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Original Article

Magnitude and Determinants of Biochemical Mineral Bone Disease Abnormalities among Predialysis Chronic Kidney Disease Patients in Tikur Anbessa Specialized Hospital

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Abstract

Introduction: *Mineral bone disease (MBD) abnormalities are common complications in patients with chronic kidney disease (CKD). The MBD abnormalities are known to be associated with increased morbidity and mortality. In spite of their importance, there are limited data on CKD-MBD abnormalities in Ethiopia. This study looked in to the magnitude and determinants of biochemical CKD-MBD abnormalities among predialysis CKD patients.*

Methods: *A cross-sectional study was conducted from July 1 to September 30, 2020 in Tikur Anbessa specialized hospital. One hundred patients who had had follow-up for at least 6 months with an estimated glomerular filtration rate (eGFR)<60ml/min/1.73m^2 using CKD-EPI equation without race factor were included. Serum calcium, albumin, phosphorus and PTH levels were determined. Demographic and clinical data were collected using a structured questionnaire. IBM SPSS software version 26 was used for analysis. Descriptive statistics was used to describe the demographic and clinical data. Chi-square was used to identify correlations between the grouped variables. The analysis for comparison among three or more categories was done using one-way ANOVA and Tukey post hoc test. Linear correlation and multiple regression analysis were used to identify associations between clinical and biochemical findings.*

Results: *Among the 100 patients included in this study; the median age was 58 years with IQR of 73. The male to female ratio was 2.7:1. Patients in stages 3a, 3b, 4 and 5 CKD accounted for 23%, 29%, 26% and 22%, respectively. The main causes of CKD were diabetes and hypertension. Among these patients, 31% had hyperphosphatemia, 36% had hypocalcemia, and 89% had hyperparathyroidism. The mean values of calcium in CKD stage 3a,3b,4 and 5 were 8.91, 8.81, 8.7 and 7.14mg/dl, respectively; where as those of serum phosphorus were 3.58, 3.83, 3.83 and 5.53mg/dl, respectively. The median values of PTH were 140.6, 137.2, 274.05 and 440.85Pg/ml, respectively. Estimated GFR correlated negatively with serum parathyroid hormone (PTH) level but correlated positively with serum calcium level. In addition, serum calcium level is inversely associated with diabetes and diastolic blood pressure whereas serum PTH is directly associated with diastolic blood pressure and female sex.*

Conclusion: *Hypocalcemia, hyperparathyroidism, and hyperphosphatemia are common biochemical CKD-MBD abnormalities among predialysis CKD patients in the renal clinic of Tikur Anbessa specialized hospital. Monitoring for CKD-MBD should begin earlier and treatment should be initiated accordingly to improve patient outcome.*

Keywords: *Chronic Kidney disease; Mineral bone disease; Hypocalcemia; hyperparathyroidism; hyperphosphatemia*

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Introduction

Chronic kidney disease (CKD) constitutes a public health problem estimated to affect more than 10% of the global population, and the prevalence of which has increased in recent years. (1) The pooled prevalence of CKD is 10.1% in the general population, 24.7% in hypertensive, and 16.6% among diabetes mellitus patients in Africa(2). The prevalence of CKD was 26% among hypertensive and diabetes mellitus patients in Ethiopia (3). According to the 2012 KDIGO guideline, CKD is defined as abnormalities of kidney structure or function, present for >3 months, with implications for health (4). It also classifies it according to severity from stages 1-5.

Bone mineral metabolism abnormalities that occur in

CKD patients are recently defined in KDIGO guidelines as CKD mineral and bone disorder (CKD-MBD)(5). CKD-MBD is a systemic disorder that is characterized by abnormal calcium, phosphorous, PTH, and Vitamin D metabolism, which, in addition to affecting the skeletal system, is related to the appearance of cardiovascular and soft tissue calcifications that in turn are associated with cardiovascular pathologies in patients with CKD (8,9). The biochemical abnormalities are common in CKD and are the primary indicators by which the diagnosis and management of CKD-MBD is made (4, 26).

Bone abnormalities are found almost universally in patients with CKD stage 5 and in majority of patients with stages 3-5 (4,23). The bone mineral metabolism abnormalities start during first stages of CKD as renal function decreases, long before the need for renal replacement therapy and can positively or negatively be influenced by the treatment strategy employed (4). Elevated PTH and hyperphosphatemia were recently identified as risk factors for mortality in dialysis patients(6,7).Elevated serum phosphate levels were independently associated with increased mortality risk among this population of patients with CKD(8). Patients with CKD-MBD are at an increased risk for bone fractures and increased CVD mortality (24, 25). As such, it is recommended that attending physicians monitor and control biochemical parameters early in the development of CKD, before the need for dialysis (5).

Because of the paucity of data in Ethiopia, an urgent need for a study in this area was felt to fill the knowledge gap. Therefore, the purpose of this study was to identify the prevalence, severity and determinants of MBD anomalies in predialysis chronic kidney disease patients.

Method

Study Setting and Design

This is a cross-sectional study which was conducted in the renal clinic of Tikur Anbessa specialized hospital located in Addis Ababa, Ethiopia. The hospital is one of the largest referral teaching hospitals in the country. The hospital provides both inpatient and outpatient services. The renal clinic gives service to wide variety of patients with renal problems; CKD comprising the majority of the cases. The study was conducted from July 1 to September 30, 2020.

Study population

The source population included consecutive patients who were ≥ 18yrs of age and have eGFR of < 60 ml/min/1.73m2 for at least 03 months with follow-up of at least 06 months. Those patients who had Stage 3-5 CKD by estimating GFR using CKD-EQI equation without race factor were included in the study. Patients on dialysis, patients who had primary hyperparathyroidism or undergone parathyroid surgery and patients who were taking Calcium supplements over the counter were excluded. One hundred consecutive patients who fulfilled the criteria were selected for the study after informed consent was obtained.

The sample size was calculated using 82 % as prevalence of MBD abnormalities among CKD patients from study done in India (27). A 95 % level of certainty and a margin of error of 5% were assumed. A single population proportion formula given below was used to calculate the sample size.

$$n = \frac{(Z\ \alpha/2)^2\ P(1-p)}{d^2} = 227$$

We deducted the sample size by finite population correction formula because our source population was less than 10,000 patients diagnosed with MBD, and the calculated sample size was larger than 5% of the source population.

n'=no/1+ no/N
Where -no- calculated sample =227
N-total population=150
n'-final population
n'=no/1+no/N=227/1+227/150=91
The corrected sample size was 91.

Sample size for secondary objective

The sample size for the second objective was calculated using Epi info version 7 with assumptions of 95% confidence level and power of 80%.

The calculated sample size for the first objective (91) was greater than sample size calculated for that of the second objective. Therefore adding 10 % non-response rate 100 was the minimum sample size required for this study. The sample size calculation is shown in the table below.

Table 1: sample size calculation

Variables	CI	Power	Unexposed: exposed	Control with exposure (%)	Cases with exposure (%)	COR	Sample size	Reference
Stage of CKD	95%	80	1	12.4	87.6	49.9	18	(27)

Data collection:
Data were collected using structured questionnaire through an interview, followed by chart review and blood sample collection. Five to ten ml of venous blood samples were taken using aseptic techniques and sent to Ethiopian public health institute laboratory for Serum Calcium, Phosphorus, albumin and PTH determination. Finally, to identify the management practice and CKD risk factors the patients' charts were revised.

Variables:
The dependent variables were Serum Calcium, Serum Phosphate and Serum PTH; whereas Age, sex, BMI, Blood pressure, place of residence, educational status, marital status, occupation, medical comorbidity, smoking history, eGFR, Cause of CKD and urine dipstick protein were the Independent Variables.

Operational definitions: In accordance with KDIGO guidelines:

CKD: serum creatinine level above laboratory baseline for sex for more than 03 months (4).

Stage 1 CKD: Estimated GFR above 90 ml/min/1.73m2
Stage 2 CKD: Estimated GFR b/n 90 and 60 ml/min/1.73m2
Stage 3A CKD: Estimated GFR b/n 59 and 45 ml/min/1.73m2
Stage 3B CKD: Estimated GFR b/n 44 and 30 ml/min/1.73m2
Stage 4 CKD: Estimated GFR b/n 29 and 15 ml/min/1.73m2
Stage 5 CKD: Estimated GFR less than 15 ml/min/1.73m2
Stage 5D CKD: Patients who have started dialysis

Mineral bone disease (MBD) abnormalities: Any patient who has either hypocalcemia, hyperphosphatemia or hyperparathyroidism (4).
Hypocalcemia: Corrected total calcium<8.5mg/dl (4)
Hypercalcemia: Corrected total calcium >10 mg/dl (4)
Hypophosphatemia: Phosphorus <2.5 mg/dl (4)
Hyperphosphatemia: Phosphorus >4.5mg/dl (4)
Hypoparathyroidism: Intact parathyroid hormone (iPTH)<15 pg/ml (4)
Hyperparathyroidism: Intact parathyroid hormone iPTH >65 pg/ml (4)

Smoking: Any patient who has smoked any number of cigarettes in the past or who, at the time of the survey, smoke either every day or some days.

BMI: was categorized as underweight (BMI<18.5); normal (BMI 18.0–24.9 kg/m2); overweight (BMI 25.0–29.9 kg/m2), or obese (BMI ≥30 kg/m2).

Data Analysis: The filled questionnaire was checked for incompleteness and Data were entered in SPSS version 26 for analysis. Descriptive statistics was used to describe the demographic and clinical data. Descriptive analysis of quantitative parameters was expressed as means, median and standard deviation. Chi-square was used to find the correlations between the stage of CKD and grouped biochemical results as significant if P- value is < 0.05. The analysis for comparison among three or more categories was done using one-way ANOVA and Tukey post hoc test. Linear correlations and Multiple linear regression analysis were used to identify relationships between clinical and biochemical findings.

Results
Patient's baseline characteristics
A total of 100 CKD patients were included in this study. The majority were males (73%), from Addis Ababa (86%) and in the age group of 50-64 (40%). Most of the patients had diabetes (40%) and Hypertension (25%). The median age was 58 years with IQR of 73 (Table 2). Among the 100 patient's that were included in this study during their follow-up of the previous 6 months, urine protein was determined in 97%, serum calcium in 61%, serum Phosphorus in 62% and serum PTH in 15%. Abdominal U/S was documented in only 55% and urine dipstick for protein in 97% of the patients since the start of their follow-up (Table 2). Even though treatment for CKD -MBD abnormalities was indicated for 58% of Hyperphosphatemia, 58.3% of Hypocalcemia and 12.3% of Hyperparathyroidism patients, only 19.3%,20% and 5.6%, respectively started the treatment (Table 3).

Table 2. Demographic and clinical characteristics of patients with CKD attending the adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020.

Characteristics	Category	Frequency (no = %)
Sex	Male	73
	Female	27
Age	18-34	14
	35-49	17
	50-64	40
	65-79	27
	≥ 80	2
Address	Addis Ababa	86
	Oromia	11
	Amhara	3
Marital Status	Single	16
	Married	74
	Divorced	6
	Widowed	4
Educational Status	Unable to read and write	11
	Able to read and write	13
	Primary education	23
	Secondary education	26
	College and above	27
Smoking	Never	94
	Former	5
	Current	1
Comorbidity	Family History of CKD	10
	Coronary Artery disease	8
	Heart failure	9
	Cerebrovascular disease	6
	PAD	3
Stage of CKD	3a	23
	3b	29
	4	26
	5	22
Cause of CKD	Hypertension	25
	Diabetes	40
	Chronic glomerulonephritis	6
	Polycystic Kidney disease	4
	Obstructive Uropathy	8
	Others[1]	17
BMI	Underweight	8
	Normal Weight	42
	Overweight	37
	Obese	13
Blood Pressure	Normal BP	34
	High Normal BP	11
	Grade 1 Hypertension	17
	Grade 2 Hypertension	8
	Grade 3 Hypertension	3
	Isolated systolic Hypertension	27

[1]Includes Unknown causes, TDF Nephropathy, Lupus Nephritis, Chronic Pyelonephritis 2o Reflux nephropathy and Tuberous Sclerosis

Table 3: Abdominal Ultrasound and urine dipstick finding among patients with stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020.

	Finding	Frequency
Abdominal Ultrasound (N=55)	Normal Kidney Size	21 (38.1%)
	Shrunken Kidney	21 (38.1%)
	Polycystic Kidney	4(0.7%)
	Hydronephrosis	6(0.12%)
	Others[1]	3(0.05%)
Urine Dipstick(N=97)	Negative	26 (26.8%)
	Trace to +1	12 (12.3%)
	+2 or more	59 (60.8%)
	Negative	26 (26.8%)

[1] Congenital renal anomaly

Table 4: Frequency of patients that need MBD treatment and are on treatment among those with stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020.

MBD abnormality	Frequency	Needs Treatment	Frequency	On Treatment
Hyperphosphatemia	31	Phosphorus >5mg/dl	18 (58%)	6 (19.3%)
Hypocalcemia	36	Calcium <8mg/dl	21 (58.3%)	8 (20%)
Hyperparathyroidism	89	PTH ≥ 9x ULN	11 (12.3%)	5 (5.6%)

Laboratory results

Among the patients included in this study, 36% were Hypocalcemic, 31% were Hyperphosphatemic and 89% developed secondary Hyperparathyroidism. Hyperparathyroidism was the most common mineral bone abnormality observed in the present study. There was a gradual increase in the prevalence of Hypocalcemia, Hyperphosphatemia and Hyperparathyroidism as the severity of CKD increases. (Tables 5 and 6).

Table 5. Laboratory Results of patients with Stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020.

Parameter		Stage of CKD					P-alue
		3a (n=23)	3b (n=29)	4 (n=26)	5 (n=22)	Total	
Calcium	Mean ± SD (mg/dl)	8.91±0.48	8.81±0.92	8.7±0.49	7.14±1.62		
	Hypocalcemia	5 (21.7%)	6 (20.7%)	10 (38.5%)	15 (68.2%)	36(36.0%)	0.01
	Normal	17 (73.9%)	21 (72.4%)	16(61.5%)	7(31.8%)	61(61.0%)	
	Hypercalcemia	1 (4.3%)	2(6.9%)	0	0	3 (3.0%)	
Phosphorus	Mean ± SD (mg/dl)	3.58±0.51	3.83±1.25	3.83±1.03	5.53±2.0		
	Hypophosphatemia	0	1 (3.4%)	3 (11.5%)	0	4 (4.0%)	<0.001
	Normal	22 (95.7%)	21(72.4%)	15(57.7%)	7(31.8%)	65(65.0%)	
	Hyperphosphatemia	1(4.3%)	7 (24.1%)	8 (30.8%)	15(68.2%)	31(31.0%)	
PTH	Median (IQR) (pg/ml)	140.6(802.9)	137.2 (942.25)	274.05 (1064.06)	440.85 (1855.95)		
	Normal	2(8.7%)	8(27.6%)	1(3.8%)	0	11(11.0%)	0.006
	Hyperparathyroidism	21(91.3%)	21(72.4%)	25(96.2%)	22	89(89.0%)	
	PTH ≥2x of ULN	13 (61.9%)	15 (71.4%)	23 (92%)	19 (86.3%)	70 (78.6%)	0.003
	PTH ≥9x of ULN	1 (4.3%)	2 (6.9%)	1 (3.8%)	7 (31.8%)	11 (12.3%)	

There was a statistically significant difference in PTH, calcium and phosphorus levels (F (3,96) = 9.383, p = <0.0001) between the stages of CKD as determined by one-way ANOVA. A Tukey post hoc test revealed that hyperparathyroidism, hypocalcemia and hyperphosphatemia were significantly higher in stage 5 (p = <0.001) compared to those at stage 3. There was no statistically significant difference between stage 3a, 3b and stage 4 groups.

Table 6: Frequency of various mineral metabolism disorders among patients with stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020.

Parameter	Mean±SD
Creatinine (mg/dl)	3±2.02
eGFR (ml/min/1.73m²)	29.6±14.70
Albumin (g/dl)	4±0.56
Corrected total Calcium (mg/dl)	8.4±1.18
Phosphorous (mg/dl)	4.1±1.47
Total PTH (pg/ml)	321.3 (4.9x)

.**Correlation of serum PTH, calcium and phosphorus with patient characteristics**

In the study using linear correlations, patients' serum total calcium was found to have direct correlation with eGFR (r= 0.476, P <0.001) and age (r=0.224, P=0.025) as well as inverse correlation with phosphorus (r= -0.5, P <0.001), PTH (r= -0.341, P = 0.001) and diastolic blood pressure (r= -0.246, P = 0.014). Additionally, serum Phosphorus was found to have direct correlation with PTH (r= 0.324, P=0.001), Urine dipstick (r= 0.161, P =0.044) and inverse correlation with GFR (r= -0.405, P<0.001), and Age (r= -0.229, P= 0.022) (Figure 1 and 4). Whereas serum PTH was found to have direct correlation with diastolic blood pressure (r= 0.25, P = 0.012), and inverse correlation with GFR (r= -0.441, P<0.001), and Age (r= -0.4, P<0.001) (Figure 2 and 3).

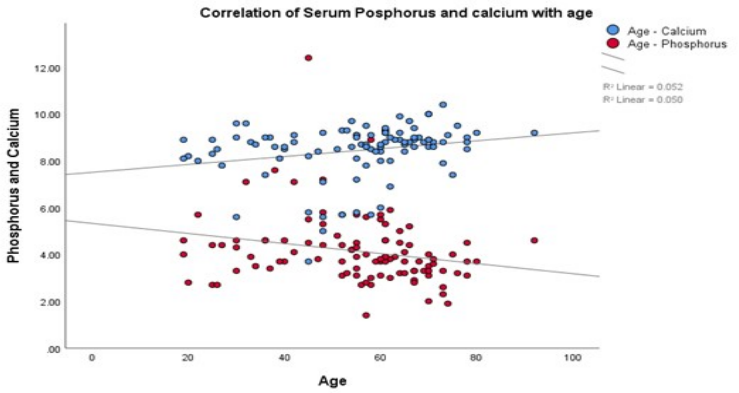

Figure 1. Correlation of Serum Phosphorus and calcium with age among patients with stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020

Figure 2. Correlation of Serum PTH with age among patients with stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020.

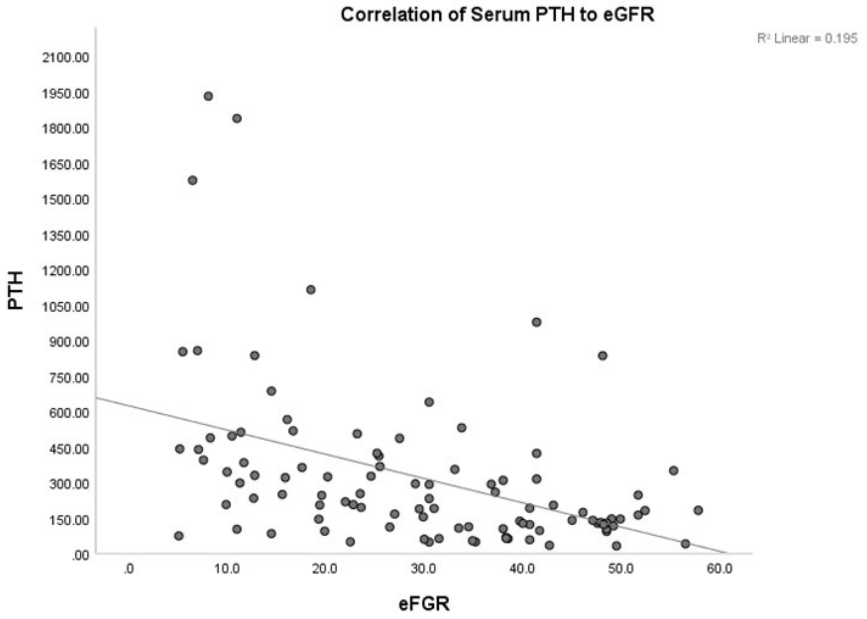

Figure 3: Correlation of Serum PTH with eGFR among patients with stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020.

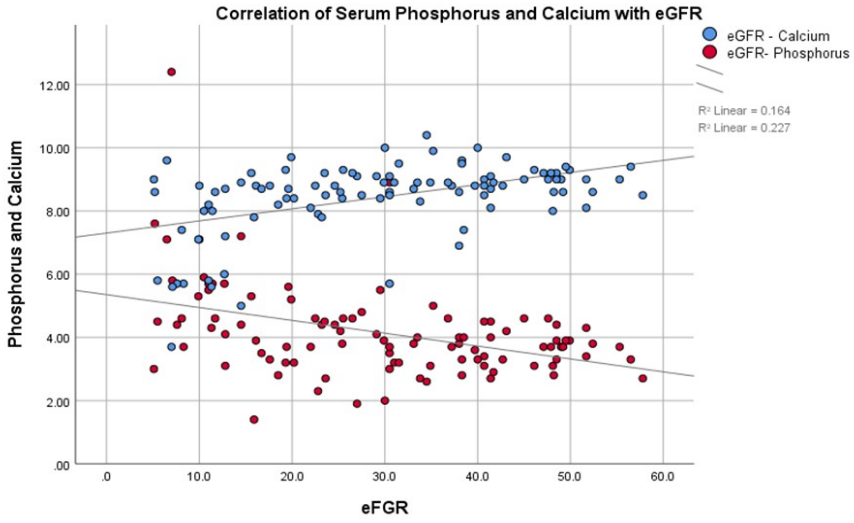

Figure 4: Correlation of Serum Phosphorus and calcium with eGFR among patients with stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020.

However, on Multiple linear regression analysis, which explained 43.3% of calcium variation, the only independent predictors for serum calcium level were eGFR, diabetes, diastolic blood pressure and serum phosphorus (Table 6). Similarly, taking PTH as dependent variable, which explained 37.3% of PTH variation, diastolic blood pressure, female sex and eGFR were the only independent predictors identified (Table 7). But none of the above variables identified on linear correlation were independent predictors of phosphorus level on multiple regression analysis.

Table 6. Predictors of serum calcium among patients with stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020**.**

Predictor	Beta	95%CI	P-value
Calcium	-	9.26 to 13.20	<0.0001
eGFR	0.349	0.01 to 0.04	0.001
Diabetes	-0.196	-0.87 to -0.07	0.022
DBP	-0.249	-0.04 to -0.01	0.004
Phosphorus	-0.275	-0.41 to -0.14	<0.0001

Table 7. Predictors of serum PTH among patients with stage 3-5 CKD attending adult renal Clinic of TASH, Addis Ababa, Ethiopia, 2020.

Predictor	Beta	95%CI	P-value
PTH	-	-932.24 to 829.21	0.908
eGFR	-0.249	0.01 to 0.04	0.025
Female sex	0.264	-0.87 to -0.07	0.006
DBP	0.191	-0.04 to -0.01	0.036

Discussion

The study revealed 31% of the CKD Stage 3–5 predialysis patients had hyperphosphatemia, 36% had hypocalcemia, and 89% had hyperparathyroidism. Estimated GFR correlated negatively with serum parathyroid hormone (PTH) level but correlated positively with serum calcium level. The mean values of calcium in CKD stage 3a,3b,4 and 5 were 8.91, 8.81, 8.7 and 7.14mg/dl, respectively where as those of serum phosphorus were 3.58, 3.83, 3.83 and 5.53mg/dl, respectively. The median values of PTH were 140.6, 137.2, 274.05 and 440.85Pg/ml, respectively.

Similar to our study, disordered mineral metabolism i.e., hypocalcemia, hyperphosphatemia and secondary hyperparathyroidism are common complications of CKD especially in those above stage 3(5,9). One study done on predialysis patients in south east Nigeria also found 70% hyperphosphatemia and 85% hyperparathyroidism which is similar with our finding of hyperparathyroidism.(10) Another study done in India in CKD patients stage 3-5D also showed hypocalcemia (23.8%), hyperphosphatemia (55.4%), secondary hyperparathyroidism (82.7%).(11) A similar high prevalence of disorders of mineral metabolism has been reported from the Western countries(9,12), India (11,13) and Nigeria(10,14).In addition, in our study the level of hypocalcemia, hyperphosphatemia and secondary hyperparathyroidism showed gradual increment with declining eGFR which was also demonstrated in other studies.(9,11).

Hyperparathyroidism was found in more than two thirds of the CKD patients, and its prevalence sharply increased with the decline in glomerular filtration, which is found in all of the patients with eGFR below 15 (stage 5). The possible mechanism for this is hypocalcemia and hyperphosphatemia which are the main physiological stimuli for increased PTH secretion (4,11). The results are similar to previous reports(15). For example, in the Study for the Evaluation of Early Kidney Disease (SEEK), 90% of the subjects with eGFR <20mL/min/1.73m2 had high levels of intact parathyroid hormone (iPTH) and the prevalence in early stages of CKD (i.e., at eGFR >80mL/min/1,73m2 and between 60-70mL/min/1.73m2) was around 12% and 21%, respectively.(9) In our study we also found that female sex and high Diastolic blood pressure were independent predictors of hyperparathyroidism. Similar positive correlation with DBP was also found in a study done in the south east Nigeria.(10) Furthermore, Blood Pressure Reduction After Parathyroidectomy and medical treatment with calcimmetics for Secondary Hyperparathyroidism was demonstrated in other studies.(16), (17)The mechanism for this correlation might be ascribed to alterations of calcium homeostasis and direct hypertensive activities induced by PTH.(18) In addition, in one study done on uremic patients also found that female patients have higher PTH level (approximately 69.6± 32.9 pg/ml) than males (13,19) The effect of gender on parathyroid activity may be regulated by sex steroids, since estrogen receptors are present in parathyroid cells and estrogens increase PTH mRNA levels,(15,20)

Hypocalcemia was found in almost one third of the CKD patients and its prevalence also increased with decline in eGFR. This relation was also demonstrated in other studies (11,12). Total serum calcium concentration decreases during the course of CKD due to phosphate retention, decreased calcitriol concentration, and resistance to the calcemic actions of PTH on bone (23). We found diabetes to be an independent predictor of lower levels of calcium, and this could be higher number of patients (40%) that were diabetic in our study. No significant correlation was identified in serum calcium when diabetics were compared to non-diabetic CKD patients in study done in India. (11) The correlation between hyperphosphatemia and hypocalcemia was also demonstrated in other studies. (14) The inverse correlation between calcium and DBP was demonstrated in some studies.(21,22), In one study done on patients with essential hypertension showed that Individuals with high diastolic blood pressure had significantly lower total serum

calcium (2.41 ± 0.10 vs. 2.47± 0.10 mmol/1, mean± SD; P<0.01)(22). The effect was attributed to widespread depression of Ca (2+)-ATPase activity with plasma Ca2+ depletion and cytosolic Ca2+ overload, which may reflect an underlying membrane abnormality in essential hypertension.

Hyperphosphatemia was also found in almost one third of the CKD patients and serum phosphate level also increased as the stage of CKD increased with 68% in stage 5. This was demonstrated in a Romanian study which showed that 93% of patients with high serum phosphate had a glomerular filtration rate below 30mL/min/1.73m2 (12). This is understandable given that the primary cause of hyperphosphatemia is a reduction in renal phosphate clearance, which frequently occurs as kidney excretion function declines (4,12). Even though the level of hyperphosphatemia increased with stage of CKD this wasn't demonstrated when multiple regression analysis was done.

Conclusion

This study found a spectrum of CKD-MBD in CKD Stage 3–5. It showed that secondary hyperparathyroidism, hyperphosphatemia, hypocalcemia, were quite common among Stage 3-5 CKD patients in TASH renal clinic. The most common type of MBD was hyperparathyroidism. The level of MBD abnormalities also increases with progressively worsening renal failure. In addition, serum calcium level is inversely associated with diabetes and diastolic blood pressure whereas serum PTH is directly associated with diastolic blood pressure and female sex.

Limitation of this study

Due to the cross-sectional nature of this study, patients were assessed only at presentation. Serum ALP, FGF-23 and 25(OH) D levels weren't determined. The number of patients included was small because the COVID pandemic limited CKD patient from visiting follow-up clinics, research time constraint and not enough funding to do the laboratory investigations.

Declarations

Acknowledgment

We would like to thank the Department of Internal Medicine, College of Health Sciences, Addis Ababa University, the renal clinic staff, Hana and EPHI chemistry laboratory staff who dedicated their time in the data collection process and all study participants.

Ethics consideration

The study was conducted after obtaining ethical clearance from Addis Ababa University, college of medicine, internal medicine department (Ref number???). Informed consent was taken from all patients after explaining the nature of the study using their own language. Medical record number was used for data collection. Access to the patient's data was limited to the research team and confidentiality was maintained throughout.

Authors contribution

SM conceived and designed the study. AM contributed to the conception, design of the study and interpretation of the findings. SM wrote the research proposal, conducted the research, performed statistical analysis and drafted the initial manuscript. All authors approved the final version of the manuscript.

Conflict of interest

The authors have declared that they have no known competing interests.

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Data availability

All relevant data are available upon reasonable request.

References

1. Coresh J, Astor BC, Greene T, Eknoyan G, Levey AS. Prevalence of chronic kidney disease and decreased kidney function in the adult US population: Third National Health and Nutrition Examination Survey. American Journal of Kidney Diseases. 2003;41(1):1–12.
2. Abd Elhafeez S, Bolignano D, D'Arrigo G, Dounousi E, Tripepi G, Zoccali C. Prevalence and burden of chronic kidney disease among the general population and high-risk groups in Africa: A systematic review. BMJ Open. 2018;8(1).
3. Kumela Goro K, Desalegn Wolide A, Kerga Dibaba F, Gashe Fufa F, Wakjira Garedow A, Edilu Tufa B, et al. Patient Awareness, Prevalence, and Risk Factors of Chronic Kidney Disease among Diabetes Mellitus and Hypertensive Patients at Jimma University Medical Center, Ethiopia. BioMed Research International. 2019;2019.
4. 2012 K. KDIGO 2012 CKD Guideline. Vol. 19, IFAC Proceedings Volumes (IFAC-PapersOnline). 2014.
5. Isakova T, Nickolas TL, Denburg M, Yarlagadda S, Weiner DE, Gutiérrez OM, *et al*. KDOQI US Commentary on the 2017 KDIGO Clinical Practice Guideline Update for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease–Mineral and Bone Disorder (CKD-MBD). American Journal of Kidney Diseases. 2017;70(6):737–51.

6. Tentori F, Blayney MJ, Albert JM, Gillespie BW, Kerr PG, Bommer J, *et al*. Mortality Risk for Dialysis Patients With Different Levels of Serum Calcium, Phosphorus, and PTH: The Dialysis Outcomes and Practice Patterns Study (DOPPS). American Journal of Kidney Diseases. 2008;52(3):519–30.
7. Block GA, Klassen PS, Lazarus JM, Ofsthun N, Lowrie EG, Chertow GM. Mineral metabolism, mortality, and morbidity in maintenance hemodialysis. Journal of the American Society of Nephrology. 2004;15 (8):2208–18.
8. Kestenbaum B, Sampson JN, Rudser KD, Patterson DJ, Seliger SL, Young B, *et al*. Serum phosphate levels and mortality risk among people with chronic kidney disease. Journal of the American Society of Nephrology. 2005;16(2):520–8.
9. Levin A, Bakris GL, Molitch M, Smulders M, Tian J, Williams LA, *et al*. Prevalence of abnormal serum vitamin D, PTH, calcium, and phosphorus in patients with chronic kidney disease: Results of the study to evaluate early kidney disease. Kidney International. 2007;71(1):31–8.
10. Okoye JU, Arodiwe EB, Ulasi II, Ijoma CK, Onodugo OD. Prevalence of CKD-MBD in pre-dialysis patients using biochemical markers in enugu, south-east Nigeria. African Health Sciences. 2015;15(3):941–8.
11. Vikrant S, Parashar A. Prevalence and severity of disordered mineral metabolism in patients with chronic kidney disease: A study from a tertiary care hospital in India. Indian Journal of Endocrinology and Metabolism. 2016;20(4):460–7.
12. Căpuşă C, Chirculescu B, Vladu I, Viaşu L, Lipan M, Moţa E, *et al*. The prevalence of biochemical abnormalities of chronic kidney disease. Mineral and bone disorders in untreated non-dialysis patients – A multicenter study. Acta Endocrinologica. 2016;12(3):282–90.
13. Valson AT, Sundaram M, David VG, Deborah MN, Varughese S, Basu G, et al. Profile of incident chronic kidney disease related-mineral bone disorders in chronic kidney disease Stage 4 and 5: A hospital based cross-sectional survey. Indian Journal of Nephrology. 2014;24(2):97–107.
14. Sanusi AA. Prevalence and Pattern of Renal Bone Disease in End Stage Renal Disease. West African Journal of medicine. 2010;29(2):75–80.
15. Han S woo, Kim S jin, Lee D joo, Kim K min, Joo N seok. The Relationship between Serum 25-Hydroxyvitamin D , Parathyroid Hormone and the Glomerular Filtration Rate in Korean Adults : The Korea National Health and Nutrition Examination Survey between 2009 and 2011. 2014;35(2):98–106.
16. Goldsmith DJA, Covic AA, Venning MC, Ackrill P. Blood Pressure Reduction After Parathyroidectomy for Secondary Hyperparathyroidism: Further Evidence Implicating Calcium Homeostasis in Blood Pressure Regulation. 1996;27(6):819–25.
17. Simeoni M, Perna AF, Fuiano G. Secondary Hyperparathyroidism and Hypertension : An Intriguing Couple. 2020;(Figure 1):1–9.
18. Massry S.G., Iseki K. CVM. Serum Calcium, Parathyroid Hormone, and Blood Pressure. Am J Nephrol. 1986;6(Suppl. 1):19–28.
19. Gupta A, Kallenbach LR, Zasuwa G, Divine GW. Race is a major determinant of secondary hyperparathyroidism in uremic patients. Journal of the American Society of Nephrology. 2000;11(2):330–4.
20. Prince RL. COUNTERPOINT : Estrogen Effects on Calcitropic Hormones and Calcium Homeostasis. 2015;15(3):301–9.
21. Behradmanesh S, Hamid Nasri. Association of serum calcium with level of blood pressure in type 2 diabetic patients. Journal of Nephropathology. 2013;2(4):254–7.
22. Reichel H, Liebethal R, Schmidt-gayk HHH, Ritz E. Clinical Investigator Disturbed calcium metabolism in subjects with elevated diastolic blood pressure. 1992;25:748–51.
23. Digishaben D. Patel,Uday Vachhani, Ajay Rajput, Pratik Raghavani, Deepak N. Parchwani, Sagar Dholariya. Analysis of the Prevalence and Severity of Dysregulated Bone Mineral Homeostasis in Nondialyzed Chronic Kidney Disease Patients. 2022;14(02):144-150
24. Hsu C, Chen L, Chen K. Osteoporosis in patients with chronic kidney diseases: A systemic review. 20230; 21(18):1-24
25. Block, G. A., Kilpatrick, R. D., Lowe, K. A., Wang, W., & Danese, M. D. (2013). CKD-mineral and bone disorder and risk of death and cardiovascular hospitalization in patients on hemodialysis. Clinical Journal of the American Society of Nephrology, 8(12), 2132–2140.
26. Lucca, L. J. (n.d.). *Braz. J. Nephrol. (J. Bras. Nefrol.)*. https://doi.org/10.1590/2175-8239
27. Reeta Choudhary, Charu Yadav, Pallavi Jain, Shyam Bihari Bansal, Beena Bansal, Arun Kumar Harith (2020). Prevalence of Mineral Bone Disease in Chronic Kidney Disease Patients using Biochemical Markers. Journal of clinical and diagnostic research, 2020