Vol. 5 No. 2 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Badar et al - 2026

DOI: http://doi.org/10.5281/zenodo.20525680

THE PREVALENCE OF BIOCHEMICAL PATTERN IN MINERAL BONE DISEASE AMONG HEMODIALYSIS PATIENTS

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Keywords:
CKD-MBD, hemodialysis, Hyperphosphatemia, secondary hyperparathyroidism, vitamin D deficiency

Received on 03 Apr 2026
Accepted on 04 May 2026
Published on 30 May 2026

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Abstract

Background:
Mineral homeostasis gradually weeakens as the function of kidney declines,with disturbance in normal phosphorus and calcium concentrations in serum and tissue,with the addition of the variations in hormone levels in blood including PTH, fibroblast growth factor-23 , and clcitriol(1,25(OH)2D).

Objectives:
To determine the pravelance of biochemical pattern of mineral bone disease among hemodialysis patients and comparing the biochemical pattern of mineral bone disease between public and private hospitals.

Methodology:
A Cross-sectional study executed at two hospitals (Ali Fatima Hospital and Chaudhri Muhammad Akram Teaching Hospital ,Lahore) between January and April 2026. 70 patients who had been on long term hemodialysis for more than three months were slected using targeted sampling. With the help of an interviewer-administered questionnaire, the demographic profile and clinical features of the patients were recorded. Before dialysis blood samples were analyzed for serum calcium, phosphorus, iPTH, vitamin D, albumin, and ALP.

Result:
50 out of 70 patients had MBD prevalance of 71.4%. The most common disorder was hyperphosphatemia (57.1%) which was followed by vitamin D low levels (55.7%) , hypocalcemia (51.4%), and raised iPTH (50.0%) . Patients in public health care had biochemical profiles that were significantly worse than those in private health care ($p<0.05$). MBD had no association with dialysis vintages.

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Conclusion:

Pattern of MBD was more worse in public sector rather than private sector .Hypertensivenephropathy was more dominant and hyperphosphatemia seen the most frequent abnormality among pakistani hemodialysis patients with mineral bone disease.There is an urgent requirments for enhanced tracking, and locally adapted treatment protocols.

INTRODUCTION

Mineral bone disorder (CKD-MBD) is defined a systemic condition of mineral and bone metabolism,which is caused by CKD and appears as abnormalities of calcium, phosphorus, parathyroid hormone , or vitamin D metabolism, as well as abnormalities of bone regeneration, calcifiction, volume, height increase or strength, and vascular or connective tissue tissue calcification with the result of secondary hyperparathiroidism ,renal osteodistrophy which is a bone disease ,vascular calcification in addition to increasing ilness and sickness(1).

Worldwide blood phosphorus, calcium, and parathyroid hormone (PTH) which regulate calcium and phosphorus abnormalities are very common in patients with final stage kidney disease receiving continuous hemodialysis however there is a great deal of regioal variations because of variations innutrition patterns, dialysis procedures, heridity, and availibility to treatment.For example, About 70–80% of hemodialysis patients in North America and Europe have hyperphosphatemia (serum phosphate >5.5 mg/dL)(2).

In Asian populations, the prevalence is similarly high but frequently accompanied by a distinct pattern of secondary hyperparathyroidism .whithin East Asian nations like Japan and South Korea, more strict dialysis procedures and dietary compliance result in comparatively lower phosphate levels; however, high PTH continues to be a prevalent issue. In India, research shows that hyperparathyroidism occurs in 84.62% of cases, followed by hyperphosphatemia at 64.10%, hypocalcemia at 56.41%, and raised TAP which is high total alkaline phosphate levels at 43.59%(3). Disorder (CKD-MBD), which is marked by remarkably high prevalence rates and serious management lacks, has a considerable and poorly managed load among Pakistan's dialysis-dependent population. In a cross-sectional study, 101 patients from a hospital in Karachi took part. Secondary hyperparathyroidism was detected in a large and sizeable proportion of patients using the KDOQI guidelines (4).

Increased parathyroid hormone (PTH) levels are connected to superior death rates, according to epidemiologic findings including dialysis patients .Treatments that treating irregular CKD-MBD characteristics are showing bettering in biomarker results, but they haven't shown to decrease major endpoints like cardiac and total mortality.thermore, clarifying the pattern (e.g., which abnormality is most common , or how variables aggregate) can emphasize unique local challenges and issues (6).

Derived from 1209 bone biopsies from five Ibero American countries. Versus Portugal and Spain, Brazil, Uruguay, and Argentina were revealed to have increased level of low bone formation bone softening and hybrid renal bone disease. Alternatively, Portugal and Spain had the greatest frequency

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of excess PTH bone changes. According to bone studies conducted in Singapore, 24.4% of subjects had CKD bone disease (7).

The inclination for people with CKD to be aged and to have increased frequency of conventional cardiovascular risk factors, like diabetes and high blood pressure, which are common risk factors for CKD, may lead to increased rates of cardiovascular disease and death rate. However, despite after adjusting for age and other interfering factors, people with CKD persist to have a greater risk of unwanted cardiac events in extensive, international epidemiological studies (8).

Meanwhile people with CKD reach renal failure, anomalies in serum phosphate, parathyroid hormone (PTH), and vitamin D breakdown are almost constantly existing. Mineral metabolism irregularities are natural to CKD.12, 13 abnormalities in bone metabolism are associated to disorders of mineral breakdown in long term kidney disease. "Renal osteodystrophy," a kidney-associated bone disease, can appear as abnormal bone change and calcification (bone quality) and bone density (bone extent) (10).

The significance and usefulness of this study are deep and complex reaching From the patient's bedside to national health policy platforms. The direct applicability is obvious at the patient level. The quality and lifespan of life for hemodialysis patients can make better by detecting and managing common irregularities like hyperphosphatemia, which can result in benefits like decreased bone pain, decreased risk of broken bone ,less pruritus (itching), and a decreased risk of cardiovascular events.This study provide a vital audit and a guide for regional quality enhancement for physicians, renal specialist, and hospital managers (12).

More importantly, it will pinpoint the most common and serious biochemical abnormalties distinct to these groups in pakistan. It ensuring that limited resources and clinical efforts are focused where they are most needed, it makes it possible to design specific treatment. This study has important consequences for health systems and policymakers. The creation of concrete, multi-center data from Pakistan closes a major knowledge void that has long obstructed the creation of clinical guidelines that take context into account (13).

At the moment, global norms frequently act as base for practice in Pakistan, which may not suficiently take into consideration local conditions There is a lack of indicative Data on the prevalence of CKD-MBD and its variety because of differences between different racial background and dialysis method. The comparitive frequency of each of these types varies in different communities and with different dialysis modalities. Low turnover bone disease,osteomalacia which is bone softening combined uremicosteodystrophy was more. Common and pravelent in Brazil, Uruguay, and Argentina.While hyperparathyroid bone, Osteitisfibroscystica were more common in Portugal and Spain (14).

The main goal of this study is to analyze and describe the chemical profile and prevalence of Pattern in Mineral and Bone Disorder in patients receiving regular dialysis treatment.This study particularly seeks to chart the Biochemical Pattern and to check the relationship between these abnormalities and their dominant pattern.it includes finding which derangement is the most common,such as hyperparathyroidism, hypocalcemia, orhyperphosphatemia with applying the goal parameter

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suggested by KDIGO (2017) . As well To produce local, multi-center epidemiological data from Pakistan that can contribute to the development of future situation..

CHAPTER 2
LITERATURE REVIEW

Butt et al. (2021)Innovative study by among hemodialysis patients in Rawalpindi established the significant burden of CKD-MBD in Pakistan. According to their results, the most of patients 68% had biochemical signs of the disease. By identifying that low turnover disease was exist in 26.8% of cases and high bone turnover was the most frequent pattern 73%, the study played a crucial role in revealing the range of bone disease. In order to manage bone disease in the population of Pakistani patients with renal failure, this early study showed the diversity of CKD-MBD at the dialysis stage, indicating the need for a range of therapeutic approaches rather than a typical approach (15).

Arbab et al. (2025) Specifically, in Peshawar studied the problem of hyperphosphatemia, a basic aspect of CKD-MBD. In the CKD group, their results showed an overall frequency of hyperphosphatemia of 56%; within patients in Stage 5 and receiving dialysis, the ratio elevated to 61.5%. This study highlights that as renal function decline, phosphate accumulation becomes a widespread and continuous biochemical disorder. The findings emphasizes how poor overall disease control is a outcome of serum phosphate level management, which is still a main and mostly unaddressed clinical target in the local management of progressive CKD (16).

Khan et al. (2023) Associated physical skeletal harm to biochemical defects . They found that osteopenia or osteoporosis impacting 77% of their CKD patient group, forming a direct relationship between the disorder of mineral metabolism and decreased bone mineral density. The prevenlance of specific biochemical abnormalities was also reported in their data, with vitamin D deficiency 72% being the most common, followed by hyperphosphatemia and high PTH. This study emphasizes the practical impact of unmanaged MBD on fracture risk and morbidity by connecting the gap between laboratory results and clinical bone health (20) .

Ikram et al.(2025) they did a recent cross-sectional observational study at Lady Reading Hospital in Peshawa. Delivers valuable regional evidence. In 127 hemodialysis patients, the inquiry planned to measure the extent of derived hormonal imbalance (SHPT), a primary segment of CKD-MBD. Their outcomes displaed that 19.7% of the cases developed SHPT challenges. Further more, the study revealed that the illness was more typical in persons who had both glucose imbalance and BP elevation, were male, and had been on dialysis for a chronic duration of time. This nearly one-fifth distribution points to a high disease tool , which stresses the value of ongoing biochemical review in Pakistani hemodialysis facilities to allow for early care and possibly lower complications (21).

AAbdulA et al. (2019) observed that the distribution of CKD-MBD among hemodialysis patients alters significantly across zones due to differences in invome- related circumstances, feeding habits, genetic factors, and provision to healthcare.Unsettling incidence rates are often seen in inquires conducted in low- income countries; one study from Nigeria observed that 58% of hemodialysis cases had CKD-MBD. This marked distribution carries on even though some survey may have had

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compact data sample. Of the 48 individual in the Nigerian report, 39 (81.3%) were masculine group and 9 (18.8%) were female participants, with an median life span of45.96±13.7years(22).

George et al.(2025) accordind to this study the prevalence patterns in Indian studies are even more remarkable.The incidence trends in Indian surveys are even eye-catching, as stated them). Exploration organized at a high- level care facility in Mumbai uncovered that hemodialysis patients about always had biochemical dysfunction in line with CKD-MBD. A diverse Indian study with 152 volunteers revealed that 66 patients (43.4%) had reduced-turnover bone disease, outlined as iPTH levels below than twice the upper normal limit, and 17 patients (11.18%) had hyperactive bone disease,specified as iPTH > 9 measures the upper boundary. These records reflect how recurring metalic bone complications are among Indian hemodialysis persons(23).

Jin JJ et al.(2018) According to a thorough study performed in Hebei region with 2,577 hemodialysis patients, 45.4% of patients had raised PTH levels above the K/DOQI-recommended limit of 300 pg/mL, 58.6% had hyperphosphatemia, and 35.9% had low calcium level.An even more worrying picture is painted by more recent information from Sichuan province: among 7,053 hemodialysis patients, serum phosphorus The success rate was only 24.3%, and the total percentage for managing calcium, phosphorus, and iPTH at the same time was only 7.5%. These numbers emphasize the considerable gap between medical care in the real world(24).

Ahmed et al. (2022) They discovered that 66.7% of kidney clients in Quetta did not know which check ups they needed on a standard, and more than half (51.5%) did not know the names or uses of their directed medicine. Critical health impacts are directly caused by this inexperience ignorance, which stops early medical control and following treatment. In Pakistan, there are many limitations to fullfiling and regulating body chemistry in the body in kidney support patients. Low quality results are caused by individual- related sources such as incorrect drug us,poor nutrition adherence and medical understanding(39).

Chan et al.(2020) The multiple of tablets of renal phosphate treatment, which can exceed 10–15 pills per day, is one medication issues that induces to poor compliance. Both phosphate binders and calcium mimicking drugs usually cause digestive problems, nausea, bowel irregularity, and lose motios, which can limit tolerence . In settings with insufficient means, the payment of calcimimetics and non-calcium-based phosphate binders produces a major challenge, as patients may have to pay a large portion of their medical expensies personally funded(40).

Ahmed et al . (2025) Found a variation in regular systems for urinary albumin testing as well as clear contrasts in vital test methods and skill across 13 major laboratories in Pakistan. Exact discovery of disease, capable clinical management, and valid health surveillance are all obstructed by these variations. The excellence of care is further compromised by the limited supply of renal dietitians and the missing of formal patient training program. CKD-MBD impacts are guided by parts of the medical system, such as how dialysis care is managed, the presence of specialized expertise, and the adoption of recommended protocols(41).

Butte AL. (2021) Found that 68% of hemodialysis patients in Pakistan had biochemical proof of CKD-MBD, with low turnover disease occurring in 26.8% of cases and high bone turnover being

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the most common pattern (73%). As stated by Arbab, Khan, and Ullah (2025), the frequency of hyperphosphatemia was 56% in CKD groups overall, increasing to 61.5% in Stage 5 and dialysis patients. According to Khan, Rehman, and Shahid (2023), 72% of patients with CKD had vitamin D deficiency, and 77% of patients had osteopenia or osteoporosis. The findings constantly show that CKD-MBD is approximately widespread in this residents, with considerable percentages of patients having abnormalities in calcium, phosphorus, PTH, and vitamin D(42).

Hutchason et al.(2023) Based on this research Low-turnover bone disease, marked by PTH levels less than dual the upper normal limit, has appeared as a sustantial characteristic in contemporary dialysis patients, impacting over 25% of patients This move toward low bone turnover likely reflects the combined impacts of calcium-based phosphate binder use, vitamin D similar therapy, and the elderly of the dialysis population. High-turnover disease, while more frequent, stays medically important due to its correlation with bone pain, fractures, and cardiovascular calcification(43).

Masoodi et al. (2020)Based on this study , in every area investigated, there is a substantial gap between the suggestion of standards and authentic clinical practice. Only 10.8% of Pakistani patients simultaneously met the recommended targets for serum calcium, phosphorus, and PTHThe multifactorial nature of treatment difficulties is indicated in this difference , which includes patient-related elements(dietary habits, compliance , health knowledge), medication-associated factors (cost, tolerability, pill burden), and healthcare system aspects(44) .

Materials and Methods

This cross-sectional multicenter study was conducted at Ali Fatima Hospital and Chaudhry Muhammad Akram Teaching Hospital over a duration of four months after synopsis approval. A total of 70 patients undergoing maintenance hemodialysis were included in the study through purposive sampling. The sample size was calculated using the formula $n = (Z^2 \times p \times q) / e^2$ with a 95% confidence level, 68% prevalence, and 11% margin of error, resulting in a required sample of 70 participants divided into two groups of 35 patients each.

The study included patients older than 18 years who had been receiving maintenance dialysis for more than three months with at least two dialysis sessions per week and who were willing to provide informed consent. Patients with acute kidney injury, temporary dialysis, peritoneal dialysis, recent parathyroidectomy, active malignancy, recent major surgery, or unwillingness to participate were excluded. Ethical approval and guidelines of Superior University were followed throughout the research process. Written informed consent was obtained from all participants, confidentiality and anonymity were maintained, and participants were informed of their right to withdraw from the study at any stage.

Data collection was performed using a structured study performa after evaluating participants according to the inclusion criteria. Demographic information, clinical history, dialysis duration, cause of chronic kidney disease, medications, and dialysis-related details were recorded. Clinical assessments included weight, height, BMI, predialysis blood pressure, and vascular access type.

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Recent predialysis laboratory investigations including phosphate, calcium, albumin, intact parathyroid hormone (iPTH), vitamin D, alkaline phosphatase, and hemoglobin levels were collected from medical records. The dependent variables mainly focused on the prevalence and biochemical pattern of mineral bone disorder (MBD), while independent variables included demographic, clinical, dialysis-related, pharmaceutical, socioeconomic, and healthcare structure factors.

Data analysis was conducted using IBM SPSS Statistics and Microsoft Excel 2016. Continuous variables such as age, dialysis duration, calcium, phosphorus, iPTH, vitamin D, alkaline phosphatase, albumin, and dialysis adequacy were presented as mean ± standard deviation along with minimum and maximum values, whereas categorical variables were expressed as frequencies and percentages. Descriptive statistics were used to determine the prevalence of MBD. Independent sample t-tests were applied to compare variables between public and private dialysis groups, while chi-square tests were used to assess associations between categorical variables. A p-value of less than 0.05 was considered statistically significant.

CHAPTER 5
RESULTS

In this research study The majority of the 70 patients were men (65.7%) and between the ages of 39 and 59 (51.4%). In terms of clinical features, (62.9%) of patients had diabetes mellitus and hypertension (75.7%), with 40% had cardiovascular disease. Participants were split equally between public and private hospitals (50% each).52.9% of respondents were using phosphate binders, and 47.1% used vitamin D (cholecalciferol).Arteriovenous fistulas were the most common vascular access (42.9%), and majorly participants (52.9%) had been on dialysis for 12–36 months. A mean calcium level of 8.06, a mean phosphorus level of 6.38, and a mean iPTH level of 217.8 were found in the analysis, suggesting variability, especially in iPTH values. Among the respondents, vitamin D deficiency (90.0%) and hyperphosphatemia (81.4%) were very common.

The findings also showed that prevalence of mineral bone disease (MBD) was 71.4% , with high turnover MBD being the most common pattern (64.3%). Vitamin supplement use was high (87.1%), and the most of participants (67.1%) received adequate dialysis. The use of phosphate binders was found to be significantly correlated with hospital. Prevalence of MBD was significantly associated with type of hospital but showed non-significant result with dialysis vintage.

Table 5.1: Gender of study population:

Gender		
	Frequency	Percent
Male	46	65.7
Female	24	34.3
Total	70	100.0

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Table 5.5 frequency of CVD

CVD		
	Frequency	Percent
Yes	28	40.0
No	42	60.0
Total	70	100.0

TThe composition of participants who had cardiovascular disease (CVD) is represented in this table. 28 (40.0%) of the total 70 had CVD, on the other side 42 (60.0%) had not. This is depicting that the major proportion of respondents had no CVD.

Table 5.6: frequency of Hypertension

HTN		
	Frequency	Percent
Yes	53	75.7
No	17	24.3
Total	70	100.0

The table depicts that the percentage of patients suffering from hypertension (HTN). From 70 sample population, 53 (75.7%) had hypertension, whereas 17 (24.3%) had no,which is the prove that major proportion of the participants are suffering with hypertension, predicating more than three-quarters of total sample proportion of 70

.

Table 5.7 Frequency of types of hospital

Types of Hospital		
	Frequency	Percent
Government	35	50.0
Private	35	50.0
Total	70	100.0

This table is showing the distribution of sample population dependent on the type of hospital. From total of 70 patients, 35 (50.0%) have been taken from government hospital while 35 (50.0%) patients were the part of private hospital. This illustrates that the participants were divided equally between both of these two hospitals.

Table 5.8 frequency of patients taking phosphate binders

Phosphate Binders		
	Frequency	Percent
Yes	37	52.9

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No	33	47.1
Total	70	100.0

The distribution of participants which I was based on hospital type is illustrated in this bar chart. It reveals that half of the patients taken from government hospitals and the other half were from private hospitals.

Table 5.9 frequency of patients taking vitamin D cholecalciferol

Vitamin D cholecalciferol		
	Frequency	Percent
Yes	33	47.1
No	37	52.9
Total	70	100.0

This table is illustrating the proportion of patients dependent on the intake of Vitamin D (cholecalciferol). From 70 participants, 33 (47.1%) were in taking Vitamin D cholecalciferol, on the other hand 37 (52.9%) showed that they don't which represents that slightly majority of the participants were not using Vitamin D cholecalciferol, T**able 5.11:Mean and standard deviation of biochemicals**

Statistics			
	Calcium	phosphorus	iPTH
N	70	70	70
Mean	8.0629	6.3807	217.8000
Std. Deviation	.62000	.97873	181.77001
Minimum	6.90	4.50	16.00
Maximum	9.20	8.20	650.00

The 70 participants' calcium, phosphorus, and iPTH levels are displayed in this table along with descriptive statistics. By applying standard deviation of 0.62 and a range of 6.90 to 9.20, the average calcium level was 8.06. With range of values from 4.50 to 8.20, 6.38 was the mean phosphorus level along with a standard deviation of 0.98.217.80 was the average iPTH level but by comparing them the high standard deviation of 181.77, is depicting more diversity among participants.

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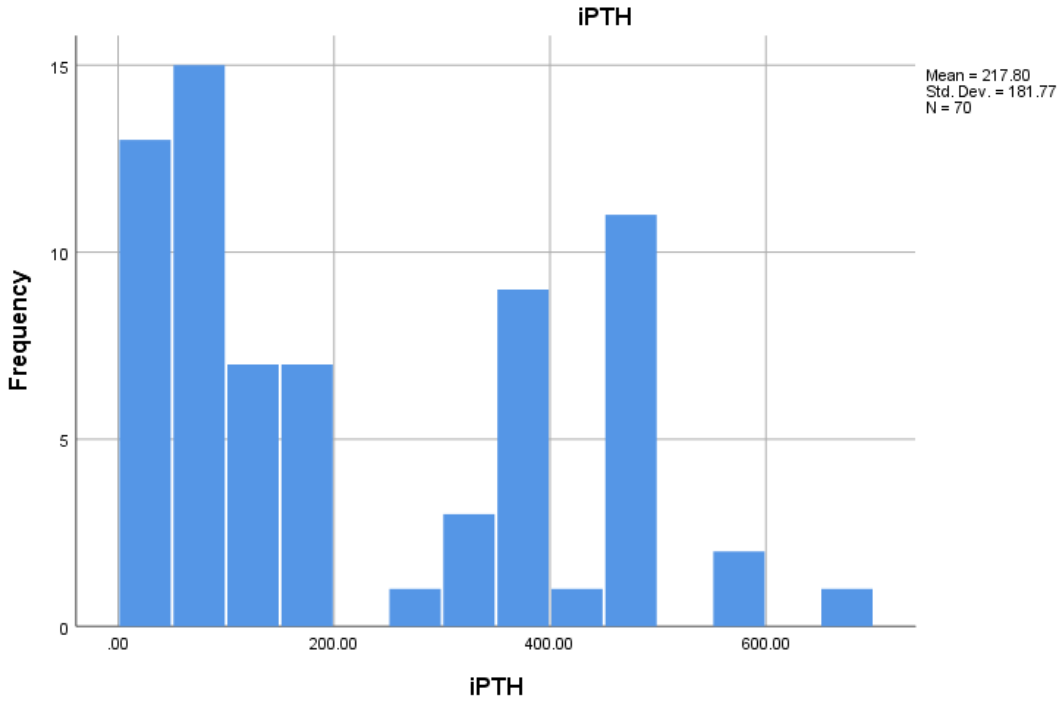

Figure 5.13:The proportion of the 70 participants' intact parathyroid hormone (iPTH) levels is depicting in this histogram. a standard deviation of 181.77 and a average iPTH level of 217.80, the participants were exhibiting a high degree of diversity. The range was very highl like from 16.00 to 650.00, illustrates that few of the participants had significantly higher iPTH in comparison with others.

Table 5.12 pravelance of MBD pattern:

MBD pattern		
	Frequency	Percent
High turnover	45	64.29
low turn over	21	30.0
Mixed	4	5.7
Total	70	100.0

The proportion of participants dependent on the pattern of mineral bone disorder (MBD) is displaying in this table. From 70 sample population , 21 (30.0%) were suffering from low turnover MBD, 4 (5.7%) suffered from mixed MBD, and 45 (64.29%) had high turnover MBD. This dipicts that only a tiny percentage of participants had the mixed type, on the other side the major proportion of participants had high turnover MBD .

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Table 5.13: severity of MBD

MBD severity		
	Frequency	Percent
Yes	50	71.4
No	20	28.6
Total	70	100.0

The proportion of participants dependent on the severity of mineral bone disorder (MBD) is displaying in this table. From 70 , 50 (71.4%) were reported as having severe MBD, whearas 20 (28.6%) had no severe MBD. This explicits that the major proportion of the participants had experienced severe MBD, while a tiny percentage had no severe MBD .

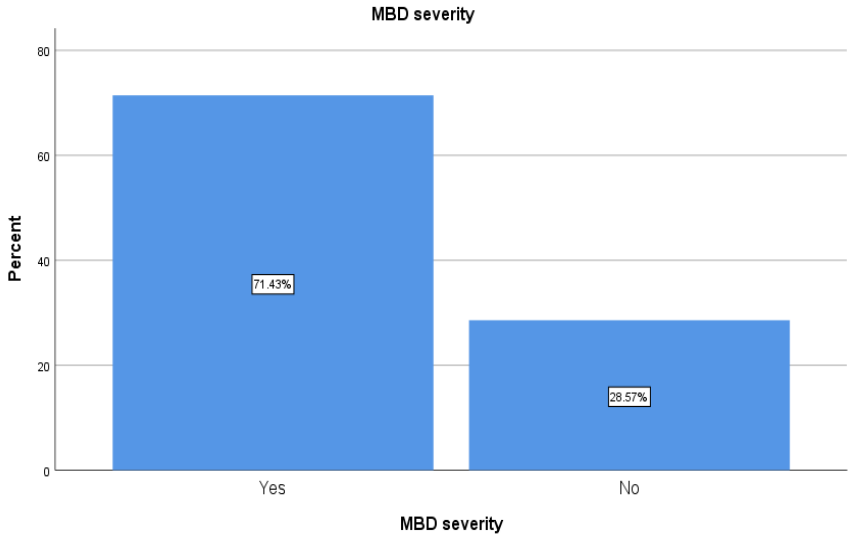

Figure 5.15:The bar chart is displayin that 71.43% of the participant w,ere reported as having severe MBD, whearas (28.6%) had no severe MBD. This explicits that the major proportion of the participants had experienced severe MBD, while a tiny percentage had no severe MBD .

Table 5.14 :frequency of dialysis vintage:

Dialysis vintage		
	Frequency	Percent
12-36 months	37	52.9
greater than 36 months	20	28.6
less than 12months	13	18.6
Total	70	100.0

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The proportion of participants dependent on the dialysis vintage is displaying in this table . Twenty (28.6%) were on dialysis for Greater than 36 months, 13 (18.6%) for less than 12 months, and 37 (52.9%) for 12–36 months. This exhibits that while smaller percentages had been receiving dialysis for longer or shorter periods of time, the major proportion of participants were doing dialysis for 12 to 36 months.

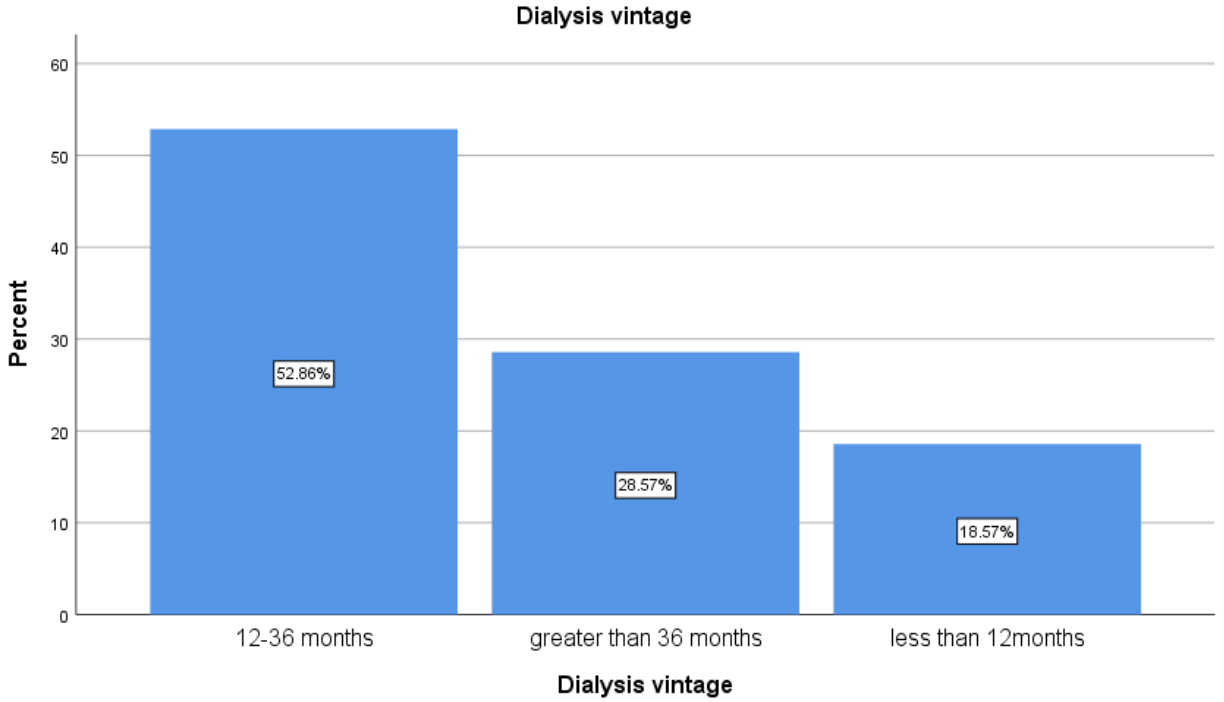

Figure 5.16:The The proportion of participants dependent on the dialysis vintage is displaying in this bar graph . (28.6%) were on dialysis for Greater than 36 months, (18.6%) for less than 12 months, and (52.9%) for 12–36 months. This exhibits that while smaller percentages had been receiving dialysis for longer or shorter periods of time, the major proportion of participants were doing dialysis for 12 to 36 months.

Table 5.15 : frequency of type of vascular access

Vascular Access		
	Frequency	Percent
AVF	30	42.9
AVG	24	34.3
Double lumen	15	21.4
11.00	1	1.4
Total	70	100.0

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The proportion of participants dependent on the type of vascular access is displaying in this table . From 70,, 30 (42.9%) had arteriovenous fistula (AVF), 24 (34.3%) had arteriovenous graft (AVG), 15 (21.4%) had a double lumen catheter, and 1 (1.4%) This depicts that majority of participants had AVF type of vascular access for dialysis.

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Table 5.18: frequency of type of phosphate binders

Phosphate binder type		
	Frequency	Percent
Calcium based	31	44.3
non-Calcium based	26	37.1
no	13	18.6
Total	70	100.0

The proportion of participants dependent on the type of phosphate binders is displaying in this table.From 70 , 31 (44.3%) were using calcium based phosphate binders , 26 (37.1%) using non calcium based,and 13 (18.6%) were not having any type .This represented that calcium-based phosphate binders was majorly used treatment among the participants .

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Table 5.19: adequacy of dialysis

Adequacy of dialysis		
	Frequency	Percent
Adequate	47	67.1
Inadequate	23	32.9
Total	70	100.0

Proportion of participants dependent on the adequacy of dialysis is displaying in this table.From 70 ,47 (67.1%) participants were taking adequate dialysis, on the other hand 23 (32.9%) were taking inadequate dialysis. This explicit that the major proportion of the participants were taking adequate dialysis treatment.

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Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

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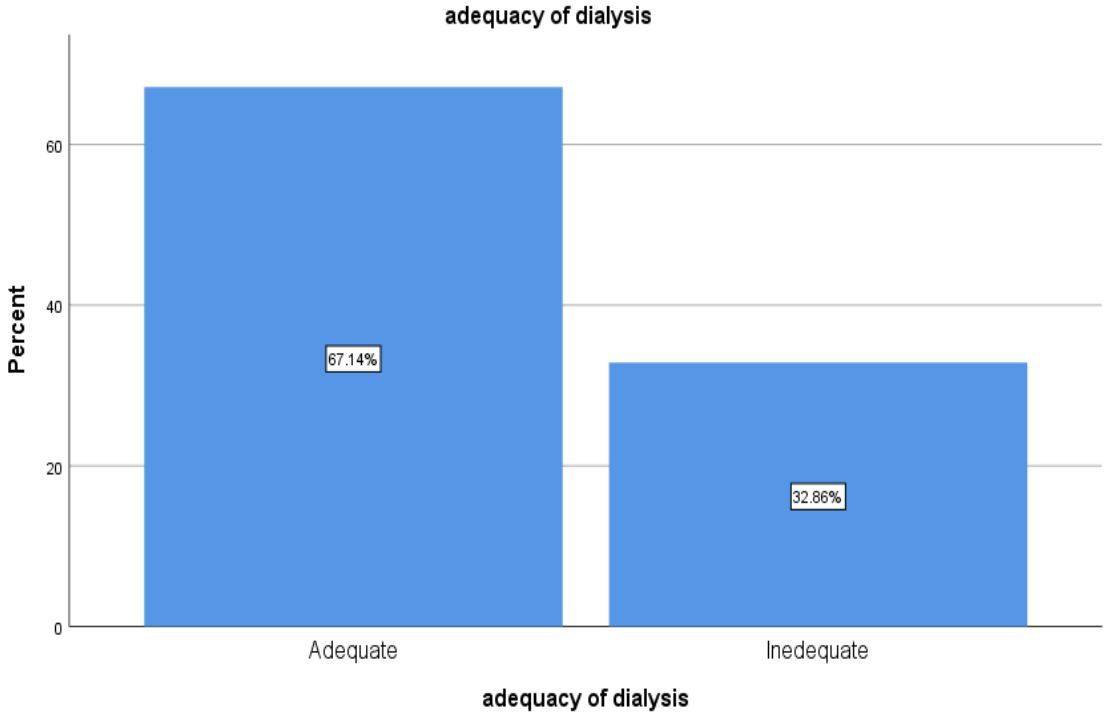
DOI: http://doi.org/10.5281/zenodo.20525680



Proportion of participants dependent on the adequacy of dialysis is displaying in this bar graph.From 70 , (67.1%) participants were taking adequate dialysis, on the other hand (32.9%) were taking inadequate dialysis. This explicit that the major proportion of the participants were taking adequate dialysis treatment.

Table 5.20: Frequency of vitamin supplements

Vitamin Supplements		
	Frequency	Percent
Yes	61	87.1
No	9	12.9
Total	70	100.0

The breakdown of feedbacks based on vitamin supplement usages is presented in the chart. Nine (12.9%) of the seventy participants said they do not use vitamin supplements, on the other hand sixty-one (87.1%) claimed they do. This indicates that just a small proportion of participants do not use vitamin supplements

Table 5.22: Descriptive statistics of biochemical abnormalities

Statistics			
	Hypocalcemia (ca less	ALP	Vitamin D value

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DOI: http://doi.org/10.5281/zenodo.20525680

	than 8.5)		
N	70	70	70
Mean	8.0629	155.34	16.6429
Std. Deviation	.62000	57.859	8.13302
Minimum	6.90	82	5.00
Maximum	9.20	295	35.00

The 70 participants' levels of vitamin D, alkaline phosphatase (ALP), and hypocalcemia which is defined as calcium less than 8.5 are displayed in this table along with descriptive statistics. By applying the standard deviation of 0.62,with range of calcium level from 6.90 to 9.20 as well as mean 8.06.For ALP level ranging from 82 to 295, with addition of a average of 155.34 including a standard deviation of 57.86. The vitamin D value ranged from 5.00 to 35.00, with an average of 16.64 including a standard deviation of 8.13. Overall, the findings are representing that the participants' levels of calcium and ALP have variations,but their remained more widely variations in vitamin D levels .

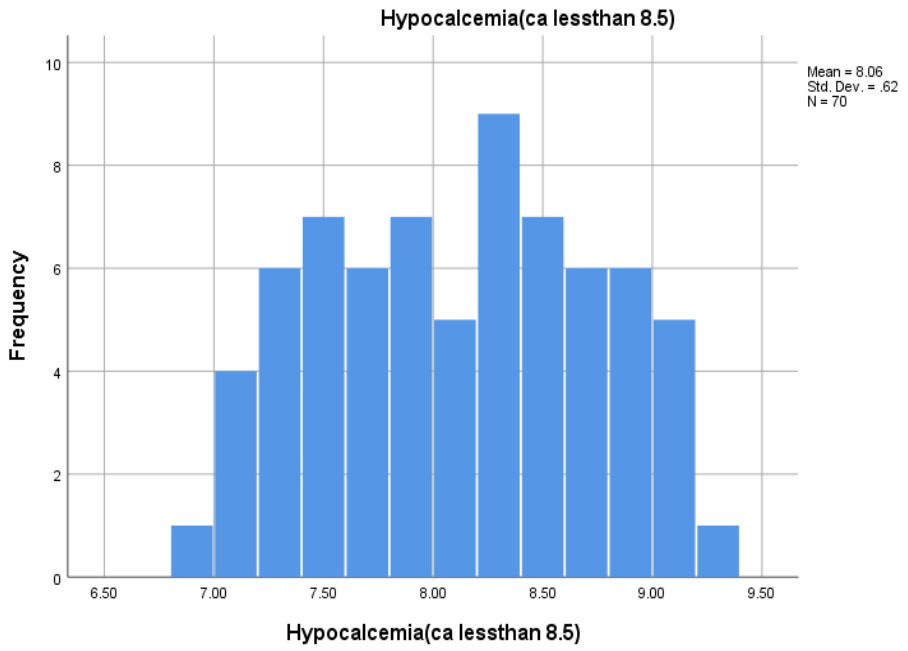

Figure 5.22:This bar chart is representing the distribution of calcium levels showing hypocalcemia defined as calcium less than 8.5.standard deviation of 0.62,with range of calcium level from 6.90 to 9.20 as well as mean 8.06.Collectively, the distribution indicates that a large number of participants have calcium levels near the lower threshold which is , suggesting that some members of the study population may have hypocalcemia.

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Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20525680

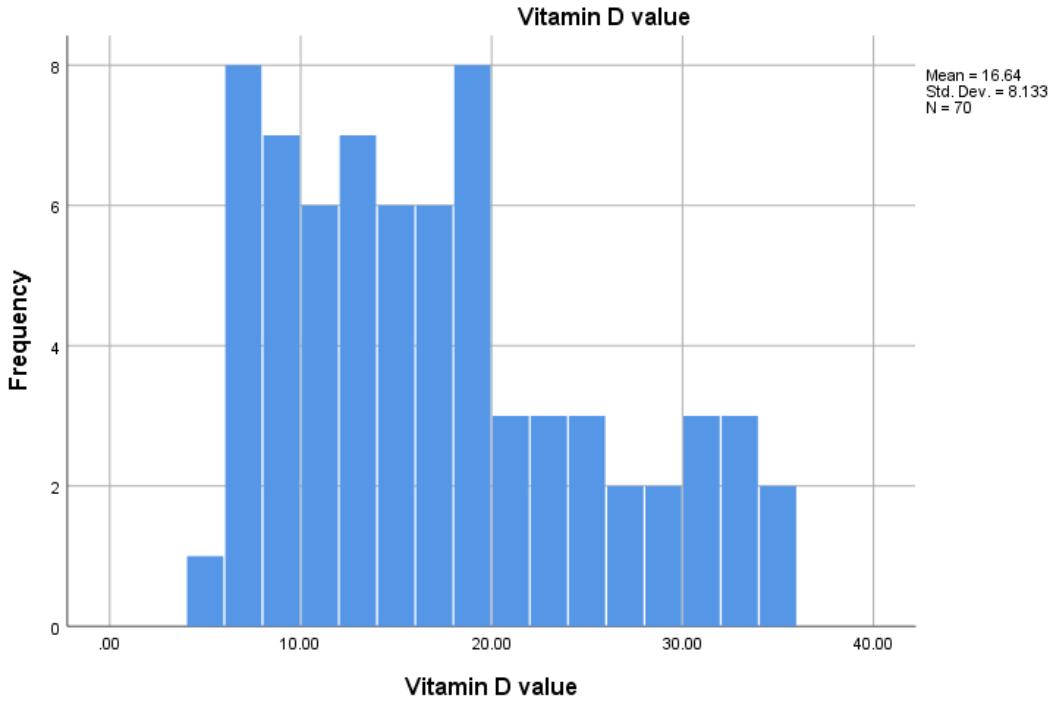

Figure 5.24:This bar chart is representing the distribution of Vitamin D levels. Vitamin D value ranged from 5.00 to 35.00, with an average of 16.64 including a standard deviation of 8.13. Collectively, the distribution indicates that major proportion of participants had low vitamin D levels which is an indication of high prevalence of vitamin d deficiency in our research.

Table 5.23: crosstabulation of hospital type and phosphate binders

Types of Hospital * Phosphate Binders Crosstabulation				
		Phosphate Binders		Total
		Yes	No	
Types of Hospital	Government	11	24	35
	Private	26	9	35
Total		37	33	70

Thee comparetive table shows the connection between the peoples implementation of phosphate medications and the hospital category. Eleven responders who visited public institutions used phosphate binders, whereas twenty-four did not. On the other hand, only nine contributors from private health care did not managed phosphate medications, as opposed to 26. Entirely, 37 of the 70 peoples said they applied phosphate binders, whereas 33 said they didn't. This denotes that respondents seeking care in private care units were highly possible than those in public care centers to apply phosphate binders.

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Table 5.24 : Association between the type of hospital and the use of phosphate binders.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.899	1	.001

Table 5.25: Prevalence of mineral bone disease (MBD)

Prevalence of mineral bone disease (MBD)		
	Frequency	Percent
Yes	50	71.4
No	20	28.6
Total	70	100.0

Table 5.26: Cross tabulation of MBD and hospital type

Prevalence of mineral bone disease (MBD) * Types of Hospital Crosstabulation				
		Types of Hospital		Total
		Government	Private	
Prevalence of mineral bone disease (MBD)	Yes	29	21	50
	No	6	14	20
Total		35	35	70

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Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20525680

Table 5.27: Correlation of mineral bone disease and hospital type:

Chi-Square Test			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	28.000	1	.001

DISCUSSION

Per many global research survey conducted in both developed and developing nations,our sample showed high anomaly rates of mineral bone biochemical anomalies (71.4%). A similar india-based study found, mineral bone abnormalities were discovered in 74%of cases 40 rapid remodeling and 34% having high turnover and adynamic bone disease, respectivly.Another India work by, Vikrant et al. revealed that 6,58% had high turnover which is increase in pth level and 18% faced slow disease low turnover illness.These findings align with our work(51).

A 2025 study reported 19.7% of 127 dialysis cases at Peshawar's Reading hospital had SHPT, average age of 51.8 ± 15 years, closely matching the 51.6 ± 14.8 years in our work. Matching our results of elevated lab abnormalities with extended dialysis duration , this study showed that dialysis patients beyond 24 months had notablely raised iPTH versus shorter treatment time (p=0.012) 62.5% of the 136 dialysis cases in a Pakistan cross- sectional study by Khan's team(2025)showed SHPT , defined as PTH greater than 70 pg/ml plus low calcium and low vitamin D. This rate is much higher than our 50% raised iPTH , possibly because of differing SHPT definition criteria.(52) .

South Africa showed 73.4% hyperparathyroidism , far above DOPP's 31 percent (china 9.5%). India's HD group had 1282.7% had SHPT (40.6% with iPTH >400) . Unlike DOPPS phase4's 11%(American's/Europe) with iPTH >600 , nearly 22% of GCC DOPPS subjects showed iPTH levels >600 and Brazil's 27.1% almost had iPTH >600. Diet ,race , drug adherence , dialysis access, frequency , and scripts explain differences(53).

In terminology of co-occuring disorders, a substantial percentage of research contributors had diabetes mellitus (62.9%) and hypertension (75.7%). These findings show the frequency of chronic kidney disease (CKD) across the globe, where diabetes and hypertension persist to be the main reasons of end-stage renal disease (ESRD). Our research's 40% frequency of cardiaovascular disease (CVD) is in row with the understanding that CVD is a significant factor to dialysis patients' disease rate and death rate. Based on the literature, the CKD-MBD syndrome by nature causes cardiovascular incidents and vascular calcification (54) .

Our research's substainable hyperphosphatemia frequency is stable with other local results. Based on a large Chinese research with 7,053 hemodialysis individuals, serum phosphorus levels with a

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Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20525680

goal achievement frequenty of solely 24.3%, hyperphosphatemia persists to be a severe worldwide issue. In a comparable vein, the Brazilian research discovered that 52% of their patients had hyperphosphatemia; yet, this is below than what we observed, maybe because of differences in nutritional, phosphate binder compliance,or dialysis adequacy.(55).

Ninety percent of our respondents had a average iPTH level of 217.8 pg/mL that was showing vitamin D deficiency was 90% of our research population.Cause of many reasons, like reduced renal transformation of 25(OH)D to its bioactive form $1,25(OH)_2D$, nutritional limitations, reduced UV exposure, and protein loss while dialysis, a high prevalence of vitamin D deficiency is predicted in dialysis patients. (56).

Hemodialysis patients have much lower $25(OH)D_3$ levels (15 ng/mL vs. 22 ng/mL) and higher incidence of low levels(69% vs. 39%) than the common people, according to a present research from Poland by Rutkowski et al. (2025). The vitamin D ratio of biomarkers, that have consequences for upcoming techniques for evaluation, was given in the similar research as a more responsive marker of vitamin D deficiency in dialysis population(57).

This study has several limitations that should be be keep in mind when using the findings. At the very First, the sample size of 70 patients which is very small, while limits subgroup analyses. Secondly, bone disease classification was based on biochemicalvalues (iPTH)not through bone biopsy,which is the gold standard. However, KDIGO guidelines accept biochemical classification for clinical decision-making. Third, the cross-sectional design precludes assessment of temporal changes.Strengths include balanced recruitment from private and government hospitals, a comprehensive panel of biochemical markers, and detailed medication and dialysis adequacy data.

CONCLUSION

The conclusion of this study is that there is a considerable load of mineral and bone disease among patients undergoing hemodialysis, with biochemical abnormalities.The there were irregularities seen like vitamin D deficiency, hypocalcemia, and increasedlevels of parathyroid hormone. And the dominant pattern of mineral one disease was High-turnover bone disease Significant inequalities were seen between two type of healthcare sectors that was private and government regarding biochemical control These findings highlight the bases that there is critical need for improved monitoring stratigies , enhanced medication accessibility in order to to alleviate the weight of mineral bone disease in this population.

The findings of this study highlight the need to develop specific medical protocols for mineral bone disorder (MBD) according to the Pakistani population. These protocols should incorporate regional demographic patterns, socioeconomic limitations, and class-specific biochemical target ranges. Furthermore, the national Essential Medicines List of Pakistan should include important medications such as calcimimetics (cinacalcet), active vitamin D analogues (calcitriol and paricalcitol), and non-calcium-based phosphate binders including sevelamer and lanthanum. Local pharmaceutical production should be encouraged to reduce treatment costs, while government procurement systems should ensure equal availability of these medicines across all public dialysis

Pakistan Journal of Medical & Cardiological Review
https://pakjmcr.com/index.php/1/about
Online ISSN 3007-2387
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centers. Patients undergoing dialysis for more than 36 months should be monitored more frequently, preferably every 1–2 months, and all hemodialysis patients should routinely be screened for vitamin D deficiency. In addition, patients with vascular calcification or persistent hypercalcemia should preferably receive non-calcium-based phosphate binders, while medication adherence should be assessed during every dialysis session with dosage adjustments according to dietary intake.

Despite its significance, the study had several limitations. The research was conducted in only two hospitals within a single urban center in Lahore, which limits the generalizability of the findings to the wider population of Pakistan. Additionally, the relatively small sample size of 70 patients may not adequately support extensive multivariate analysis. The cross-sectional study design assessed biochemical parameters at a single point in time, limiting the ability to evaluate long-term changes and causal relationships. Data collection regarding medication adherence depended largely on patient self-reporting, which may have resulted in overestimation of compliance. Moreover, the study did not include diagnostic tools such as DEXA scanning or bone biopsy for direct assessment of bone density, and classification of bone disease patterns was based only on biochemical markers.

7.2: CHAPTER 8
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