ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 08 | August - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

PREVALENCE AND DETERMINANTS OF OSTEOPOROSIS IN PATIENTS WITH CHRONIC KIDNEY DISEASE ON MAINTENANCE HEMODIALYSIS: A CROSS-SECTIONAL STUDY

Nephrology

Dr. Aniket Premanand Malve*	Assistant Professor *Corresponding Author
Dr. Kshitija Gadekar	Professor and Head, Department of Nephrology
Dr. Gauri Kulkarni	Assistant Professor
Dr. Pranav Kulkarni	3rd Year Senior Resident
Dr. Amulya Sharma	2nd Year Senior Resident
Dr. Sudhir Kulkarni	Honorary Professor

ABSTRACT

Background: Osteoporosis is a common but under-recognized complication in patients with Chronic Kidney Disease (CKD) on maintenance hemodialysis (MHD). This study aims to estimate the prevalence and clinical correlates of osteoporosis in this population. **Methods:** We conducted a cross-sectional study on 100 adult CKD patients receiving MHD for >6 months at our tertiary care hospital. Data collected included demographics, clinical history, biochemical parameters (serum calcium, phosphate, alkaline phosphatase, iPTH, and vitamin D), and bone mineral density (BMD) measured via DEXA scan.

KEYWORDS

Osteoporosis, Hemodialysis, Chronic Kidney Disease, DEXA, Bone Mineral Density, iPTH

INTRODUCTION

Osteoporosis is a skeletal disorder characterized by reduced bone strength, predisposing individuals to an increased risk of fractures. In patients with chronic kidney disease (CKD), particularly those on maintenance hemodialysis (MHD), bone health is significantly compromised due to complex disturbances in calcium, phosphate, vitamin D, and parathyroid hormone (PTH) metabolism. This constellation of mineral and bone abnormalities in CKD is referred to as CKD–Mineral and Bone Disorder (CKD-MBD).

Patients on MHD are prone to high bone turnover (secondary hyperparathyroidism) or adynamic bone disease, both contributing to poor bone quality and increased fracture risk. Despite this, osteoporosis in CKD remains underdiagnosed due to lack of routine screening and the complexity of interpreting bone health in this population.

This study was conducted to assess the prevalence of osteoporosis in CKD patients on MHD and to identify associated clinical and biochemical risk factors to guide early detection and management.

MATERIALS AND METHODS

Study Design & Participants

This was a single-center, cross-sectional observational study conducted in the Department of Nephrology, MGM Hospital and Research Centre, Chhatrapati Sambhaji Nagar, over a period of 6 months (January 2025 – June 2025).

Inclusion Criteria

- Age ≥ 18 years
- Diagnosed with CKD Stage 5D and on MHD for >6 months
- Provided informed consent

Exclusion Criteria

- Acute illness or hospitalization in the past 1 month
- Patients on corticosteroids, bisphosphonates, or hormone therapy
- Known history of primary bone disease unrelated to CKD

Data Collection

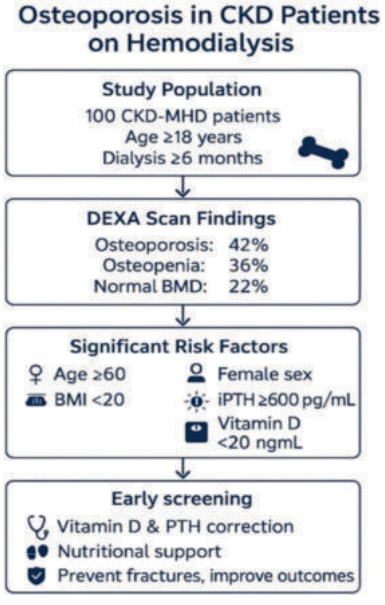
Demographic Details: Age, Gender, Height, Weight, BMI, duration of dialysis

Laboratory tests: Serum calcium, phosphate, alkaline phosphatase (ALP), intact parathyroid hormone (iPTH), and 25(OH) vitamin D

Imaging: BMD was measured using dual-energy X-ray absorptiometry (DEXA) at the lumbar spine and femoral neck. WHO classification was used:
Normal: T-score ≥ -1
Osteopenia: T-score between -1 and -2.5
Osteoporosis: T-score ≤ -2.5

Statistical Analysis

Data were analyzed using SPSS version 26. Continuous variables were expressed as mean ± SD. Chi-square test and independent t-tests were used for comparison. p-value <0.05 was considered statistically significant



RESULTS

A total of 100 adult CKD patients on maintenance hemodialysis (MHD) were enrolled. The mean age was 57.3 ± 12.6 years, and 64% were male. The average duration of dialysis was 3.2 ± 1.8 years, and the mean BMI was 21.7 ± 3.5 kg/m². Comorbidities included diabetes mellitus (48%) and hypertension (76%).

Bone Mineral Density (BMD) Distribution:
42% of patients were diagnosed with osteoporosis (T-score ≤ -2.5).
36% had osteopenia (T-score between -1.0 and -2.5).
Only 22% had normal BMD (T-score ≥ -1.0).

This indicates that 78% of the dialysis population had some degree of low bone mass.

Biochemical Profile:

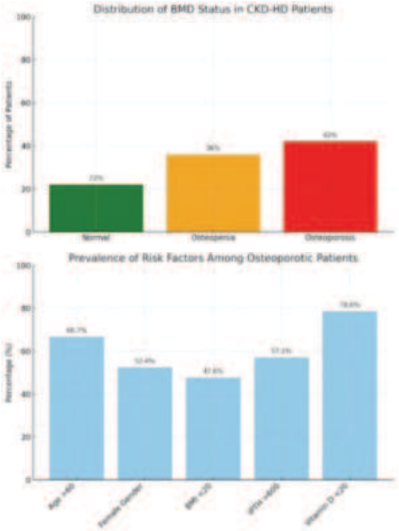
Parameter	Mean ± SD
Serum Calcium (mg/dL)	8.1 ± 0.7
Phosphorus (mg/dL)	5.6 ± 1.2
Alkaline Phosphatase (IU/L)	190 ± 68
iPTH (pg/mL)	585 ± 280
25(OH) Vitamin D (ng/mL)	18.2 ± 7.6

A high proportion of patients exhibited hypovitaminosis D and elevated iPTH, consistent with CKD–Mineral and Bone Disorder (CKD-MBD).

Factors Associated with Osteoporosis:

Risk Factor	Osteoporosis Group (n=42)	p-value
Age > 60 years	28 (66.7%)	0.003 ★
Female Gender	22 (52.4%)	0.031 ★
BMI < 20 kg/m²	20 (47.6%)	0.012 ★
iPTH > 600 pg/mL	24 (57.1%)	0.045 ★
Vitamin D < 20 ng/mL	33 (78.6%)	<0.001 ★

Statistically significant associations were found between osteoporosis and:
Older age (likely due to bone loss from aging and comorbidities)
Female gender (postmenopausal status contributing to estrogen deficiency)
Low BMI (suggesting nutritional deficits)
Elevated iPTH (reflecting high bone turnover)
Severe vitamin D deficiency, which impairs calcium absorption and bone mineralization



DISCUSSION

Our study demonstrates a strikingly high prevalence (42%) of osteoporosis among CKD patients on maintenance hemodialysis, with an additional 36% exhibiting osteopenia. This aligns with global literature, which reports BMD abnormalities in 60–80% of patients with advanced CKD. The significant burden of skeletal fragility in this population is a major concern, especially given the increased risk of falls, fractures, hospitalization, and mortality.

Comparison with Prior Studies:

Our prevalence findings are similar to those of Nickolas et al. (2008), who reported over 50% bone loss in dialysis patients. Jadoul et al. (2006) also observed that hemodialysis patients have a 4–6 times higher fracture risk than the general population.

Age and Gender:
The strong association between age >60 years and osteoporosis is consistent with normal senile bone loss compounded by uremia-related bone changes. Furthermore, females, especially post-menopausal women, are at higher risk due to reduced estrogen, which plays a protective role in bone metabolism.

Nutritional Status:
A low BMI (<20) emerged as a strong predictor of osteoporosis. Poor nutrition and muscle wasting are common in dialysis patients and may contribute to both low bone mass and increased fall risk.

Vitamin D Deficiency and PTH Imbalance:
Our results emphasize that vitamin D deficiency (<20 ng/mL) and secondary hyperparathyroidism (iPTH >600 pg/mL) are significantly associated with osteoporosis. The deranged mineral metabolism in CKD, involving calcium-phosphorus imbalance, reduced vitamin D activation, and PTH overactivity, leads to impaired bone remodeling.

Interestingly, while PTH levels were elevated in many patients, adynamic bone disease cannot be ruled out without bone biopsy. However, our data suggest a predominance of high turnover bone disease.

Clinical Implications:
These findings highlight an urgent need for:
Routine DEXA screening in dialysis patients
Correction of vitamin D deficiency
Better control of PTH with medications like calcimimetics
Nutritional support to maintain adequate BMI
Avoidance of unnecessary phosphate binders and aluminum toxicity

Strengths and Limitations:
Strengths: First such cross-sectional analysis from our region, well-defined biochemical workup, and inclusion of 100 MHD patients.

Limitations: Single-center design, lack of bone biopsy for definitive diagnosis, and absence of fracture history tracking

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