must be written in English and also should not be published before in other place, so it can avoid duplication and make the study more valid.



**Figure 1.** Article search flowchart

Only the papers that meet all the inclusion criteria are used in this systematic review. This makes the result more focused and only includes studies that are really relevant to the topic. Studies that do not match the requirements are not considered, and their conclusions are also not used in this research. After that, the selected studies are analyzed in more detail. From this process, some important information is collected, such as the title or name of the study, authors, year of publication, location of study, research activities, and also the parameters used in each study.

### Quality Assessment and Data Synthesis

Each author checks the title and abstract of the study by themselves before deciding which paper should continue to the next step. After that, all articles that match the inclusion criteria will be evaluated deeper. Then, the researcher decides again which article is really suitable to be included in the review based on the results already found. This criterion is used to help in selecting the papers so the process becomes more simple and not too complicated. In this part, it also explains about previous studies that have already been done and what factors make those studies appropriate to be included in this review.

## RESULTS AND DISCUSSION

In this study, the research team first collected about 1751 articles from databases like Science Direct, PubMed, and SagePub. After that, a strict screening process with three levels was done to filter the studies, and finally only eight papers were considered directly relevant for this systematic review. Next step, all selected articles were read in full text and checked more carefully for deeper analysis. To make it easier to understand and see the results, all the literature that has already been analyzed is arranged and summarized in Table 1.

**Table 1.** The literature included in this study

Author	Origin	Method	Sample	Result
Lim, RK et al., 2022	USA	The study reviewed medical records from 439 pediatric patients who were diagnosed with AA between January 2015 and December 2017. Only	439	The medical records of 439 children patients with alopecia areata (AA) from January 2015 until December 2017 were checked in this

Author	Origin	Method	Sample	Result
		patients who have data of 25-hydroxyvitamin D level are included in the study. Patients who have history of vitamin supplementation, chronic disease, or other autoimmune disease besides AA are not included, so the result can be more focused only on alopecia areata condition.		study. Only patients who have data about 25-hydroxyvitamin D level are taken. Patients who have history of taking vitamin supplement, chronic disease, or other autoimmune disease besides AA are not included, so the study can be more specific and not mixed with other condition.
<b>Lizarondo, FPJ et al., 2021</b>	Philippines	This cross-sectional study include 29 patients with alopecia areata (AA) and also 29 healthy people as control group. The level of serum 25-hydroxyvitamin D was measured using chemiluminescent immunoassay method, to see the difference between both group.	58	There is no significant difference in the average vitamin D level between AA patients ( $24.41 \pm 6.87$ ng/mL) and healthy control group ( $24.68 \pm 6.68$ ng/mL), with P value 0.88. This mean the difference is not statistically significant. However, the percentage of vitamin D deficiency (less than 20 ng/mL) is higher in AA patients (34.4%) compared to healthy controls (17.2%). The odds ratio is 2.53 (95% CI 0.73–8.65), but this result still not statistically significant, so it cannot strongly prove the association.
<b>Rehman, F et al., 2019</b>	India	This hospital-based study include 135 patients with AA and 135 control subjects with same age and sex. The AA patients are grouped based on severity, pattern, and extent of the disease. Vitamin D levels are measured and then compared between AA patients and control group, and also compared among the different groups of AA patients. After that, the data is analyzed to see the relationship or correlation between vitamin D level and the condition of alopecia areata.	270	More patients in the alopecia areata (AA) group have low and insufficient vitamin D level compared to control group, and this difference is statistically significant ( $P = 0.01$ ). Also, there is very significant difference in the average vitamin D level between case and control ( $P = 0.0004$ ). There is negative correlation between vitamin D level and severity of AA based on SALT score, which mean if vitamin D is lower, the disease severity become higher. Negative correlation also found between vitamin D level with pattern and extent of the disease, showing that lower vitamin D is related with more severe and widespread condition.
<b>Dasankunju, BB et al., 2021</b>	India	This cross-sectional study include patients with AA who are above 12 years old, along with control group that have same age and sex.	60	The study population consist of 30 patients with alopecia areata (AA) and 30 control subjects with same age and sex. The male to female ratio

Author	Origin	Method	Sample	Result
		All participants come to dermatology department in a tertiary care hospital during one year period. In this study, serum vitamin D level is measured in each participant, and then the result from AA patients and control group is compared to see if there is any difference between both groups.		is 1.7:1. Most of the patients are in age group 31–40 years (9 patients, 30%). Patchy AA is the most common type, found in 17 patients (56.7%), and nail involvement is seen in 9 patients (30%). Serum vitamin D level show that 16 patients (53.3%) have insufficient or deficient level, while in control group only 7 people (23.3%) have low vitamin D. This difference is statistically significant ( $P = 0.03$ ), which mean there is possible association. However, there is no significant relation between vitamin D level with number of alopecia lesions or clinical pattern of AA. Also, no significant difference is found between patients with only scalp involvement and those with other body parts involvement.
<b>Abedini, R et al., 2020</b>	Iran	In this case-control study, there are 50 patients with alopecia areata (AA) and 50 control subjects. The study measure serum level of 25-hydroxy vitamin D [25-(OH)-D3] in all participants. The vitamin D level is grouped into three category, which is deficient (<20 ng/ml), insufficient (20–30 ng/ml), and sufficient (>30 ng/dl). The severity of the disease in AA patients is evaluated using SALT score (Severity of Alopecia Tool), to see how serious the condition is and if there is relation with vitamin D level.	100	The serum level of 25-(OH)-D3 is significantly lower in alopecia areata (AA) patients compared to control group. Patients who have more severe type like totalis or universalis show lower vitamin D level than patients with milder type like patchy or ophiasis. Also, severe cases have much lower vitamin D compared to mild and moderate cases. There is also significant negative relation between vitamin D level and age, which mean older patients tend to have lower vitamin D. However, there is no relation found between vitamin D level with gender, duration of disease, recurrence, nail involvement, or family history of AA.
<b>Siddappa, H et al., 2019</b>	India	This retrospective case–control study include 100 patients with alopecia areata (AA) and 100 healthy control with same age and sex. The study was done from December 2014 until November 2015. All participants undergo full clinical examination, and	200	The mean serum vitamin D level is significantly lower in alopecia areata (AA) patients ( $18.90 \pm 8.32$ ng/mL) compared to healthy control group ( $28.21 \pm 18.32$ ng/mL), and this difference is statistically significant ( $P < 0.001$ ). Also, more patients in AA group have vitamin D

Author	Origin	Method	Sample	Result
		serum vitamin D level is measured in each subject to see the difference between AA patients and control group.		deficiency (64%) compared to control (38%). When comparing old cases and new cases, the old cases have lower vitamin D level ( $15.11 \pm 4.75$ ng/mL) than new cases ( $20.85 \pm 9.09$ ng/mL), with significant difference ( $P < 0.001$ ). The percentage of vitamin D deficiency is also higher in old cases (84.3%) compared to new cases (53.1%) ( $P < 0.05$ ). There is also negative correlation between SALT score and vitamin D level ( $r = -0.298$ , $P < 0.05$ ), which mean lower vitamin D is related with higher severity of alopecia areata.
<b>Daroach, M et al., 2017</b>	India	This prospective study include 30 patients with alopecia areata (AA) and 30 healthy control subjects. Clinical information is collected, and serum vitamin D level is measured in all participants. Also, scalp biopsy is done to check histopathology and vitamin D receptor (VDR) expression in both patients and control group. These examinations are done at the beginning (baseline) and also after 6 months of treatment for AA, to see any changes over time.	60	The mean age of alopecia areata (AA) patients is $28.9 \pm 9.96$ years, while in control group is $31.17 \pm 9.43$ years. The average SALT score in patients is $35.8 \pm 27.5$ , and the median duration of disease is about 48 weeks. The mean serum vitamin D level is much lower in patients ( $7.65 \pm 4.50$ ng/ml) compared to control group ( $15.8 \pm 11.47$ ng/ml). Also, almost all patients, about 29 people (96.7%), are vitamin D deficient, which show very high proportion of deficiency in AA patients.
<b>Bhat, YJ et al., 2017</b>	India	This hospital-based cross-sectional study include 50 patients with alopecia areata (AA) that diagnosed clinically and by trichoscopy, and also 35 healthy control with same age and sex. The study was done during summer months. Blood samples were taken from both patients and control group, then processed using centrifugation at 4000 rpm in room temperature. After that, plasma 25-hydroxyvitamin D (25(OH)D) level is measured using chemiluminescence method. In this study,	85	The mean body mass index (BMI) in alopecia areata (AA) patients is $20.96 \pm 1.91$ , while in control group is $21.37 \pm 1.70$ , and this difference is not statistically significant ( $P = 0.31$ ). However, the mean serum 25(OH)D level is much lower in AA patients ( $16.6 \pm 5.9$ ng/ml) compared to control group ( $40.5 \pm 5.7$ ng/ml), and this difference is statistically significant ( $P < 0.001$ ). There is also strong negative correlation between SALT score and vitamin D level ( $P < 0.001$ ; $r = -0.730$ ), which mean lower vitamin D is related with higher disease severity. In addition,

Author	Origin	Method	Sample	Result
		vitamin D deficiency is defined when the serum 25(OH)D level is less than 30 ng/ml.		negative correlation also found between number of hair loss patches and vitamin D level (P < 0.001; r = -0.670), showing that more patches is associated with lower vitamin D level.

Hair loss is one of the most common aesthetic problem in many people around the world. Around 50% of men and almost 50% of women over age 50 experience this condition. Even though hair loss can be part of normal aging process, it still can give negative effect to quality of life, because some people feel stress, low confidence, or even psychological problem because of it. It is important to understand if the hair loss is still normal (physiological) or already become abnormal condition caused by other problem, for example issue in scalp or hair bulb. The classification of hair loss, baldness, and alopecia is not simple, because this condition usually happen from many factors together, so it is sometimes difficult to clearly categorize each case (Angelo et al., 2019; Lee et al., 2018).

AA is common autoimmune skin disease that cause hair loss in scalp and also other part of body. About 2% of people can experience this condition sometime in their life. This disease not only affect physical appearance, but also can cause anxiety and increase risk of psychological or psychiatric problem in patients. The hair loss in AA is believed happen because immune system attacks the hair follicle after loss of immune privilege in that area. Some immune components are involved in this process, such as autoreactive T cells, mast cells, CD8+NKG2D+ cytotoxic T cells, also signaling pathway like JAK/STAT, regulatory T cells (Tregs), immune checkpoints, and oxidative stress. Even though many mechanisms already studied, the exact pathogenesis of AA still not fully clear, and until now this disease still cannot be completely cured (Lie & Buket, 2024).

Vitamin D is fat-soluble vitamin that have important role in many cell function in the body. It is well known for its role in bone health and also in maintaining calcium balance. But now, many research start to focus on other function of vitamin D in different organ system. Recent studies show that vitamin D also have relation with cardiovascular health, autoimmune disease, and even cancer, even if the exact mechanism still not fully clear and still need more research (Rossi et al., 2019; Science et al., 2017).

Vitamin D act as modulator for both innate and adaptive immune system. Low level of vitamin D is reported in many autoimmune disease, including alopecia areata (AA). Keratinocyte cells have vitamin D receptor (VDR), and this receptor is important for normal hair cycle. If there is lack of VDR, the growth of hair follicle can be reduced. Because of that, it is believed that vitamin D deficiency maybe can trigger autoimmune reaction and have role in the development of AA, even if the exact mechanism still not fully clear (Maldonado-Colin et al., 2018; Papadimitriou et al., 2021).

Many autoimmune disease already reported have connection with vitamin D, like vitiligo, systemic lupus erythematosus, type 1 diabetes mellitus, rheumatoid arthritis, psoriasis, multiple sclerosis, and inflammatory bowel disease. But this relation not always mean it directly cause, it only show that low vitamin D maybe can act like environmental trigger that start abnormal immune response. The active form of vitamin D, 1,25(OH)D<sub>3</sub>, able to influence both innate

and adaptive immune system by affecting many immune cells such as T lymphocytes, B lymphocytes, monocytes, macrophages, and dendritic cells. Because of this function, vitamin D seen as important in controlling immune response, even if the exact mechanism still not fully clear (Lin et al., 2019).

During the anagen phase of hair growth, many inflammatory cells like CD8+ T cells, NK T cells, regulatory T cells, Th17 cells, and mast cells start to attack the hair follicle. This process cause release of IFN- $\gamma$  and increase expression of NKG2D ligands in the hair follicle. Because of this, autoantigen in hair follicle become exposed and trigger autoimmune response in AA. This condition make the immune privilege of hair follicle become lost and finally lead to destruction of the hair follicle. Besides immune process, other factors such as genetic predisposition, allergy, psychological stress, and microbiota also have role in the development and progression of AA (Ma et al., 2023).

Even though the cause of chemotherapy-induced alopecia and alopecia areata (AA) is different, there might be some relation with vitamin D. In chemotherapy alopecia, hair loss happen because cytotoxic drugs kill fast-growing cells in hair follicle, while in AA it is caused by autoimmune process. But vitamin D deficiency maybe can be risk factor for AA, because vitamin D is known to help protect hair follicle from damage like in chemotherapy condition. Keratinocyte cells can produce active vitamin D, which is 1,25-dihydroxyvitamin D3 [1,25(OH)D3], and also have vitamin D receptor (VDR). This receptor is important to maintain normal hair cycle. Without enough vitamin D or VDR, hair growth can be disturbed. In addition, 1,25(OH)D3 also work as immunomodulator for both innate and adaptive immune system by affecting many immune cells such as T lymphocytes, B lymphocytes, monocytes, macrophages, and dendritic cells. Because of this, vitamin D may have important role in preventing abnormal immune reaction like in AA, even if the exact mechanism still not fully clear (Liu et al., 2020).

## **CONCLUSION**

This comprehensive systematic review of eight studies published between 2017 and 2022 demonstrates that vitamin D deficiency is consistently associated with alopecia areata (AA). The evidence shows that AA patients have significantly lower serum vitamin D levels compared to healthy controls, with a higher proportion of vitamin D deficiency in AA patients. Moreover, there is a significant inverse correlation between vitamin D levels and AA severity measured by SALT score, disease extent (number of patches/body surface area), and disease pattern (more severe patterns such as alopecia total/universalis associated with lower vitamin D levels). Although one study from a tropical country (Philippines) did not find a significant difference in mean vitamin D levels between AA and controls, the overall evidence supports the conclusion that vitamin D deficiency is associated with AA and may serve as a contributing factor in its pathogenesis or exacerbation. The biological plausibility of this association is supported by the known expression of vitamin D receptors in hair follicles and the immunomodulatory functions of vitamin D. For future research, prospective cohort studies should be conducted to establish the temporal relationship between vitamin D deficiency and AA onset. Randomized controlled trials are urgently needed to determine whether vitamin D supplementation improves AA outcomes, including SALT score reduction, time to regrowth, and response to conventional therapies. Mechanistic studies should further elucidate the role of

vitamin D-VDR signaling in maintaining hair follicle immune privilege and how its disruption leads to AA. Additionally, research should explore whether VDR genetic polymorphisms influence AA susceptibility and whether vitamin D supplementation is more effective in patients with specific VDR genotypes. Large-scale, multi-ethnic studies are needed to confirm the generalizability of these findings and to establish evidence-based guidelines for vitamin D assessment and supplementation in AA management.

## REFERENCES

- Abedini, R., Shakiba, S., Ghandi, N., Yazdaniamjad, F., Haddadi, N. S., & Nasimi, M. (2021). Study of vitamin D deficiency in patients with alopecia areata attending a dermatology center in Iran. *Iranian Journal of Dermatology*, *24*(2), 97–101.
- Angelo, D., Del, L. C., Dottor, M., Nardo, D., & Labrozzi, A. (2019). Nutrients in hair supplements: Evaluation of their function in hair loss treatment. *Hair Therapy & Transplantation*, *10*(1), 1–6.
- Bakry, O., El Farargy, S., El Shafiee, M., & Soliman, A. (2016). Serum vitamin D in patients with alopecia areata. *Indian Dermatology Online Journal*, *7*(5), 371.
- Bhat, Y. J., Latif, I., Malik, R., Hassan, I., Sheikh, G., Lone, K. S., et al. (2017). Vitamin D level in alopecia areata. *Indian Journal of Dermatology*, *62*(4), 407–410. <http://www.ncbi.nlm.nih.gov/pubmed/28794553>
- Daroach, M., Narang, T., Saikia, U. N., Sachdeva, N., & Sendhil Kumaran, M. (2018). Correlation of vitamin D and vitamin D receptor expression in patients with alopecia areata: A clinical paradigm. *International Journal of Dermatology*, *57*(2), 217–222.
- Darwish, N. M. M., Marzok, H. F., Gaballah, M. A. M., & Abdellatif, H. E. (2017). Serum level of vitamin D in patients with alopecia areata. *Egyptian Journal of Basic and Applied Sciences*, *4*(1), 9–14. <https://doi.org/10.1016/j.ejbas.2016.12.001>
- Dasankunju, B. B., Nair, P. S., & George, A. E. (2021). Serum vitamin D levels and alopecia areata: A comparative cross-sectional study. *Journal of Skin and Sexually Transmitted Diseases*, *5*(1), 36–39.
- Erpolat, S., Sarifakioglu, E., & Ayyildiz, A. (2017). 25-hydroxyvitamin D status in patients with alopecia areata. *Postępy Dermatologii i Alergologii*, *34*(3), 248–252.
- Fawzi, M. M. T., Mahmoud, S. B., Ahmed, S. F., & Shaker, O. G. (2016). Assessment of vitamin D receptors in alopecia areata and androgenetic alopecia. *Journal of Cosmetic Dermatology*, *15*(4), 318–323.
- Gilhar, A., Schrum, A. G., Etzioni, A., Waldmann, H., & Paus, R. (2016). Alopecia areata: Animal models illuminate autoimmune pathogenesis and novel immunotherapeutic strategies. *Autoimmunity Reviews*, *15*(7), 726–735. <https://linkinghub.elsevier.com/retrieve/pii/S1568997216300568>
- Lee, S., Kim, B. J., Lee, C. H., & Lee, W. S. (2018). Increased prevalence of vitamin D deficiency in patients with alopecia areata: A systematic review and meta-analysis. *Journal of the European Academy of Dermatology and Venereology*, *32*(7), 1214–1221. <https://onlinelibrary.wiley.com/doi/10.1111/jdv.14987>
- Lie, M., & Maulida Buket, C. B. (2024). Vitamin D deficiency in patients with alopecia areata, and responsiveness to vitamin D analogues: A systematic review. *Journal of Advanced Research in Medical and Health Science*, *10*(1), 117–127. <https://nnpub.org/index.php/MHS/article/view/2027>
- Lim, R. K., Castelo-Soccio, L., Putterman, E., Qureshi, A. A., & Cho, E. (2022). Predictors of vitamin D insufficiency in children and adolescents with alopecia areata. *Cureus*, *14*(3), 8–10.

- Lin, X., Meng, X., & Song, Z. (2019). Vitamin D and alopecia areata: Possible roles in pathogenesis and potential implications for therapy. *American Journal of Translational Research*, *11*(9), 5285–5300.
- Liu, Y., Li, J., Liang, G., Cheng, C., Li, Y., & Wu, X. (2020). Association of alopecia areata with vitamin D and calcium levels: A systematic review and meta-analysis. *Dermatology and Therapy*, *10*(5), 967–983. <https://doi.org/10.1007/s13555-020-00433-4>
- Lizarondo, F. P. J., Gervasio, M. K. R., Chamberlin, C. V. S., Gnilo, C. M. S., & Silva, C. Y. (2021). Determination of serum 25-hydroxyvitamin D levels in patients with alopecia areata and their comparison with levels in healthy controls: A cross-sectional study. *JAAD International*, *5*, 78–84. <https://doi.org/10.1016/j.jdin.2021.07.008>
- Ma, Y. Q., Sun, Z., Li, Y. M., & Xu, H. (2023). Oxidative stress and alopecia areata. *Frontiers in Medicine*, *10*, 1–7.
- Maldonado-Colin, G., Orozco-Covarrubias, L., Altamirano-Bustamante, N., Sáez-De-Ocariz, M., & Ruiz-Maldonado, R. (2018). Vitamin D supplementation in children with alopecia areata. *Indian Journal of Paediatric Dermatology*, *19*(4), 380.
- Papadimitriou, D. T., Dermitzaki, E., Mastorakos, G., Bothou, C., & Alexopoulos, A. (2021). Treatment of alopecia totalis/universalis/focalis with vitamin D and analogs: Three case reports and a literature review. *World Journal of Clinical Pediatrics*, *10*(6), 192–199.
- Putterman, E., & Castelo-Soccio, L. (2018). Response to “Vitamin D deficiency in patients with alopecia areata: A systematic review and meta-analysis” and an investigation of vitamin D in pediatric patients. *Journal of the American Academy of Dermatology*, *79*(3), e43–e44. <https://doi.org/10.1016/j.jaad.2018.03.057>
- Rajabi, F., Drake, L. A., Senna, M. M., & Rezaei, N. (2018). Alopecia areata: A review of disease pathogenesis. *British Journal of Dermatology*, *179*, 1033–1048.
- Rehman, F., Dogra, N., & Wani, M. A. (2019). Serum vitamin D levels and alopecia areata: A hospital-based case-control study from North India. *International Journal of Trichology*, *11*(2), 49–57. <http://www.ncbi.nlm.nih.gov/pubmed/31007473>
- Rossi, A., Muscianese, M., Piraccini, B. M., Starace, M., Carlesimo, M., Mandel, V. D., et al. (2019). Italian guidelines in diagnosis and treatment of alopecia areata. *Giornale Italiano di Dermatologia e Venereologia*, *154*(6), 609–623.
- Science, M., Maguire, J. L., Russell, M. L., Smieja, M., Walter, S. D., & Loeb, M. (2017). Prevalence and predictors of low serum 25-hydroxyvitamin D levels in rural Canadian children. *Paediatrics & Child Health*, *22*(3), 125–129.
- Siddappa, H., Kumar, Y. H. K., & Vivekananda, N. (2019). Evaluation of association of vitamin D in alopecia areata: A case-control study of 100 patients in a tertiary rural hospital of Southern India. *Indian Dermatology Online Journal*, *10*(1), 45. [https://journals.lww.com/10.4103/idoj.IDOJ\\_84\\_18](https://journals.lww.com/10.4103/idoj.IDOJ_84_18)