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Vitamin D Levels in Chronic Kidney Disease: A Cross-Sectional Study Conducted in Community Based Medical College, Bangladesh (CBMC,B) Hospital

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Abstract

Patients with chronic kidney disease (CKD) have a high prevalence of vitamin D deficiency; such a deficiency can exacerbate the CKD and related complications. The population in Bangladesh gets exposure to sunlight radiation; however, levels of vitamin D levels could be affected due to factors like skin color, dressing etiquette, etc. This cross-sectional study was done in Community Based Medical College, Bangladesh (CBMC,B) Hospital, from January 2021 to January 2022, to determine the prevalence vitamin D deficiency among of CKD patients and to examine association between vitamin D and CKD classification. A total of 120 patients who had been diagnosed with CKD (stages 3-5) were included in this study. Data on age, gender, past medical history, and blood samples for serum creatinine and 25-hydroxyvitamin D levels were obtained. The eGFR was estimated from the CKD-EPI formula. Serum (>30 ng/mL) levels were classified into a normal range, which was greater than 30 ng/mL, insufficient, between 10 and 30 ng/mL, and deficient if lower than 10 ng/mL. The mean age of the study participants was 53.25±7.6 years, with 66.7% male. Vitamin D deficiency was found in 25% of patients, while 35.8% had insufficiency. A significant inverse relationship was observed between CKD stages and mean vitamin D levels ($p<0.00001$). Mean vitamin D levels decreased from 33.53±6.24 ng/mL in stage 3a to 12.36 ± 3.43 ng/mL in stage 5. Our study gives an indication that vitamin D deficiency and insufficiency are considerable among the CKD patients in Bangladesh, and it correlates significantly with the severity of kidney disease. Hence, we recommend vitamin D monitoring and possibly supplementation in the context of CKD, especially in the late stages.

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Introduction

Chronic kidney disease (CKD) has become a major public health problem that is being experienced across the world, with current trends indicating higher prevalence and incidence rates.[1] As with much of the developing world, Bangladesh has experienced a growing CKD burden, which remains a large source of morbidity and mortality.[2] This is a condition in

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which there is a gradual decline in kidney function over periods of time, and it imposes a variety of complications and metabolic disorder. Vitamin D is a fat-soluble vitamin important in calcium balance and bone metabolism and has received much attention recently for its involvement in CKD outcomes.[3] Kidneys are important in vitamin D processing by transforming vitamin D stored form, 25-hydroxyvitamin D, to active form, 1,25-dihydroxyvitamin D. Over time, as renal function deteriorates in CKD, these conversion steps will be affected, and the patient is at risk of developing vitamin D deficiency.[4] In addition to its classic functions, vitamin D has been ascribed a multitude of other roles, namely antireumatic, immunomodulating, protection of the cardiovascular system, glucose homeostasis, and more, all of which are highly critical within CKD populations.[5] Multiple cross-sectional studies have shown low vitamin D levels in CKD patients; the range of prevalence was between 35% and 80%, depending on the population studied and stage of renal disease. It is still unclear whether vitamin D status is differently associated with CKD stages and whether this association may orient patient care.[6]

In Bangladesh, hypovitaminosis D ranged from 21% to 75% for infants, children, and adolescents, 38% to 100% percent for premenopausal women, 66% to 94.2% for pregnant women, 6% to 91.3% for adult men and 82% to 95.8% for postmenopausal women.[7] What comes as a shock is that in Bangladesh, where people get exposed to the sunlight throughout the year, thus receiving adequate amounts of vitamin D from the sun, one would be surprised that this disease is common.[8] Nevertheless, there are some predisposing factors of vitamin D deficiency, for instance, skin pigmentation, cultural practices that could hinder one from getting exposed to the sun, and diet as well.[9] Knowledge of the frequency and risk factors of vitamin D deficiency in Bangladeshi CKD patients is important for several reasons. Firstly, it could help in enlightening clinical practice regarding computed tomography screening and also supplementation of vitamin D in this vulnerable group. Secondly, due to plausible effects of vitamin D on progression of CKD and its associated complications, patients at risk could be detected with the overall purpose of enhancing their prognosis.[10,11]

This research is an attempt to fill this knowledge gap by evaluating the prevalence of vitamin D deficiency/insufficiency in a CKD patient in a community-based medical college hospital in Bangladesh. Further, we want to examine the correlation of vitamin D levels with the stage of kidney disease, determined by estimated glomerular filtration rate (eGFR). We will also explore whether there is an interaction between vitamin D status and demographic characteristics and other comorbid conditions, as well as the aetiologies of CKD in this cohort. Knowledge of these connections could be used within practical recommendations for using vitamin D to enhance clinical outcomes in patients with CKD, as well as for advancing scholarly understanding of vitamin D processing in the context of CKD in Bangladesh within the context of its climate, culture, and healthcare system.

Methods

This hospital-based cross-sectional study was conducted at Community Base Medical College, Bangladesh (CBMC,B) hospital, from January 2021 to January 2022. Patients were selected based on the following criteria:

Inclusion Criteria:

1) Adult patients (age ≥18 years) with diagnosed CKD stages 3-5 (eGFR <60 mL/min/1.73 m^2); and
2) Patients attending the hospital for routine follow-up or dialysis.

Exclusion Criteria:

1) Patients already on vitamin D supplementation;
2) Patients with chronic debilitating conditions or terminal illness; and
3) Patients on medications known to affect vitamin D metabolism (e.g., steroids, anticonvulsants).

A structured questionnaire was used to get the demographic data, medical history, and lifestyle data, if any, of the participants. Serum creatinine and 25(OH) Vitamin D levels were measured from the blood samples, and the eGFR was derived from the CKD-EPI formula. Hypovitaminosis D was defined based on serum 25(OH) vitamin D levels and the following classification: normal (>30 ng/mL), insufficient (10–30 ng/mL), and deficient (<10 ng/mL). The collected data were analyzed by using descriptive statistics, analysis of variance (ANOVA), and correlation analysis. Statistical significance was determined when p value <0.05. Statistical analysis was done by using Statistical Package for the Social Sciences (SPSS) version 18.0. This study was approved by the Ethical Review Committee of Community Base Medical College, Bangladesh (CBMC,B), Mymensingh, Bangladesh.

Results

A total of 120 patients with CKD were selected for this study. The participants' average age was 53.25±7.6 years, with a majority of the males (66.7%). 50% of patients had hypertension, and 48% had diabetes mellitus. In the present series, the mean duration of kidney disease was 5.4±1.5 years. The leading identifiable etiologies of CKD in this study were diabetes mellitus (32.5%), chronic interstitial nephritis (24.17%), and hypertension (19.17%) chronic Glomerulonephritis (14.17%) and obstructive uropathy (5.83%) (Table-I).

Table-I: Demographic and clinical characteristics of the CKD patients (N=120)

Characteristic	**Frequency**	**Percentage**
Age Group (years)		
41-50	40	33.33
51-60	20	16.67
61-70	24	20.0
>70	36	30.0
Mean Age (years)	53.25 ± 7.6	
Sex		
Male	80	66.7
Female	40	33.3
Male-Female ratio	2:1	
Comorbidities		
Hypertension	50	41.67
Diabetes	48	40.0
Cardiovascular Disease	44	36.67
Causes of CKD		
Diabetic Kidney Disease	39	32.5
Chronic Interstitial Nephritis	29	24.17
Hypertensive Nephropathy	23	19.17
Chronic Glomerulonephritis	17	14.17
Obstructive Uropathy	7	5.83
Mean duration of CKD (years)	5.4±1.5	
Smoking Status		
Smokers	49	40.83
Non-smokers	71	59.17

120 patients were categorized into CKD stages: 8.33% in stage 3a, 16.67% in stage 3b, 44.17% in stage 4, and 30.83% in stage 5. Table-II illustrates the distribution of the patients' vitamin D levels according to stages of CKD. The prevalence of vitamin D deficiency (<10 ng/mL) was 25%, while 35.8% had insufficient levels of vitamin D (10-30 ng/mL). Normal vitamin D levels (>30 ng/mL) were observed in 39.2% of patients (Table-III). A significant association was observed between CKD stage and mean vitamin D levels ($p<0.00001$). Mean vitamin D levels decreased as CKD stage advanced, i.e., 33.53±6.24 ng/mL in stage 3a, 25.71±3.94 ng/mL in stage 3b, 21.62±7.47 ng/mL in stage 4, and 12.36±3.43 ng/mL in stage 5 (Table-IV).

Table-II: Distribution of the patients according to CKD stages (N=120)

CKD stage	Mean GFR (mL/mn/ 1.72 m^2)	Vitamin D status		
		Normal	Insufficient	Deficient
Stage 3a (n=10)	55.3±4.7	10 (100%)	-	-
Stage 3b (n=20)	38.1±3.8	10 (50%)	5 (25%)	5 (25%)
Stage 4 (n=53)	22.9±7.3	17 (32.08%)	25 (47.17%)	11 (20.75%)
Stage 5 (n=37)	10.6±2.8	10 (27.03%)	13 (35.14%)	14 (37.83%)

Table-III: Distribution according to Vitamin D status in CKD patients (N=120)

Vitamin D status	Frequency	Mean±SD
Normal (>30 ng/mL)	47 (39.17%)	35.0±5.0
Insufficiency (10-30 ng/mL)	43 (35.83%)	20.0±5.0
Deficiency (<10 ng/mL)	30 (25%)	8.0±2.0

Table-IV: Distribution of mean vitamin D levels according to CKD staging. (N=120)

CKD Stages	Vitamin D levels (ng/mL)	p-value
Stage 3a (n=10)	33.53±6.24	0.00001[S]
Stage 3b (n=20)	25.71±3.94	
Stage 4 (n=53)	21.62±7.47	
Stage 5 (n=37)	12.36±3.43	

Data were expressed as Mean±SD; p-value reached from one way ANOVA (post hoc); S =Significant

Discussion

Our study furnishes significant information about the vitamin D status of patients suffering from chronic kidney disease (CKD) in a Bangladeshi population. Consequently, the identified deficiencies and insufficiency rates show that 60.83% of the CKD patients in our study had suboptimal vitamin D levels below 30 ng/mL. These rates are similar to the findings of some of the previous studies – Satirapoj *et al.*[12] working with Thai participants, where a prevalence of 65% was observed, while Bellizzi *et al.*[13] studied on Italian population and found a prevalence of 71%. Mean vitamin D levels have also been found to be inversely related to the stage of CKD, as documented earlier. In concordance with our results, where the mean vitamin D level was found to be lower in stages IIIb, IV, and V (12.36±3.43 ng/mL in stage V and 33.53±6.24 ng/mL in stage IIIa), Ghosh duo[14] also reported that vitamin D level is positively associated with eGFR in their study from Kolkata, India. Likewise, Hu *et al.*[15] studied patients with CKD in Brazil and discovered that 80% of patients in CKD stages 4-5 suffered from vitamin D deficiency as compared to 66% in CKD stages 2-3. This trend has been associated with a progressive nature of vitamin D

deficiency with kidney function, most probably caused by the reduced 1α-hydroxylase activity and a subsequently decreased synthesis of 1,25-dihydroxyvitamin D. Notably, while Bangladesh gets plenty of sunlight, vitamin D deficiency remains disturbingly high in our population of CKD patients. This fact was described in other sunny countries; for instance, in a study done by Abdul Razzaque *et al.*[16], 70.8% of patients with CKD had deficiency of vitamin D. This implies that aetiology beyond inflammation secondary to sun exposure may partly determine vitamin D status in CKD patients due to the diminished ability to metabolize vitamin D because of impaired kidney function. Consequently, cultural factors, diets, and skin color, as mentioned by Nimitphong & Holick[17], in their global view on the status of vitamin D, may have also played their part in the variations recorded herein. The age and sex distribution of our study population was equally consistent with that of other CKD populations in South Asia, with a mean age of 53.25 years and 66.7% males. Similarly, another study done by Kumar *et al.*[18] from India described the demographic characteristics of their CKD population as comparable to the current study results, with a mean age of 50.1 years and 70.3% male. The high frequency of hypertension (50%) and diabetes (48%) as cofactors in our study also supports the fact that these conditions play a large role in CKD development in Bangladesh, as indicated by the Global Burden of Disease Study. In agreement with our study, diabetic kidney disease emerged as the most frequent cause (39%) of CKD. Report other studies conducted in other developing countries. For instance, Duan *et al.*[19] concluded that diabetic kidney disease was responsible for 19.1% of the cases of CKD in China. But our prevalence is higher, which may be due to the fact that the burden of diabetes is rising in Bangladesh. The mean duration of kidney disease computed from our subjects was 5.4±1.5 years, and this sets the stage for CKD progression and its effects on vitamin D levels. This period is comparable with that used by Levin *et al.*[20] in their prospective cohort study, in which they noted altered mineral metabolism kinetics averagely over a median of 5.5 years. Several limitations need to be addressed in the present study: First, data were collected from a single center; second, the study was cross-sectional in nature, and as such, no causal inferences could be made.

Moreover, we also did not evaluate the levels of vitamins specifically in the diet or sun exposure practices that could complement and explain the presented results. These limitations are not unique to this work and have been reported in other studies, including that of Satirapoj *et al.* It is therefore essential for higher-center prospective studies to be conducted to provide a comprehensive view of the dynamics of vitamin D status in CKD progression.

Finally, the findings of the present study add to preexisting literature examining the CKD patient groups and indicating that vitamin D deficiency is expressed independently of the quantity of sunshine they receive. Such results emphasize the need for a routine assessment of kidney function and vitamin D level among CKD patients in order to implement possible supplementation measures. More tailored and comparison prospective cohort studies and randomized control trials need to be conducted in order to determine the effects of vitamin D supplementation on CKD in different populations.

Conclusion

Our data suggests that vitamin D deficiency and insufficiency are very common among CKD patients in Bangladesh and also confirmed that vitamin D levels were adversely affected by the severity of CKD. These observations underscore the importance of fundamental evaluation of the vitamin D level in patients with CKD, most importantly those who are in the advanced stage. Thus, further long-term research should be conducted to establish the relationship between vitamin D status and the prognosis of CKD and its progression in such patients. Future research should focus on identifying effective strategies of increasing vitamin D intake among CKD patients in Bangladesh, which should take into account the environmental and cultural factors with potential influence on vitamin D levels.

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