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ORIGINAL ARTICLE

The Relationship between Vitamin D3 and Inflammatory Markers in Hemodialysis Patients

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ABSTRACT

Background: Vitamin D and hemodialysis patients' inflammation and inflammatory markers has been the subject of few investigations, with contradictory findings. This research aimed for assessment of the correlation between novel inflammatory markers and vitamin D levels among hemodialysis patients.

Methods: Ninety-four patients on hemodialysis who had End stage renal disease (ESRD) were involved in this cross-sectional study who were classified based on vitamin D level into: Vitamin D Deficient Group (n=67) in addition to Vitamin D Sufficient/ Normal Group (n=27). Serum 25-hydroxyvitamin D level, among other laboratory investigations were assessed with calculation of both platelet lymphocyte rate (PLR) and neutrophil lymphocyte ratio (NLR) among all patients each month prior to the first midweek dialysis appointment.

Results: Higher ferritin level was found among Vitamin D deficient group versus Sufficient/ Normal group with P-value (0.0001). Vitamin D deficient group has shown Vitamin D level 10.8±2.9 vs. 28.7±6.5 in the Sufficient/ Normal group with statistically significant differences; P-value = 0.00001. The Vitamin D deficient group had higher levels of CRP, ESR, NLR and PLR than the Sufficient/ Normal group with statistically significant differences; (P-value = 0.014, 0.0001, 0.003 and 0.011 respectively). Statistically significant negative correlations were revealed between Vitamin D and all of the following (CRP, ESR, NLR and PLR) with (P-values= 0.002, 0.0001, 0.006 and 0.001 respectively).

Conclusions: Our findings underscore the high prevalence of insufficiency of vitamin D levels among this population and their correlation with increased levels of inflammatory markers such as CRP, ESR, NLR, and PLR.

Keywords: Vitamin D3; Inflammatory Markersl Hemodialysis Patients

INTRODUCTION

Nearly 10% of the global population suffers from chronic kidney disease (CKD), making it a significant public health concern [1]. Damage to the kidneys occurs when the estimated glomerular filtration rate (eGFR) remains below 60 ml/min/1.73 m2 for at least three months. ESRD is recognized when the estimated glomerular filtration rate (eGFR) becomes lower than 15 ml/min/1.73 m2 or in case of the need for dialysis or a kidney transplant [2].

While the death rate for people on hemodialysis has declined in the past 10 years, it is considered to be prevalent among the general population [3]. Even in the earliest stages of chronic kidney disease (CKD), patients frequently experience an inflammatory state. Inflammation that occurs in CKD patients could have many different origins, some of which include infection, obesity, comorbidities, oxidative stress, immunological variables, and underlying illnesses. An elevated C-reactive protein or other inflammatory marker is seen in almost half of CKD patients [4].

Research has demonstrated that the inflammation could be in charge of vascular diseases, left ventricular hypertrophy, cardiovascular events, malnutrition, protein-energy wasting, as well as mortality among CKD patients [5]. So, one of the crucial components of managing chronic kidney disease is reducing systemic inflammation. A common consequence of CKD is lower vitamin D levels. [6].

The mean platelet volume (MPV), platelet-to-lymphocyte ratio (PLR), sin addition to the neutrophil-to-lymphocyte ratio (NLR) have recently been added to the list of inflammatory indicators used in various diseases [7]. Inflammation markers among hemodialysis patients can be reliably and affordably assessed by several current research, namely by NLR and PLR [8].

Another potential marker of inflammation is vitamin D, a steroid hormone that plays a crucial role in the metabolism of bone mineral. Anemia, cognitive dysfunction, cancer, cardiovascular disease, infections, autoimmune diseases, kidney disease, and vitamin D defeciency are all linked [9]. Although there is still debate over whether higher vitamin D levels cause inflammation or the other way around, Vitamin D and its analogues may exert anti-inflammatory effects via many routes, as established in several previous studies [10].

The hemodialysis population has a significant issue with chronic inflammation. Vitamin D insufficiency is observed in most hemodialysis patients, which is quite interesting [11]. Nevertheless, there have been contradictory findings from the few research that have investigated vitamin D's impact on inflammation as well as inflammatory markers [12].

To our knowledge, this could be the first study in Zagazig University Hospitals for assessment of the correlation between novel inflammatory markers and vitamin D levels among hemodialysis patients.

METHODS

Between June 2023 and December 2023, we performed this cross-sectional study in the Nephrology Unit, Internal Medicine Department, Zagazig University Hospitals, on 94 patients on hemodialysis due to ESRD.

Written informed consent was obtained from all participants after explaining the procedure and medical research. The research was conducted under the World Medical Association's Code of Ethics (Helsinki Declaration) for human research. This study was carried out after the approval of the Institutional Review Board (IRB) (#10840/21-5-2023).

Cases with the following criteria were included: those aged 18 or older on hemodialysis management due to ESRD for at least 3 months as long as they agreed to participate (Figure 1).

Cases with the following characteristics were excluded: cases who were younger than 18 years, Patients with active inflammation or infection or fever data during the study, with active/history of malignancy, patients who were under treatment by immunosuppressive drugs, cases with immobility, obesity (BMI≥30 kg/m2), smoking, severe anemia (hemoglobin (Hb)≤9), as well as patients who refused to share in the study.

All patients were subjected to Full history taking involving age, name, sex, history of medical diseases, and family history of end-stage renal disease.

Complete clinical examination to exclude any hidden medical condition that may interfere with the results and diagnosis.

Laboratory investigations: Each month prior to the first midweek dialysis appointment, blood samples were collected from the cases. It included: Complete blood count (CBC). Using the full blood cell count, the calculation of both NLR and PLR were determined. A full blood cell count was performed using fluorescence flow cytometry (Sysmex XN 2000) to quantify hemoglobin, platelets, white blood cells (WBCs), and mean platelet volume (MPV), Immunonephelometric assays (NFL BN-II) were used to measure C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and spectrophotometry (Beckman Coulter AU 2700) was used to evaluate serum albumin. and electrolytes in the blood.

Total and ionized calcium levels were determined using the Arsenazo III colorimetric method (ADVIA® XPT - Siemens Healthineers), while ferritin levels were measured using an ADVIA Centaur XPT immunoassay (Siemens).

Agilent Technologies' liquid chromatography tandem mass spectroscopy was used to evaluate serum 25(OH)D levels. Vitamin D insufficiency was defined as a serum 25(OH) D level below 20 ng/ml. Hence, vitamin D deficiency was determined as a serum 25(OH) D level below 20 ng/ml, and normality was established as a serum level over 20 ng/ml. Two groups of patients were classified regarding Vitamin D Level into Vitamin D Deficient Group (n=67) and Vitamin D Sufficient/ Normal Group (n=27).

STATISTICAL ANALYSIS

We used SPSS 25.0 for Windows (SPSS Inc., Chicago, IL, USA) to undertake statistical analysis after collecting and tabulating all data in Microsoft Excel 365. The mean ± SD and median (range) were used to express quantitative variables. Chi-square test (X2) was used for comparing categorical data. A non-parametric statistic To compare variables in the case group to the control group and between the two subgroups of cases, the Mann-Whitney U (M-W) test was adopted, while Kruskal-Walli's test (K-W) was used to compare a variable between more than two case subgroups. Spearman coefficient correlation was used to assess the correlation between Vitamin D and Inflammatory markers (CRP, ESR, NLR and PLR). At confidence interval 95% and P-value <0.05), the applied test was considered statistically significant.

RESULTS

Vitamin D deficient group included 34 males and 33 females, while the Vitamin D sufficient group involved 14 males and 13 females. The age of Vitamin D deficient group ranged from 23 to 77 years with mean value 48.5±13.5 years, while for the sufficient group ranging from 20 to 70 years with mean value 48.2±15.4 years (Table 1).

Higher ferritin level was found among the Vitamin D deficient group versus Sufficient/ Normal group with P-value 0.0001. Vitamin D deficient group has shown Vitamin D level 10.8±2.9 vs. 28.7±6.5 in the Sufficient/ Normal group with statistically significant differences; (P-value = 0.00001). The Vitamin D deficient group has shown higher levels of CRP, ESR, NLR and PLR than the Sufficient/ Normal group with statistically significant differences (P-value = 0.014, 0.0001, 0.003 and 0.011 respectively) (Table 2).

It was found that there were statistically significant negative correlations between Vitamin D and (CRP, ESR, NLR and PLR) with (P-values= 0.002, 0.0001, 0.006 and 0.001 respectively) (Table 3, Figures 2, and 3).

To investigate the potential risk factors for Vitamin D deficiency, we conducted logistic regression analyses. In multivariate analysis, only ESR (Odds Ratio [OR]: 0.78, Confidence interval [CI]; 0.67 – 0.91) was significantly associated with vitamin D deficiency among studied patients, whereas no effect of other predictors was observed (Table 4).

Table (1): Distribution of the studied groups regarding demographic data and comorbididitie**s.**

		Vitamin D Deficient Group (n=67)	**Vitamin D Sufficient/ Normal Group (n=27)**		
Sex	**Male**	**34(50.7%)**	**14(51.8%)**	**X^2**	**P-value**
	Female	**33(49.3%)**	**13 (48.2%)**	**0.009**	**0.923**
Age (years)	**Mean± SD**	**48.5±13.5**	**48.2±15.4**	**T**	**P-value**
	Median(Range)	**50(23 -77)**	**53 (20 - 70)**	**0.7555**	**0.941**

Comorbidities	**Vitamin D deficient group (n=67)**	**Sufficient / Normal group (n=26)**	**Total Studied Cases (n=94)**	
	No.	**No.**	**No.**	**%**
HTN	34	11	45	48.3
HTN,DM	1	6	7	7.52
HTN,IHD	1	1	2	2.15
IHD	5	0	5	5.37
DM	8	3	11	11.8
Chronic Liver disease	2	1	3	3.22
Metabolic disorder	2	1	3	3.22
Congential heart disease	1	0	1	1.07
HTN, Dyslipidemia	8	0	8	8.6
FMF	1	0	1	1.07
Immune disorders	3	3	6	6.45
Unkown	1	0	1	1.07
Chi-Square	X2: 20.097 P-Value: 0.044*			

HTN, Hypertension, DM: Diabetes mellitus, IHD: Ischemic Heart Disease, FMF: Familial Mediterranean Fever (X^2): Chi-square test, (t): T-test.

Table (2): Laboratory data and inflammatory markers of the Vitamin D deficient group versus Sufficient/ Normal group.

	Vitamin D deficient group (n=67)	**Sufficient/ Normal group (n=27)**	**Test**	**P-Value**
Hemoglobin (gm/dL) Median ± SD	11.3±2.4	11.01±2.2	0.22	0.62
WBCs	7.6±3.4	7.4±2.2	0.495	0.8
Platelets	222(62-599)	204(132-390)	-0.57	0.57
Hematocrit	32.5±6.6	31.5±5.9	0.41	0.48
Total iron	65(10-263)	85(43.263)	-1.6	0.099
Ferritin	112(47-845)	88(3-1034)	-3.54	**0.0001***
TIBC	280(112-850)	270(112-370)	-1.9	0.058
Transferrin saturation	25(1.9-234.8)	30.9(15.9-234.8)	-1.53	0.13
Potassium	4.1±0.62	4.2±0.65	0.54	0.61
Sodium	139.1±3.6	140±3.4	0.69	0.25
Phosphorus	4.9±1.6	4.6±1.4	0.7	0.43
Calcium	8.7±0.97	8.9±1.09	0.27	0.58
Parathormone	314.6(6.3-1691)	207.9(6.8-1335)	-1.18	0.24
Create/ BUN	0.16±0.04	0.18±0.06	6.8	0.79
Albumin	3.9±0.45	3.9±0.29	1.08	0.57
Vitamin D	10.8±2.9	28.7±6.5	23.74	**0.00001***
CRP	11(1-166)	6.2(3-15)	-2.45	**0.014***
ESR	52(25-96)	22(5-43)	-7.3	**0.0001***
NLR	3.33±1.05	2.9±0.84	0.99	**0.003***
PLR	154.8±21.11	142.7±18.2	2.61	**0.011***

WBCS: white blood cells, TIBC: total iron binding capacity, BUN: Blood urea nitrogen, CRP: C- reactive protein, ESR: Erythrocyte sedimentation rate, NLR: Neutrophil lymphocyte ratio, PLR: Platelet lymphocyte ratio

Table (3): Correlation between Vitamin D & Inflammatory markers.

	Vitamin D	
	r	p
CRP	-0.322	**0.002***
ESR	-0.5	**0.0001***
NLR	-0.21	**0.006***
PLR	-0.327	**0.001***

CRP: C- reactive protein, ESR: Erythrocyte sedimentation rate, **NLR**: Neutrophil lymphocyte ratio, **PLR**: Platelet lymphocyte ratio

Table 4: Logistic regression analysis for predictors of Vitamin D deficiency among studied patients

Variable	Multivariate	
	p-value	OR (95% CI)
Age	0.703	1.01 (0.94 – 1.08)
ESR	**0.001**	0.78 (0.67 – 0.91)
CRP	0.979	1.00 (0.91 – 1.10)
NLR	0.166	0.31 (0.06 – 1.63)
PLR	0.356	0.98 (0.93 – 1.03)

CRP: C- reactive protein, **ESR**: Erythrocyte sedimentation rate, **NLR**: Neutrophil lymphocyte ratio, PLR: Platelet lymphocyte ratio.

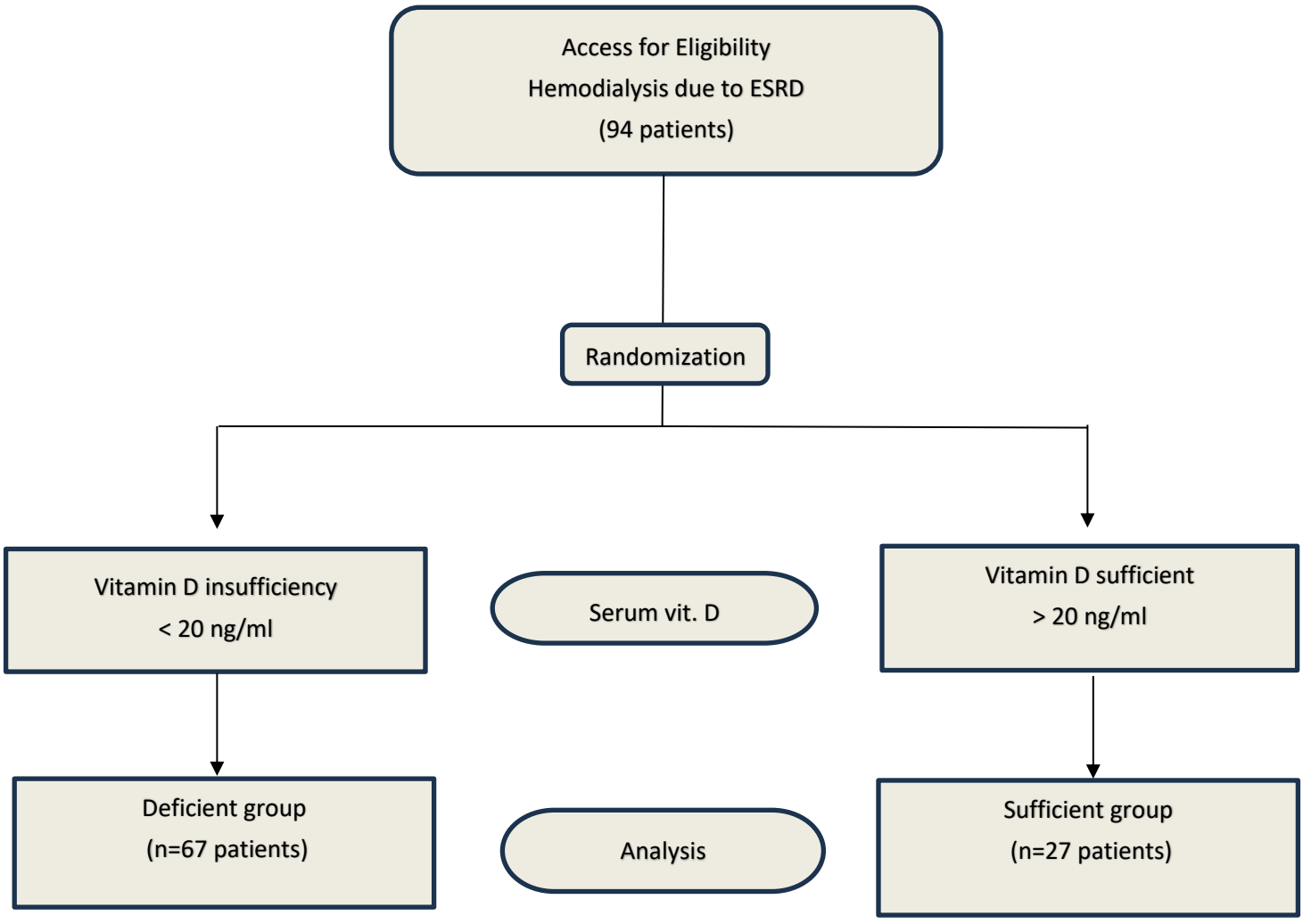
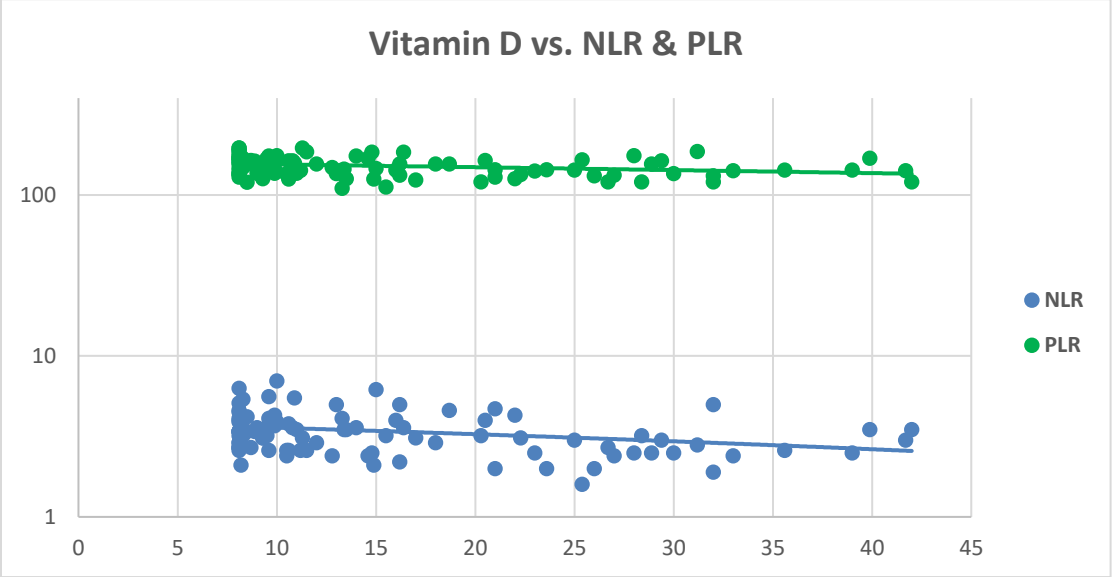
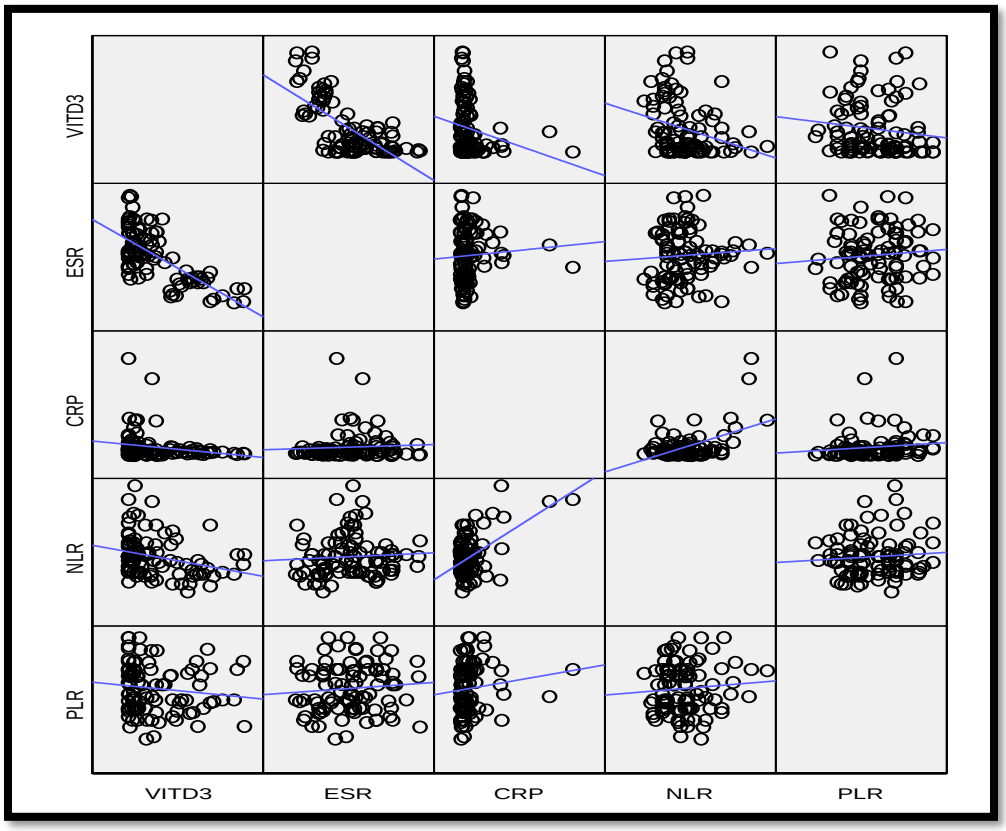


Figure (1): Flow chart for the patient selection



CRP: C- reactive protein, **ESR**: Erythrocyte sedimentation rate, **NLR**: Neutrophil lymphocyte ratio, **PLR:** Platelet lymphocyte ratio

Figure (2): Correlation between Vitamin D versus NLR & PLR.



CRP: C- reactive protein, **ESR:** Erythrocyte sedimentation rate, **NLR:** Neutrophil lymphocyte ratio, **PLR**: Platelet lymphocyte ratio, **VITD**#: Vitamin D3

Figure (3): Correlation between Vitamin D and Inflammatory markers.

DISCUSSION

Recent research has demonstrated that vitamin D can both prevent kidney damage (nephroprotection) and play a potential role in the CKD progression. Vitamin D has also been correlated with higher mortality rate among cardiovascular diseases, depression, autoimmune diseases, cancer, and chronic renal disease patients who experience poor mood and cognitive function [13].

More and more research points to vitamin D's direct and indirect effects on systemic inflammation and the regulation, proliferation, differentiation, and function of a wide range of cell types, including B-cells, T-cells, dendritic cells, and macrophages. It is possible to measure inflammation in hemodialysis patients using a number of indicators, including albumin, ferritin, high sensitivity C-reactive protein, tumor necrosis factor alpha, procalcitonin, cholesterol scores as well as interleukin-6 [14].

Because of its availability, cheap cost, and demonstrated accuracy, CRP is the inflammatory marker of choice in hemodialysis. In addition to these markers, NLR, PLR and MPV have recently been included as inflammatory markers in various diseases. In hemodialysis patients, the NLR and PLR in particular have shown promise as cost-effective and dependable markers of inflammation [15].

In the current study we found that the vitamin D deficient group included (50.7%) males and (49.3%) females, while the vitamin D sufficient group included (51.8%) males and (48.2%) females. The age of vitamin D deficient group ranged from 23 to 77 years with mean value 48.5±13.5 years, while for the sufficient group it ranged from 20 to 70 years with mean value 48.2±15.4 years with non-statistically significant differences between the both studied groups as regards age and gender.

This agreed with, Abdel-Messeih et al. [4] who reported that when comparing the two groups based on gender and age, no statistically significant difference was discovered (P<0.05).

Alternatively, Kara et al. [14] revealed a statistically significant variation between the two studied groups as regards age and gender. There was a correlation between vitamin D deficiency and both gender and age. Men had a 4.8-fold lower risk of vitamin D deficiency compared to women. This finding could be explained by the customary religious garb that women wear. Clothes that cover the body prevent the sun from converting vitamin D. A second explanation could be that women tend to have a higher percentage of body fat than men. It is likely that the elevated vitamin D storage in adipose tissue is responsible for the deficient vitamin D status seen in the female individuals. Yildirim et al. [16] reported that 25-(OH) D3 levels were statistically different across sexes, with females exhibiting noticeably lower levels than males. The higher incidence of osteoporosis and the fact that women get less sun exposure may explain why they make up the bulk of vitamin D deficient patients.

The current study showed non statistically significant between the two groups as regards hemoglobin level, white blood cells count, Hematocrit % and platelet count.

Similar findings were obtained by Kara et al. [14] who revealed a statistically insignificant variation between the two studied groups as regards hemoglobin level (P<0.05). Yildirim et al. [16] found white blood cell (WBC) levels did not correlate significantly between the vitamin D3 deficiency and normal groups in either men or women. Mohiuddin et al. [17] cleared that Vitamin D levels were not significantly related to hemoglobin levels or the need for erythropoietin.

The current findings clearly revealed that higher ferritin level was found among cases of the Vitamin D deficient group versus Sufficient/ Normal group with P-value 0.0001.

The current study findings were in accordance with Mogire et al. [18] who revealed that Children with low vitamin D levels (25(OH)D concentrations <50 nmol/L) were 98% more likely to have iron deficiency, while children with low iron levels were more likely to have low vitamin D levels overall. Decreased ferritin, hepcidin, and hemoglobin levels were linked to poor vitamin D status, which is in line with an escalating iron shortage. Thus, compared to non-inflamed children, children with inflammation had lower ferritin concentrations and higher 25(OH)D concentrations. Cihan et al. [19] stated that positive significant correlation was noted between serum ferritin levels and 25(OH)D levels (p<0.05).

Unlikely, Kara et al. [14] found insignificant difference found between the two studied groups as regards ferritin level. Higher ferritin levels were found among cases who had normal vitamin D than those who had vitamin D deficiency. This may be attributed to the fact that elevated ferritin levels can be caused by iron overload states such as hereditary hemochromatosis or secondary iron overload due to chronic transfusions or excessive iron supplementation. In these cases, ferritin levels may be increased regardless of vitamin D status. The current study revealed non statistically significant

variance between the two groups regarding albumin. Kara et al. [14] also corroborated our findings by noting no statistically significant variation in albumin levels between the two groups they studied. Blood albumin and vitamin D3 levels did not correlate significantly in male and female people who did not have renal failure, according to research by Yildirim et al. [16]. Patients with vitamin D3 insufficiency had reduced serum albumin levels, however this did not reach statistical significance.

Mohiuddin et al. [17] revealed that Vitamin D levels and serum albumin did not correlate, It goes against the findings of an earlier study by Matias et al. [20] that linked decreased vitamin D levels to reduced albumin levels in hemodialysis patients.

The present work revealed non statistically significant difference between the two groups as regards parathormone. In the same context, Abdel-Messeih et al. [4] found that among the earliest mineral metabolism issues in hemodialysis patients is secondary hyperparathyroidism. Reduced levels of active vitamin D, acidosis, and resistance to calcitriol all lead to elevated parathormone (PTH). Parathormone has the potential to harm several organs as it is a uremic toxin. Dialysis patients had considerably greater serum iPTH levels than the control group. The symptoms and quality of life of dialysis patients with secondary hyperparathyroidism are affected by PTH levels, according to Cheng et al. [21]. More and more research is linking elevated PTH levels to low-grade inflammation. It is still unclear what causes inflammation and how PTH is associated with it.

In the current study we found that vitamin D deficient group has shown Vitamin D level 10.8±2.9 vs. 28.7±6.5 in the sufficient group with statistically significant differences; P-value = 0.00001. The Vitamin D deficient group has shown higher levels of CRP, ESR, NLR and PLR compared to the sufficient group with statistically significant differences; P-value = 0.014, 0.0001, 0.003 and 0.011.

One possible explanation is that vitamin D deficiency disrupts the immune system's normal functioning and causes an inflammatory response dysregulation. Vitamin D plays a crucial role in modulating immune cell activity and suppressing excessive inflammation. In the absence of sufficient Vitamin D, immune cells may exhibit dysregulated responses, leading to increased production of inflammatory markers. An increased inflammatory response has been linked to vitamin D deficiency. Insufficient Vitamin D levels may fail to properly regulate the immune system's inflammatory activity, leading to an overactive response and increased production of inflammatory markers. This dysregulation can result in higher levels of CRP, ESR, NLR, and PLR [22].

This agreed with Kara et al. [14] who revealed a statistically significant difference between the two studied groups as regards CRP as well as NLR with higher levels of in vitamin D deficient group than the normal group. On the other hand, Esen et al. [23] found that Elevated ESR and CRP values have been linked to vitamin D insufficiency. Unlikely, Yildirim et al. [16] reported that in male and female patients who did not have renal failure, there was no significant association between CRP and ESR levels in the groups that had vitamin D3 deficiency and those that had adequate vitamin D3 levels.

In the current study we found that statistically significant negative correlation was found between Vitamin D and (CRP, ESR, NLR and PLR) with P-values= 0.002, 0.0001, 0.006 and 0.001.

This could be attributed to the fact that vitamin D deficiency has been linked to increased oxidative stress. Oxidative stress can promote inflammation and contribute to elevated levels of inflammatory markers. Inadequate Vitamin D levels may impair the body's antioxidant defenses, leading to an imbalance between oxidative stress and antioxidant capacity, which can contribute to heightened inflammation. Vitamin D deficiency may disrupt feedback mechanisms that regulate inflammation. Vitamin D has been shown to interact with various signaling pathways involved in inflammation, including those related to the production and regulation of inflammatory markers. Insufficient Vitamin D levels may disrupt these feedback mechanisms, leading to an imbalance favoring increased inflammation and elevated levels of inflammatory markers [24]. This was in accordance with, Kara et al. [14] who stated that the correlation analysis showed a small but statistically significant inverse relationship between the levels of serum 25(OH)D and the inflammatory markers CRP ($r=-0.205$, $p=0.020$) and NLR ($r=-0.219$, $p=0.013$). Likewise, there was a slight but significant inverse relationship between the PLR and serum 25(OH)D levels ($r=-0.182$, $p=0.039$). Abdel-Messeih et al. [4] reported that Hemodialysis patients' serum CRP levels were significantly greater than controls. Mirchi et al. [12] studied hemodialysis and peritoneal dialysis patients' 25(OH)D levels in connection to inflammatory markers and discovered that those with lower levels of 25(OH)D had

considerably greater levels of NLR and hsCRP. Between 25(OH)D and hsCRP, a weak negative inverse connection was also discovered. The PLR and NLR were shown to be significantly associated with 25(OH) D levels in the retrospective study conducted by Akbas et al. [25]. There is a strong inverse correlation between 25(OH)D insufficiency and CRP levels, as shown by Amer et al. [26]. Although they could not find a causal association, Liefaard et al. [27] demonstrated that vitamin D levels were inversely related to CRP levels. Eleftheriadis et al. [28] found that vitamin D levels were inversely related to CRP in hemodialysis patients. On the other hand, Mohiuddin et al. [17] tested hemodialysis patients for inflammatory markers and vitamin D levels; they discovered no linkage between the two. Finding no statistically significant relationship between vitamin D and C-reactive protein levels, Yildirim et al. [16] and Grzanka et al. [29] concluded that according to inflammatory indicators including C-reactive protein, enzyme-linked immune soluble protein, or leukocyte counts were not linked to vitamin D3 insufficiency.

LIMITATIONS

Since this study is a small-scale, cross sectional study, there is bound to be some selection bias in the results. Adjusting for all potential confounders, such as the unknown intervention outside of the nephrology unit, is challenging. Second, our findings only apply to the Egyptian population. Additional further research, such as randomized controlled trials to evaluate the effect of vitamin D3 supplementation on inflammatory markers in hemodialysis patients. This can provide insights into the potential anti-inflammatory properties of vitamin D3 and its impact on the inflammatory response in this population.

Author contribution: All authors contributed to the study. MHZ was responsible for selecting the subject, AAG, RKS were accountable for laboratory revisions and analysis, AMAB was responsible for data collection, statistical analysis, and initial writing, and TMG was responsible for collecting the data of the studied cases and all shared for the formulation of the study design, editing, revision, and preparation of the final manuscript

CONCLUSIONS

This study sheds light on the significant correlation between vitamin D deficiency and inflammatory markers among hemodialysis patients. Our findings underscore the high prevalence of vitamin D insufficiency among CKD patients, and its association with elevated levels of inflammatory markers such as CRP, ESR, NLR, and PLR. The negative correlation observed between vitamin D levels and inflammatory markers suggests a potential role for vitamin D in modulating the inflammatory response in hemodialysis patients.

These findings have important clinical implications, highlighting the need for routine monitoring of vitamin D levels and early intervention to address deficiency in hemodialysis patients. Furthermore, strategies aimed at optimizing vitamin D status may help mitigate inflammation and its associated complications in this vulnerable population.

Conflict of Interest: None.
Financial Disclosure: None.

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Figure Legend

Figure (1): Flow chart for the patient selection

Figure (2): Correlation between Vitamin D versus NLR & PLR.

Figure (3): Correlation between Vitamin D and Inflammatory markers.

Citation

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