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THE EFFECTS OF VITAMIN D SUPPLEMENTATION ON DISEASE ACTIVITY IN SYSTEMIC LUPUS ERYTHEMATHOSUS PATIENTS: AN EVIDENCE-BASED CASE REPORT

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Abstract

Background: Systemic lupus erythematosus (SLE) is a chronic systemic autoimmune disease characterized by the production of autoantibodies and multisystem involvement, predominantly affecting women of reproductive age. Vitamin D is known to have immunomodulatory effects, including inhibition of T and B cell activation and suppression of pro-inflammatory cytokine production. **Objectives:** This evidence-based case report aims to evaluate the effect of vitamin D supplementation on disease activity in SLE. **Methods:** A literature search was conducted using PubMed, Scopus, and Cochrane. Medical Subject Headings (MeSH) terms and relevant keywords based on the clinical question components were applied. All retrieved literature was screened using predefined eligibility criteria, followed by a critical appraisal of eligible studies**. Results:** One meta-analysis of randomized controlled trials (RCTs) and two RCTs met the eligibility criteria. Almost all of the included studies recruited patients with SLE who had vitamin D deficiency/insuficiency. The methodological validity of all three studies was considered acceptable. The studies demonstrated heterogeneity in terms of baseline disease activity levels among their study populations. The meta-analysis and one of the RCTs reported non-significant results, while the other RCT showed a significant improvement in disease activity following vitamin D supplementation. **Conclusion:** Current evidence is insufficient to recommend vitamin D supplementation as an adjuvant therapy for improving disease activity in patients with SLE and further research is needed.

keywords : Disease Activity, SLE, SLEDAI, Vitamin D

Introduction

Systemic lupus erythematosus (SLE) is a chronic autoimmune disorder with multisystem involvement, marked by the presence of autoantibodies and a wide range of clinical manifestations. The global prevalence is estimated at 43.7 cases per 100,000 individuals.[1] The condition predominantly affects females, with a female-to-male ratio ranging from 9:1 to 14:1. Although SLE can occur at any age, it is most frequently diagnosed in individuals between 15 and 40 years of age, the reproductive age group.[2] Vitamin D status has been implicated in the pathogenesis of various autoimmune diseases, including SLE. Notably, among individuals with SLE, 29.7% present with vitamin D insufficiency, while 62.3% exhibit vitamin D deficiency.[3]

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The pathogenesis of systemic lupus erythematosus (SLE) involves a multifactorial interplay of genetic predisposition, environmental exposures, hormonal influences, and immunological dysregulation. Vitamin D deficiency has emerged as an important contributing factor in the development of SLE, functioning not only through immunological mechanisms but also as a modifiable environmental determinant.[4] Deficient vitamin D levels have been associated with increased disease activity and cumulative organ damage in patients with SLE.[3,5] Vitamin D exhibits immunomodulatory properties, including the suppression of T and B lymphocyte activation, inhibition of proinflammatory cytokine production, and promotion of immune tolerance via the expansion of regulatory T cell populations.[6]

In patients with systemic lupus erythematosus (SLE), reduced vitamin D levels are frequently attributed to limited sunlight exposure due to photosensitivity concerns, as well as the use of medications such as glucocorticoids, which can disrupt vitamin D metabolism.[7] This deficiency has been associated with heightened disease activity and increased risk of organ damage.[3] Disease activity in SLE is commonly evaluated using the Systemic Lupus Erythematosus Disease Activity Index (SLEDAI), a validated tool incorporating both clinical and laboratory indicators. Several modified versions of the original index have been developed, including the SELENA-SLEDAI, MEX-SLEDAI, and SLEDAI-2K, to enhance its applicability in different clinical and research settings.

The relationship between vitamin D and systemic lupus erythematosus (SLE) is intricate, as SLE itself can lead to reduced vitamin D levels, while vitamin D deficiency may also contribute to the onset and exacerbation of SLE symptoms.[3] However, the association between vitamin D levels and disease activity in SLE remains inconsistent and is a subject of ongoing debate. Some studies have proposed that vitamin D influences SLE disease activity through various immunological mechanisms, whereas other research has found no significant correlation between vitamin D levels and disease activity. This evidence-based case report aims to evaluate the impact of vitamin D supplementation on disease activity in patients with SLE.

Case Ilustrasi

A 28-year-old female patient, Mrs. N, presented with a primary complaint of progressive bilateral lower limb weakness, which had persisted for five months and worsened over the last two weeks prior to her admission. She had been diagnosed with systemic lupus erythematosus (SLE) one year prior and was compliant with her prescribed medications. There was no known family history of SLE. The patient's clinical history revealed chronic neurologic symptoms,

including tingling, weakness, and a sensation of heaviness in the lower extremities during ambulation. Comprehensive history taking, physical examination, and additional diagnostic testing were performed. The patient was subsequently diagnosed with transverse myelitis and polyneuropathy, complications associated with SLE. Based on her clinical evaluation, the patient was assigned a Systemic Lupus Erythematosus Disease Activity Index (SLEDAI-2K) score of 14, indicating high disease activity. Her serum 25-hydroxyvitamin D level was found to be deficient at 12.1 ng/mL. Management consisted of intravenous methylprednisolone (1000 mg daily for 5 days, followed by a tapering regimen), hydroxychloroquine (200 mg daily), and mycophenolate sodium (360 mg twice daily). Additionally, the patient was prescribed vitamin D3 supplementation at a dose of 5000 IU per day.

Problem Formulation

In adult patients diagnosed with SLE, can vitamin D supplementation reduce disease activity?

Based on the clinical question, the following PICO was created:

P (Patient) : adult patient with a diagnosis of SLE

I (Intervention): vitamin D supplementation

C (Comparison) : placebo

O (Outcome) : disease activity

Type of clinical question : therapy.

Methods

A literature search was conducted on June 15, 2025, across three databases: PubMed, Cochrane, and Scopus, utilizing the search terms "Vitamin D supplementation AND Disease Activity AND Systemic Lupus Erythematosus." Advanced search features were employed, incorporating MeSH terms and Boolean operators ("OR" and "AND") as detailed in Table 1.

Eligibility Criteria:

1. Adult patients (≥18 years) with a confirmed diagnosis of systemic lupus erythematosus (SLE).
2. Studies with randomized controlled trial (RCT) or systematic review/meta-analysis designs that included RCTs.
3. The intervention group received vitamin D supplementation, while the control group received either a placebo or standard therapy.
4. Studies that reported outcomes using the SLE Disease Activity Index (SLEDAI) scores.
5. Articles published in English or Indonesian.

Exclusion Criteria:

1. Studies not conducted in human populations.

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2. Studies where the full manuscript was inaccessible.

The titles and abstracts of all retrieved articles were reviewed to assess their relevance to the clinical question. Studies that met the eligibility criteria were further screened. In cases where an RCT was already included in a systematic review or meta-analysis, it was excluded to prevent duplication. A critical appraisal of the included studies was conducted using the Oxford Centre for Evidence-Based Medicine (OCEBM) assessment tool, evaluating each article for Validity, Importance, and Applicability (VIA).

Results

A total of 202 articles were retrieved from PubMed, Cochrane, and Scopus (Table 1). These articles were subsequently filtered to assess the relevance of their titles and abstracts in relation to the PICO framework. After screening, three studies met the eligibility criteria (Figure 1), including one meta-analysis of randomized controlled trials (RCTs) and two RCT-based studies. Detailed study characteristics, including research design, population, intervention, and outcomes assessed, are summarized in Table 2. Critical evaluations of each study are provided in Tables 4, 5, and 6.

Table 1, Article Search Strategy Method

Database	Search strategy	Number
Pubmed	((((systemic lupus erythematosus[MeSH Terms])) OR (SLE[Title/Abstract])) AND (((24 hydroxylase, vitamin d3[MeSH Terms]) OR (vitamin d[Title/Abstract])) OR (vitamin d supplementation[Title/Abstract])))) AND ((disease activity[Title/Abstract]) OR (SLEDAI[Title/Abstract])) AND ((meta-analysis[Filter] OR randomizedcontrolledtrial[Filter] OR systematicreview[Filter]) AND (humans[Filter]))	17
Cochrane	#1 MeSH descriptor: [Lupus Erythematosus, Systemic] #2 MeSH descriptor: [Vitamin D] #3 (sledai) OR ("SLE disease activity index") #4 #1 AND #2 AND #3	18
Scopus	(((TITLE-ABS-KEY (systemic lupus erythematosus) OR TITLE-ABS-KEY (systemic lupus erythematosus) OR TITLE-ABS-KEY (SLE))) AND ((TITLE-ABS-KEY (vitamin d supplementation)) AND ((TITLE-ABS-KEY (disease activity) OR TITLE-ABS-KEY (sledai))) AND NOT (TITLE-ABS-KEY (children)) AND (LIMIT-TO (SRCTYPE , "j"))	167

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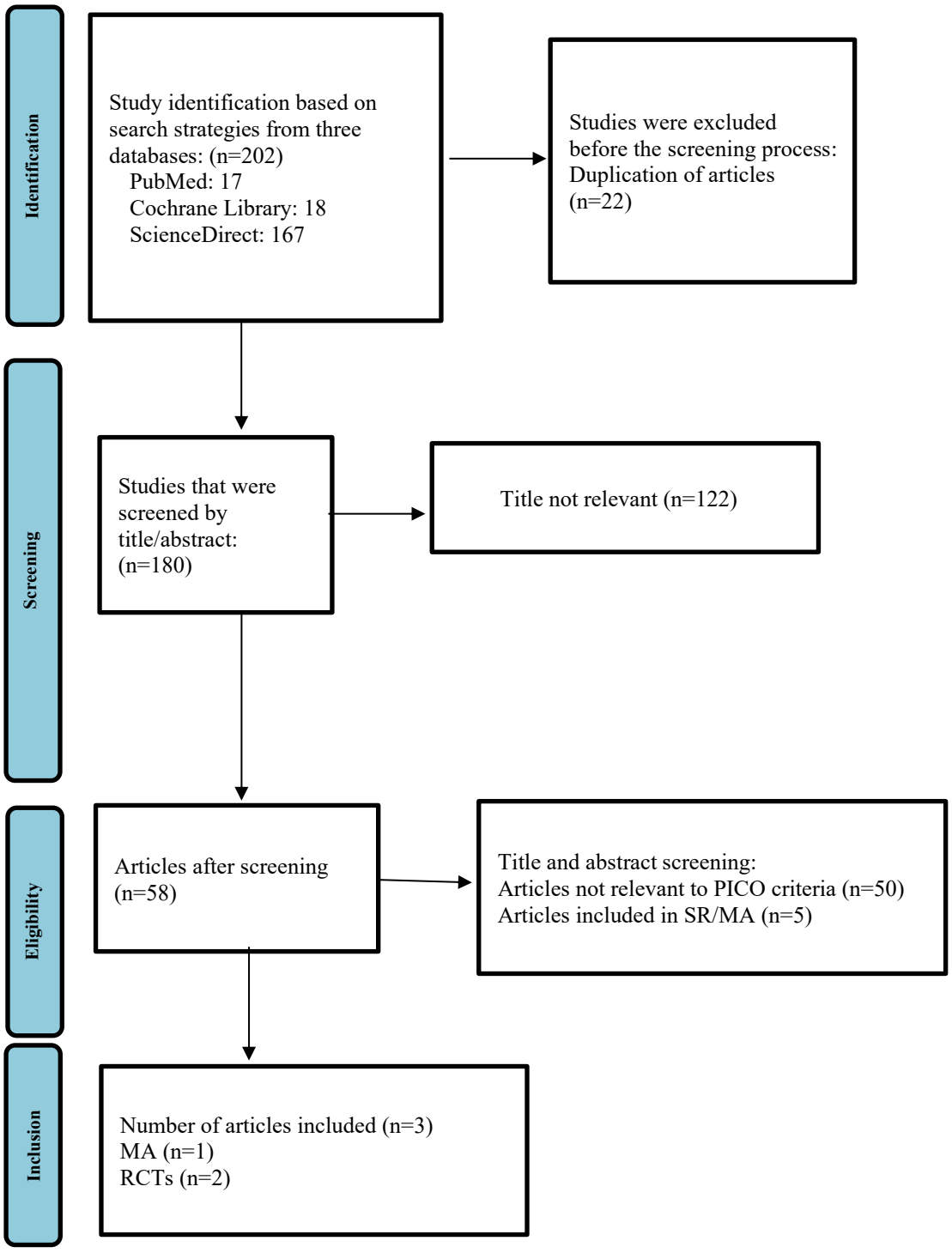

Figure 1 Flowchart of Literature Search Strategy

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Table 2. Study characteristics

Researcher (year)	Design	Population	Intervention	Outcome	Conclusion
Zheng, et al[8] (2019)	Meta Analysis of RCTs	5 RCT studies (n=490) with SLE patients	Vitamin D supplementation≥ 1200 IU/day for at least 3 months	Serum 25(OH)D levels, SLEDAI, anti-dsDNA positivity, fatigue severity score (FSS), and adverse events	Vitamin D supplementation was relatively safe, significantly increased serum 25(OH)D levels, and improved fatigue in SLE patients, but did not decrease anti-dsDNA positivity and SLEDAI.
Fiblia, et al[9] (2022)	RCT	SLE patients (n=60) aged 18-60 years with hypovitaminosis D.	Vitamin D3 supplementation 5000 IU/day for 12 weeks	Vitamin D levels, MEX-SLEDAI, Lupus QoL	Vitamin D3 supplementation at a dose of 5000 IU/day for 12 weeks significantly increased vitamin D levels and improved disease activity, but did not significantly improve the quality of life of SLE patients.
Lomarat, et al[10] (2022)	RCT	SLE patients aged≥ 18 years, serum 25(OH)D level > 10 ng/mL (n=104)	Ergocalciferol supplementation 100,000 IU/week for 4 weeks followed by 40,000 IU for 20 weeks	Serum 25(OH)D, SLEDAI-2K, inflammatory markers, urine protein creatinine ratio (UPCR), health assessment questionnaire (HAQ)	Administration of high doses of ergocalciferol was not significant in improving SLE disease activity. However, the supplementation could increase vitamin D levels to normal.

Table 3. Summary of Critical Validity Review

Question	Zheng, et al.	Fiblia, et al.	Lomarat, et al.
SR/MA study			
Does the SR describe the clinical question (PICO) and is it used in article search and selection?	+		
Did the search find all relevant evidence?	+		
Were the selected studies subjected to critical review?	+		
Did it include only high quality studies?	-		
Were results of studies summarized in tables and diagrams?	+		
And was heterogeneity between studies assessed?	+		
RCT studies			
Were study participants randomized? And is the randomization table hidden?		+	+
Were the characteristics of the two groups comparable before the intervention?		+	+
Was each group given the same treatment?		+	+
Were all patients who participated in the clinical trial included in the final analysis?		-	?
Are measurements made objectively or are both patients and doctors blind to the therapy provided?		+	+

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Table 4, Summary of Importance Critical Review

SR/MA Study Question	Zheng, et al.	
What was the measure used, how big was the effect (could it be due to chance)?	The measure used was standardized mean difference (SMD). Vitamin D supplementation decreased the SLEDAI score by 0.507. Based on the p value there is still a possibility of chance.	
How are the results presented?	Results are presented with a forest plot.	
Are the clinically important results statistically significant?	Not statistically significant (p=0.070).	
Question RCT study	**Fiblia, et al.[9]**	**Lomarat, et al.[10]**
How big is the effect of therapy?	The decrease in MEX-SLEDAI in the intervention group was 1.29 and in the placebo group was 0.12. These results were statistically significant (p = 0.015).	The change in median value (IQR) of SLEDAI score in the intervention group was from 4.0 (2, 6) to 0.0 (0, 4) at the end of the intervention. While in the placebo group from 4.0 (1, 4) to 2.0 (0, 2) at the end of the intervention. This result was not statistically significant (p = 0.101).
How precise is the estimate of the therapeutic effect?	This study did not report confidence intervals, so it cannot be assessed how precise the estimated treatment effect is even with a significant result.	This study did not report confidence intervals, so it cannot be assessed how precise the estimated treatment effect is.

Table 5, Summary of Applicability Critical Review

Question	Zheng, et al.	Fiblia, et al.	Lomarat, et al.
Are your patients very different from the study population?	No	No	No
Is the therapy available at your facility?	Yes	Yes	Yes
Will the benefits of the therapy outweigh the harms for your patients?	Yes	Yes	Yes

Discussion

The literature search identified three relevant studies addressing the clinical question concerning the impact of vitamin D supplementation on SLE disease activity, as measured by the SLE Disease Activity Index (SLEDAI). Of these, one was a meta-analysis of randomized controlled trials (RCTs), while the other two were individual RCTs. These three studies were subsequently analyzed to evaluate the effectiveness of vitamin D supplementation as an intervention for modulating disease activity in patients with systemic lupus erythematosus (SLE).

The validity of the evidence presented in the three studies warrants

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careful consideration. Zheng et al.'s meta-analysis[8] included studies with a high risk of bias, which may have compromised the overall quality of the evidence. The randomized controlled trials (RCTs) by Fiblia et al.[9] and Lomarat et al.[10] generally demonstrated strong validity; however, the potential for bias remains. Specifically, the study by Fiblia et al.[9] employed a per-protocol analysis, while Lomarat et al.[10] did not clarify whether they used a per-protocol or intention-to-treat analysis. This lack of clarity raises the possibility of attrition bias, which could result in an overestimation of the intervention's effect in the broader population.

The study by Fiblia et al.[9] demonstrated that vitamin D supplementation resulted in a significant reduction in SLEDAI scores. In contrast, the studies by Zheng et al.[8] and Lomarat et al.[10] reported a reduction in SLEDAI scores following the intervention, but the results were not statistically significant. Zheng et al.'s meta-analysis[8] included only four studies and exhibited high heterogeneity ($I^2 = 73.3\%$, $p = 0.010$), which undermined the reliability of the effect estimate and limited the clinical applicability of the findings. Additionally, the studies by Zheng et al.[8], Fiblia et al.[9], and Lomarat et al.[10] all involved populations with heterogeneous characteristics, further complicating the interpretation and generalizability of the results.

The characteristics of the study populations primarily consisted of adult individuals with systemic lupus erythematosus (SLE). However, it is important to highlight that one of the studies included in Zheng et al.'s meta-analysis[8], specifically the study by Lima et al.[11], focused on adults with juvenile-onset SLE—defined as SLE diagnosed before the age of 18. Juvenile-onset SLE is a distinct subset, as patients with early-onset disease typically experience more severe disease activity, a more aggressive clinical course, and a higher risk of organ damage compared to those with adult-onset SLE.[11] The inclusion of juvenile-onset SLE patients introduces additional heterogeneity to Zheng et al.'s meta-analysis[8], which may limit the generalizability of the findings regarding the effects of vitamin D supplementation to the broader adult-onset SLE population.

Almost all studies recruited patients with hypovitaminosis D, and all vitamin D supplementation interventions were effective in increasing mean or median serum vitamin D levels to normal levels by the end of the study period. Therefore, the findings from this evidence-based case report can only be generalized to SLE patients with hypovitaminosis D. The effect of interventions in patients with normal

vitamin D levels at baseline is unknown and has not been included in the studies available to date.

The level of baseline disease activity in patients varied among the three studies. The studies of Fiblia et al.[9], Lomarat et al.[10], and the majority of studies in the meta-analysis of Zheng et al.[8]had low baseline mean/median SLEDAI scores of <5. In populations with mild disease activity, the maximum effect of interventions may be difficult to detect due to limited room for improvement, a condition known as the floor effect. There was only one study in the Zheng et al. meta-analysis [8], which was the Rifa'I et al. study [12]with a high mean baseline SLEDAI score of 12.65± 4.85. Although the statistical significance of the results of the three studies varied, all studies showed a decrease in the mean/median SLEDAI score after vitamin D supplementation.

Vitamin D, whether obtained through diet or synthesized endogenously, binds to the Vitamin D Binding Protein (VDBP) before undergoing hydroxylation in the liver to form 25-hydroxyvitamin D (25[OH]D). This is followed by a second hydroxylation step in the kidneys, converting it into its active form, 1,25-dihydroxyvitamin D (1,25[OH]$_2$D), also known as calcitriol.[3] Calcitriol exerts its effects through the vitamin D receptor (VDR), which is expressed on a variety of cell types, including immune cells such as T cells, B cells, and dendritic cells.[13]

A theoretical framework supports the role of vitamin D in modulating systemic lupus erythematosus (SLE) disease activity. Vitamin D has been shown to inhibit the activation of pro-inflammatory Th1 and Th17 pathways while promoting the expansion of anti-inflammatory regulatory T cells (Tregs). Additionally, vitamin D reduces the expression of cytokines, including IL-6, IL-17, and TNF-α, which are implicated in SLE flares and organ damage.[14] At the molecular level, vitamin D suppresses the transcription of proinflammatory and autoimmune-related genes. As a result, correcting vitamin D deficiency is believed to mitigate disease activity, which can be quantified using the SLE Disease Activity Index (SLEDAI).[15]

The expression of the vitamin D receptor (VDR) and vitamin D binding protein (VDBP) is regulated by various factors, including genetic polymorphisms such as the TaqI and FokI variants, which can influence individual responses to vitamin D supplementation.[16],[17] Beyond genetic factors, nutritional status, the level of systemic inflammation, and the severity of the disease also play significant roles.[1],[7],[8] These factors contribute to inter-individual

variability in the physiological response to vitamin D supplementation, affecting aspects such as the required dose, duration of administration, and overall therapeutic outcomes.[19]

The evidence regarding the efficacy of vitamin D supplementation in reducing disease activity in adult patients with systemic lupus erythematosus (SLE) remains inconclusive and inconsistent. The observed high heterogeneity, the limited number of studies, and the suboptimal validity of the included studies all contribute to the limitations in drawing strong recommendations for clinical practice.

Conclusions and Recommendation

The review of the three selected studies indicates that the evidence supporting the effectiveness of vitamin D in reducing disease activity in SLE patients is not robust. Additional high-quality randomized controlled trials (RCTs) are warranted, particularly those involving SLE populations with moderate to severe disease activity.

Conflict of Interest

The authors declare that there are no conflicts of interest related to the studies in this manuscript.

Author Contributions

Author 1 - generated the clinical question, conducted the search and critical review, analyzed the data and synthesized the evidence, and drafted the manuscript.

Author 2 - provided academic supervision, directed the process of data analysis and interpretation, and reviewed and edited the manuscript.

References

1. Tian J, Zhang D, Yao X, Huang Y, Lu Q. Global epidemiology of systemic lupus erythematosus: a comprehensive systematic analysis and modelling study. Ann Rheum Dis 2023;82(3):351. https://doi.org/10.1136/ard-2022-223035
2. Engli KA, Handono K, Eko MH, Susiani H, Gunawan A. Proteinuria severity in lupus nephritis is associated with anti-dsdna level and immune complex deposit location in kidney. Journal of Tropical Life Science. 2018;8(3):217-26. https://doi.org/10.11594/jtls.08.03.03
3. Shevchuk S, Marynych L, Malovana T, Denyshchych L. Vitamin D level in patients with systemic lupus erythematosus: its relationship to disease course and bone mineral density. Lupus Sci Med 2023;10(2):e000968. https://lupus.bmj.com/content/10/2/e000968
4. Accapezzato D, Caccavale R, Paroli MP, Gioia C, Nguyen BL, Spadea L, et al. Advances in the pathogenesis and treatment of systemic lupus erythematosus. Int J Mol Sci 2023;24:6578. https://doi.org/10.3390/ijms24076578
5. Hassanalilou T, Khalili L, Ghavamzadeh S, Shokri A, Payahoo L, Bishak YK. Role of vitamin D deficiency in systemic lupus erythematosus incidence and aggravation. Auto Immun Highlights

2017;9(1):1. https://doi.org/10.1007/s13317-018-0105-0

6. Buleu F, Gurban C, Sarbu E, et al. The relationship between vitamin D, inflammation and the activity of systemic lupus erythematosus. Fiziol - Physiol 2015;25:87.
7. Dall'Ara F, Cutolo M, Andreoli L, Tincani A, Paolino S. Vitamin D and systemic lupus erythematosus: a review of immunological and clinical aspects. Clin Exp Rheumatol 2018;36:153–62. PMID: 29148401
8. Zheng R, Gonzalez A, Yue J, Wu X, Qiu M, Gui L, et al. Efficacy and safety of vitamin D supplementation in patients with systemic lupus erythematosus: a meta-analysis of randomized controlled trials. Am J Med Sci 2019;358(2):104–14. https://doi.org/10.1016/j.amjms.2019.04.010
9. Fiblia F, Rengganis I, Purnamasari D, Widhani A, Karjadi TH, Shatri H, et al. Effect of cholecalciferol supplementation on disease activity and quality of life of systemic lupus erythematosus patients: a randomized clinical trial study. Acta Med Indones 2022;54(3):406–13. PMID: 36156472.
10. Pakchotanon R, Lomarat W, Narongroeknawin P, Chaiamnuay S, Asavatanabodee P. Randomized double-blind controlled trial to evaluate efficacy of vitamin D supplementation among patients with systemic lupus erythematosus. J Southeast Asian Med Res 2020;4(1):24–32. https://doi.org/10.55374/jseamed.v4i1.57
11. Lima GL, Paupitz J, Aikawa NE, Takayama L, Bonfa E, Pereira RM. Vitamin D supplementation in adolescents and young adults with juvenile systemic lupus erythematosus for improvement in disease activity and fatigue scores: a randomized, double-blind, placebo-controlled trial. Arthritis Care Res 2016;68(1):91–8. https://doi.org/10.1002/acr.22621
12. Rifa'i A, Respatiningsih B, Maulidiana MA, Oktaria V, Rahadyan RW. Effect of vitamin D supplementation on disease activity (SLEDAI) and fatigue in systemic lupus erythematosus patients with hipovitamin D: an open clinical trial. Indones J Rheumatol 2016;8(2):80–6. https://doi.org/10.37275/ijr.v8i2.59
13. Singh A, Kamen DL. Potential benefits of vitamin D for patients with systemic lupus erythematosus. Dermatoendocrinol 2012;4(2):146–51. https://doi.org/10.4161/derm.20443
14. Jiang LJ, Rong ZH, Zhang HF. The changes of Treg and Th17 cells relate to serum 25(OH)D in patients with initial-onset childhood systemic lupus erythematosus. Front Pediatr 2023;11:1228112. https://doi.org/10.3389/fped.2023.1228112
15. Miskovic R, Plavsic A, Raskovic S, Jovicic Z, Bolpacic J. Vitamin D status in patients with systemic lupus erythematosus in Serbia: correlation with disease activity and clinical manifestations. Open Access Maced J Med Sci 2015;3(2):256–61. https://doi.org/10.3889/oamjms.2015.052
16. Usategui-Martín R, De Luis-Román DA, Fernández-Gómez JM, Ruiz-Mambrilla M, Pérez-Castrillón JL. Vitamin D Receptor (VDR) Gene Polymorphisms Modify the Response to Vitamin D Supplementation: A Systematic Review and Meta-Analysis. Nutrients. 2022 Jan 15;14(2):360. https://doi.org/10.3390/nu14020360.
17. Rozmus D, Ciesielska A, Płomiński J, Grzybowski R, Fiedorowicz E, Kordulewska N, Savelkoul H, Kostyra E, Cieślińska A. Vitamin D Binding Protein (VDBP) and Its Gene Polymorphisms—The Risk of Malignant Tumors and Other Diseases. *International Journal of Molecular Sciences*. 2020; 21(21):7822. https://doi.org/10.3390/ijms21217822.
18. Sun J, Liu C, Zhang S, Yi B, Gui M, Zhang W, Li YC, Zhang H. Vitamin D receptor expression in peripheral blood mononuclear cells is inversely associated with disease activity and inflammation in lupus patients. Clin Rheumatol. 2019 Sep;38(9):2509-2518. http://doi:10.1007/s10067-019-04594-2.
19. Mazahery H, von Hurst PR. Factors Affecting 25-Hydroxyvitamin D Concentration in Response to Vitamin D Supplementation. Nutrients. 2015 Jun 25;7(7):5111-42. https://doi.org/10.3390/nu7075111.