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Assessment Of Vitamin D Within Saudi Systemic Lupus Erythematosus Patients And Its Integration With Lupus Nephritis

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ABSTRACT

Background: *An autoimmune condition known as systemic lupus erythematosus (SLE) can impact several organs in the body and present with a range of clinical symptoms and severity levels.* ***Objective:*** *This work aimed to assess the level of vitamin D in the serum of Saudi patients with and without lupus nephritis and its association with disease activity, clinical and laboratory findings.****Methods:*** *This cross-sectional study included 150 participants divided into 3 groups: Group 1 (LN group) included 50SLE cases with lupus nephritis, group II (SLE group) contained 50 SLE cases without lupus nephritis and group III (control group) consisted of 50 healthy and sex-matched subjects. All cases were subjected to assessment of the diseaseactivity by SLE Disease Activity Index 2000 (SLEDAI), renal SLE Disease Activity Index (rSLEDAI) and laboratoryinvestigations [complete blood cou[1]nt (CBC), C- reactive protein (CRP), ESR, anti-ds-DNA, ANA, C3 and C4 concentration, urine analysis, 24-hours' protein in the urine, serum creatinine and serum 25(OH) vitamin D level].* ***Results:*** *There was a significant difference between the 3 studied groups regarding 25(OH) D where the lowest level was in the LN group (p-value < 0.001). In LN and SLE groups there was a significant relation between serum 25(OH)D titre and SLEDAI (p-value.36, 0.011 respectively). Also, regression analysis test revealed that there was a significantassociation between 25 (OH) D and HB, WBCs, PLT, Anti-ds DNA, C3, C4, SLEDAI, and renal SLEDAI in LN and SLE groups. Low vitamin D titre showed high frequency in patients with SLE and was more frequent in SLE with lupusnephritis in all grades of low vitamin D titre (Insufficient, Deficient and sever).* ***Conclusions:*** *In patients with lupus nephritis, there was a significant relationship found between low vitamin D titre and high and very high disease activity.*

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Keywords: *Vitamin D, Systemic lupus erythematosus, Lupus nephritis, Disease activity.*

INTRODUCTION

An autoimmune condition known as systemic lupus erythematosus affects numerous organs and can present with a wide range of clinical symptoms, including cutaneous, cardiac, neurologic, hematologic, and renal. Additionally, the severity of SLE can vary from mild to severe (mild, moderate, and severe). The gold standard for evaluating disease activity globally is the Lupus Erythematosus Disease Activity Index (SLEDAI) [1].

It is believed that a variety of factors, including as genetics, the environment, and hormones, may contribute to the development of SLE. Numerous researches have demonstrated that SLE has a favorable family history [2].

As a form of glomerulonephritis, lupus nephritis (LN) is one of the most severe organ symptoms associated with SLE. Histologically, lupus nephritis is divided into five groups that correspond to various renal involvement severities and symptoms. 10% of LN cases develop end-stage kidney disease (ESKD) within ten years. Renal involvement may obstruct 1-hydroxylation, which is necessary for the production of an active form of vitamin D [3].

The main element preserving calcium homeostasis is vitamin D (VD). Improved renal calcium reabsorption and intestinal calcium intake have been related to the existence of VD. Moreover, the physiologically active form of vitamin D, 1, 25 dihydroxycholecalciferol [1, 25OHD3], might modulate the immune system. The vitamin D receptor (VDR) is a transcription factor that is activated by ligands and controls gene expression in relation to immunological regulation. Low levels of 25 (OH) D3 (VD3) have been associated in the past ten years with an increased risk of several disorders, such as diabetes, cardiovascular disease, dermatological disease, various types of cancer, and autoimmune diseases [4].

Studies have linked VD deficiency to SLE, suggesting that it may play a role in the disease's pathogenesis and pathology. Avoiding sunlight, using sunglasses, renal inadequacy, and using medications like glucocorticoids, anticonvulsants, antimalarials, and calcineurin inhibitors 6 are all potential causes of VD deficiency in SLE cases [5]. This work aimed to assess thelevel of vitamin D in the serum of Saudi patients with and without lupus nephritis and its association with disease activity, clinical and laboratory findings.

PATIENTS AND METHODS

This cross-sectional study included 100 SLE patients older than 18 years, who were labelled as having lupusnephritis according to SLICC classification criteria [6] and 50 healthy age- and sex-matched as control group. They were selected from the Outpatient Clinic of Rheumatology, Rehabilitation and Physical Medicine Department of Makkah Hospitals, Saudi Arabia.

Exclusion criteria: Patients with kidney disease due tocauses other than SLE, ESRD with or without dialysis, granulomatous disorders, malignancy, and other autoimmune diseases. Also, patients on medications for osteoporosis except for calcium supplements and on VD supplementation or medications that can alter VD metabolism.

The participants were divided into 3 groups: GroupI: 50 SLE cases with LN, group II: 50 SLE cases withoutLN and group III: 50 healthy age- and sex-matched subjects as control group. All were subjected to complete history taking, complete clinical examination,assessment of the disease activity, and laboratory investigation [complete blood count (CBC), C- reactiveprotein (CRP), ESR, anti-ds-DNA, ANA, C3 and C4 concentration, urine analysis, 24-hours' protein in urine,serum creatinine and serum 25OH vitamin D level.).

Assessment of the disease activity:

The disease activity was assessed according to SLEDAI. The SLEDAI is a global index that

evaluatesdisease activity. It includes 24 items collecting specificmanifestations in 9 organ systems: neurological, musculoskeletal, renal, mucocutaneous, general, heart, respiratory, vascular, and hematological. The SLEDAI classifies levels of exercise as follows: no activity (SLEDAI = 0), light activity (SLEDAI = 1-5), moderateactivity (SLEDAI =6-10), high activity (SLEDAI =11-19), and very high activity (SLEDAI =20).

To evaluate the severity of kidney disease, researchers used the rSLEDAI. The four factors linked to the kidney were hematuria, pyuria, proteinuria, and urinary casts, which make up the total. The kidney SLEDAI scale includes a 0 (no evidence of renal disease) to a 16 (severe renal disease). To be diagnosedwith active lupus nephritis, a case must have a rSLEDAIscore of 4 or higher [7].

Measuring VD:

The serum vitamin D level (25, OH VD) was evaluated with an ELISA kit. Estimated levels of insufficient VD were below 30 ng/ml, deficient at below20 ng/ml, and severely deficient below 12 ng/ml.

Ethical approval: Tanta University Hospitals' Ethical Council approved the study's procedures onMarch 2021. The participants provided their writtenconsents after being fully informed of the risks involved (approval code: 34489/2/21) in accordance with Helsinki.

Statistical analysis

Statistical analysis was done by SPSS version 27 (IBM©, Armonk, NY, USA). Histograms and the Shapiro-Wilks test were used to determine if the data followed a normal distribution. Parametric quantitativedata were summarised and analysed using the ANOVA (F) test and post hoc test for means and standard deviations (Tukey). The Kruskall-Wallis test and the Mann-Whitney U test were used to make group comparisons from the quantitative non-parametric datagiven as the median and IQR. The Chi-square test was used to analyse qualitative factors given in frequency and percentage (%) formats. The cutoff for statistical significance was a two-tailed P value of less than 0.05. To determine which clinical or laboratory symptoms of SLE are most strongly correlating with blood 25-OH- VD level, we performed a linear regression analysis in the current research. The threshold for statistical significance was $p \leq 0.05$.

RESULTS

There is a significant difference between 3 groupsaccording to 25OHD level (Table 1).

		LN (n = 50)	**SLE (n = 50)**	**ontrolled (n = 50)**	**P value**	
Age (years)		32.36 ± 8.94	32.28 ± 7.95	35.48 ± 14.8	0.255	
Sex	**Male**	6 (12%)	7 (14%)	11 (22%)	0.352	
	Female	44 (88%)	43 (86%)	39 (78%)		
Marital	**Single**	17 (34%)	13 (26%)	15 (30%)	0.683	
	Married	33 (66%)	37 (74%)	35 (70%)		
25OHD	**Normal (>30)**	0 (0%)	0 (0%)	13 (26%)	<0.001*	P1<0.001*
	nsufficient (20 - 30)	6 (12%)	21 (42%)	15 (30%)		P2<0.001*

	12 – 20 (Deficient)	17 (34%)	24 (48%)	21 (42%)		P3<0.001*
	Severe (<12)	27 (54%)	5 (10%)	1 (2%)		
25OHD		12.86 ± 4.56	18.12 ± 6.15	32.54 ± 10.98	<0.001*	P1<0.001* P2<0.001* P3<0.001*

There was no significant difference between the 2 groups as regards clinical manifestations except for malar rash andoral ulcer (Table 2).

		LN (n = 50)	**SLE (n = 50)**	P value
Special habits	**No smoker**	45 (90%)	44 (88%)	0.749
	Smoker	5 (10%)	6 (12%)	
Onset (years)		7.64 ± 3.8	5.94 ± 3.12	0.017*
Fatigue		39 (78%)	38 (76%)	0.812
Fever		31 (62%)	26 (52%)	0.419
Alopecia		17 (34%)	9 (18%)	0.110
Malar rash		45 (90%)	34 (68%)	0.014*
Ulcer		44 (88%)	30 (60%)	0.003*
Myositis		0 (0.0%)	0 (0.0%)	–
Arthritis		24 (48%)	29 (58%)	0.422
Neuropsychiatric		0 (0.0%)	0 (0.0%)	–
Vacuities		5 (10%)	0 (0%)	0.056
Renal		50 (100.0%)	0 (0.0%)	---
Serositis		0 (0.0%)	0 (0.0%)	–
Hb (mg/dL)		10.34 ± 1.7	10.13 ± 2.06	0.575
RBCs (x 10^6/ µL)		3.75 ± 0.79	3.61 ± 0.68	0.369
WBCs (x 10^6/ µL)		7.67 ± 1.64	6.64 ± 1.61	0.106
PLT (x 10^3/ µL)		333.52 ± 31.14	363.46 ± 73.48	0.333
ESR		67.1 ± 6.22	56.1 ± 3.94	0.076
CRP (mg/L)		7.66 ± 1.15	6.26 ± 1.44	0.015*
Creatinine (mg/L)		2.33 ± 0.07	1.18 ± 0.26	<0.001*
Proteinuria		2065.58 ± 178.9	244.7 ± 17.83	
		(n =49)	**(n = 45)**	
ANA		6.93 ± 2.3	6.22 ± 2.25	0.135
		(n = 50)	**(n = 38)**	
Anti-dsDNA		125.5 ± 7.19	118.03 ± 6.1	0.460
C4		94.68 ± 3.49	103.98 ± 5.91	0.277
C3		18.36 ± 4.64	15.46 ± 3.63	0.098
Urinary cast		47 (94%)	0 (0.0%)	<0.001*
Crystals in urine		5 (10%)	0 (0%)	0.056
Pus HPF in urine		14.42 ± 6.94	10.02 ± 5.73	0.001*
RBCs in urine		8.86 ± 5.51	3.76 ± 2.59	<0.001*
SLEDAI		19.1 ± 5.26	6.34 ± 4.42	<0.001*
rSLEDAI		7.2 ± 2.76	0 ± 0	---
Renal biopsy		35 (70%)	0 (0%)	---
		(n = 15)	**(n = 0)**	
	2	3 (20%)	–	

Class	**3**	1 (6.67%)	–	----
	4	6 (40%)	–	
	5	5 (33.33%)	–	

A significant positive correlation between 25OHD and hemoglobin (Hb), red blood cells (RBCs), white blood cells (WBCs), and platelets was detected. A significant negative correlation between 25OHD and proteinuria, rSLEDAI andSLEDAI was detected. Serum VD level was significantly reduced in cases with consumed C3 and C4 and cases with positive anti-ds DNA in LN and SLE groups (Table 3).

	25OHD			
	LN		**SLE**	
	r	**p**	**r**	**p**
Age (years)	0.126	0.385	0.086	0.551
Onset (years)	- 0.194	.176	0.094	0.518
Hb	0.565	< 0.001*	0.419	0.002*
RBCs	0.355	0.011*	0.388	0.005*
WBCs	0.493	<0.001*	0.481	<0.001*
PLT	0.374	0.007*	0.310	0.029*
ESR	0.155	0.282	0.057	0.694
CRP	0.179	0.214	-0.134	0.353
Creatinine	0.071	0.626	0.133	0.356
Proteinuria	-0.410	0.003*	0.071	0.622
ANA	0.117	0.424	-0.045	0.770
Anti-dsDNA	- 0.322	0.023*	-0.615	<0.001*
C3	0.460	<0.001*	0.482	<0.001*
C4	0.398	0.004*	0.284	0.046*
Pus HPF in urine	0.008	0.959	-0.107	0.459
RBCs in urine	0.052	0.718	-0.150	0.297
SLEDAI	-0.419	0.002*	-0.463	<0.001*
rSLEDAI	-0.495	<0.001*	--	--

Serum VD level was significantly decreased in cases with fatigue in LN and SLE group (Table 4).

		25OHD	**P value**
Sex	**Male**	15.25± 4.1	0.173
	Female	12.53± 4.5	
Marital	**Single**	14.4± 4.8	0.083
	Married	12.05 ± 4.2	
Special habits	**No smoker**	12.8±4.6	0.966
	Smoker	12.9 ± 4.6	
Fatigue		11.17±3.4	<0.001*
Fever		12.9 ± 4.6	0.942
Alopecia		14.3 ± 4.9	0.100
Malar rash		12.8 ± 4.6	0.953
Ulcer		12.9 ± 4.5	0.676
Arthritis		13.7±5.0	0.203

Vacuities		12.2±3.5	0.723
Urinary cast	**Negative**	18.2±3.8	<0.001*
	Positive	11.8 ± 3.9	
Crystals in urine	**Negative**	12.6 ± 3.3	0.130
	Positive	17.6 ±3.3	
Renal biopsy	**0**	13.5 ± 4.4	0.545
	1	12.6 ± 4.6	
Different parameters in SLE group			
Sex	**Male**	16.14 ± 5.4	0.365
	Female	18.4±6.3	
Marital	**Single**	19.38±5.5	0.395
	Married	17.7 ± 6.4	
Special habits	**No smoker**	17.7 ± 6.1	0.254
	Smoker	20.8 ± 5.9	
Fatigue		16.5 ± 5.8	<0.001*
Fever		15.4 ± 5.7	<0.001*
Alopecia		17.8±8.5	0.856
Malar rash		18.12±6.4	0.997
Ulcer		18.13 ± 6.4	0.985
Arthritis		18.24 ± 6.5	0.872

In the present study, we noticed that there was a significant inverse relation between a low titre of 25OHD and SLEDAI activity, in LN and SLE groups there was a significant relation between a low titre of 25OHD and very high SLEDAI activity and high SLEDAI activity respectively (Table 5).

	SLEDAI				**P value**
	High (n = 24)		**Very High (n = 26)**		
25OHD	14.25 ± 3.91		11.57 ± 2.87		0.036*
In SLE					
	Inactive (n = 3)	**Mild (n = 24)**	**Moderate (n = 8)**	**High (n = 15)**	
25OHD	18 ± 3.61	20.88± 5.53	16.75± 3.16	14.47± 3.76	0.011*
	P1=0.838, P2=0.988, P3=0.754, P4=0.289, P5=0.006*, P6=0.791				

In LN and SLE groups, linear regression analysis revealed that there was a significant link between low titre of 25OHD and Hb, WBCs, PLT, nati-ds DNA, C3, C4, SLEDAI, rSLEDAI, but inversely correlated with SLEDAI andrSLEDAI (Table 6).

	linear regression test	
	p	**SE (95%C. I)**
Hb	<0.001*	3.34 (-9.56: 3.89)
WBCs	<0.001*	0.16 (0.30: 0.93)
PLT	0.007*	0.004 (0.003: 0.022)
Anti-dsDNA	0.022*	0.01 (-0.58: -0.004)
C3	<0.001*	0.07 (0.12: 0.43)
C4	0.004*	0.019 (0.019: 0.099)
SLEDAI	0.002*	0.11 (-0.59: -0.13)
rSLEDAI	<0.001*	0.20 (-1.2: -0.40)
in SLE		
Hb	0.002	0.39 (0.46: 2.04)

WBCs	<0.001*	0.29 (0.53: 1.73)
PLT	0.028*	0.004 (0.001: 0.02)
Anti-dsDNA	<0.001*	0.017 (-0.11: 0.045)
C3	<0.001*	0.08 (0.14: 0.47)
C4	0.045*	0.016(0.001: 0.06)
SLEDAI	<0.001*	0.18 (-1.002: -0.29)

DISCUSSION

SLE is a chronic inflammatory multisystem illness characterized by prototypical abnormalities of the immune response and causes a wide range of symptoms. Our research clearly demonstrated this, as there is a significant difference between the two groups with respect to clinical manifestations, with the exception of oral ulcers and malar rash (p-value 0.003, 0.014, respectively). Our findings are consistent with those of Elessawi et al. [9], Elsaid et al. [10], and Kwon et al. [11], who found no discernible differences between SLE with and without nephritis in terms of fatigue, mucocutaneous, alopecia, musculoskeletal, myositis, and arthritis. Among the two groups under study, mucocutaneous had the highest prevalence, which is consistent with reports by Niazy et al. [12] and Abdel Galil et al. [13]. In our study, the second most prevalent signs were weariness and arthritis, accounting for 75–90% of the cases.

The strongest predictor of VD status in people is themeasurement of circulating 25-OH-VD, which represents VD reserves accumulated from both foodconsumption and ultraviolet light exposure. Current study indicated that VD deficiency was broadly commonin instances of active SLE and LN in Saudi Arabia, despite the country's year-round sunshine. This agrees with the findings of **Elsaid et al.** [14] that VD deficiency andinsufficiency in LN can reach 93.4% in the country's year-round sunshine as Egyptian.

The current study found a significant difference in the 25-OH-D level between the three groups, which is consistent with the findings of Mahmoud et al. [15], who reported that vitamin D was clearly lower in SLE/LN than in SLE/no LN and the control group. Despite our research, García-Carrasco et al. [16] did not detect a statistically significant difference in VD concentrations between the LN and SLE groups. However, their reason for their findings was unclear.

In the present research, regarding VD status among the groups, the highest frequency of VD (severe and deficiency) was categorised in the LN and SLE groups respectively, while they were least in the control group. Also, VD insufficiency category was highest in the SLEand was least in SLE with LN (42% versus 12% respectively). These differences were significant. The lowest value was in the LN group (p-value <0.001), which may be due to that kidneys are playing a vital rolein making vitamin D useful to the body. In chronic kidney disease, it was founded that vitamin D levels werebelow the normal range, or even severely low. This can occur due to injury in kidneys making them not efficientto convert vitamin D to its active form [17]. Gaik et al.'s [18] research on the relationships between VD status and SLE symptoms, cardiovascular risk factors, autoantibodies, and disease activity is consistent with our findings. They examined 216 SLE cases in their retrospective study. Only LN demonstrated a statistically significant correlation with VD status among the other clinical symptoms of SLE. Only 46 (21.3%) of the lupus nephritis cases had an adequate vitamin D content, whereas 50 (23.1%) had a deficiency. Apart from its antiproliferative properties, VD controls the development of the cell cycle, which makes it a crucial component in the pathophysiology of SLE. If a connection between VD and the activity of the disease and lupus nephritis (LN) can be established, then VD may offer a new approach to treating SLE [19].

In the present research, there was a significant positive correlation between 25-OH-D and HB,

RBCs, WBCs, and Platelet. There was a significant negative correlation between 25-OH-D and proteinuria, renal SLEDAI and SLEDAI. There was a significant correlation between 25-OH-D level and creatinine, pus, RBCs in urine, ESR and CRP in LN group. In SLE our research revealed a significant positive correlation between 25-OH-D and HB, RBCs, WBC and Platelet. There was a significant negative correlation between 25-OH-D and SLEDAI. There was a significant correlationbetween 25-OH-D level and age, duration, creatinine, proteinuria, pus and RBCs in urine and CRP in SLE cases. Mahmoud et al. [15], who found that vitamin D was clearly positively linked with HB and PLT in SLE cases, corroborate our findings.

Regarding clinical manifestation in the present research, serum vit D level was significantly decreased in cases with fatigue and musculoskeletal disorders in LN group. Also, decreased with fatigue in SLE cases. Our findings are consistent with the findings of Correa-Rodríguez et al. [20] and Isalam et al. [21], who discovered that insufficient serum levels of VD in SLE cases have been commonly linked to fatigue. This can be explained by the fact that VD is an effective skeletal muscle physiology modulator. Thus, one way that VD influences the differentiation and growth of muscle, particularly in fast-twitch fibers, is by upregulating the expression of type II genes implicated in these processes. Increased interfibrillar gaps, fat infiltration, fibrosis, and glycogen are also seen in muscle samples from individuals with a VD deficit; these features are indicative of muscular dystrophies. [22]

In the present research, serum VD level was significantly lower in cases with consumed C3 & C4 andcases with positive anti-ds DNA in LN and SLE groups.Our findings are in line with those of Athanassiou et al. [23], who investigated VD in SLE patients and discovered a favorable correlation between C3 and C4 levels and 25-OHD3. They claimed that the liver and kidneys are essential for the production of VD. Complement component level can be utilized as a surrogate for the health of the liver and kidneys because impairments in C3 and C4 complement are linked to these organs' problems. Vitamin D3 is hydroxylated to 25-OH-D in the endoplasmic reticulum and mitochondria of hepatocytes. The 1-hydroxylase system then catalyzes this reaction once more to 1,25-(OH)2D3 in the kidney's proximal convoluted tubule epithelial cells. Additionally, pathological diseases correlating with C3 or C4 amounts may also impede VD activation and reabsorption [24]. This is consistent with the VD's inhibitory effects on B-cell activities that a negative link has been shown to exist between VD3 level and titres of autoantibodies such as anti-dsDNA [25].

In LN and SLE groups, linear regression analysis revealed that there is a significant link between low titreof vit D (OH D 25) and HB, WBCs, PLT, Anti-ds DNA,C3, C4, SLEDAI, renal SLEDAI, but inversely correlated with SLEDAI and renal SLEDAI. Possible explanations include VD's immune-supportingproperties. Sufficient VD supplementation has been proposed to improve the function of VD receptor- expressing immune cells like macrophages, dendriticcells, B cells, and T cells. [26]

Hemoglobin content (r = - 0.04, p = 0.003), mean corpuscular hemoglobin (r = - 0.11, p 0.001), and red blood cell count (r = - 0.04, p = 0.002) were all evidentlyand inversely correlated with 25-OH-D level. In a population-based group of teenagers, there was a substantial correlation between serum VD level and several indices of red blood cell maturation, which is inconsistent with VD's role as a growth factor [27]. In theresearch by **Zhou et al.** [26] who noted that linear regression analysis showed that 25-OH-D could evidently impact the renal outcome in these cases with biopsy proven DN [HR, per SD 25-OH-D 0.261, 95% CI0.155-0.441, p<0.001]. However, **Lin et al.** [28] linear analysis demonstrated that serum 25-OH-D status was not evidently correlating with the level of white blood cell (p = 0.987), hemoglobin (p=0.428), platelet (p=0.389), creatinine (p =0.775), and anti-dsDNA (p=0.243), or daily and cumulative steroid dosages within 1 month before the examination (p= 0.794 and p = 0.328, respectively)

In the current investigation, we found that a low titre of 25-OH-D was significantly

inversely correlated with SLEDAI activity; in the LN and SLE groups, a low titre of HO-D was significantly correlated with very high SLEDAI activity and high SLEDAI activity, respectively. According to Yeap et al. [30] (P = 0.033) and Borba et al. [29] (P = 0.0005), two more SLEDAI-based cross-sectional studies, SLEDAI was associated with low levels of VD and high levels of cytokines like TNF and IL-6. A number of additional research supported our findings, however they used different activity measurement techniques than SLEDAI. For instance, Amital et al. [31] questioned whether or not VD supplements should be regularly administered to individuals with SLE after finding a negative association between VD level and SLE disease activity. Preliminary studies revealed that VD inhibits Th1 immunity and autoantibody production, which explains this link. Additionally, it was discovered that by targeting T-helper cells, VD inhibits the release of pro-inflammatory cytokines by B cells and cytokine-mediated B-cell activation [32].

Individuals with systemic lupus erythematosus who had severe VD deficiency had considerably more SLE flares and nephritis [33]. The observed significant negativecorrelation between SLE activity and VD level in our research could be predicted because the underlying inflammation in lupus enhances the catabolic process ofVD.

In our research, there was a significant relationbetween low VD and pus in urine (p-value <0.001) and this is in agreement with **Deng et al.** [34] who found that a lack of VD was linked to a marked rise in the probability of contracting a UTI. It is unclear how VD shortage contributes to UTI recurrence. Different urine host defence proteins like the Tamm-Horsfall protein, lactoferrin, and lipocalin can help ward off infections. Epithelial cells in the urinary system generate the antibacterial molecule cathelicidin LL-37 in response toinfections. Innate defence antibacterial peptides, such ascathelicidin LL-37, may be stimulated by vitamin D [35].

CONCLUSION

Inadequate and insufficient levels of vitamin D were found in a large percentage of SLE cases, and they were more common in SLE patients who also had lupus nephritis. Low serum VD significantly linked positively with C3 and C4 and negatively with disease activity, renal disease activity, ESR, and ds DNA. We found a substantial correlation between fatigue and musculoskeletal problems and low serum VD.

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