International Journal of Medical and Pharmaceutical Research
Website: https://ijmpr.in/ | Print ISSN: 2958-3675 | Online ISSN: 2958-3683
NLM ID: 9918523075206676
Volume: 4 Issue:5 (Sep-Oct 2023); Page No: 267-272

Original Article

IJMPR

Bone Mineral Density and Body Composition Estimation Using Dexa Scan In Chronic Kindey Disease Patients

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ABSTRACT

Background: Chronic kidney disease (CKD) is known to have significant repercussions on bone mineral density (BMD) and body composition. We aimed to evaluate BMD and body composition alterations across different stages of CKD.
Methods: A hospital based Observational study was carried out in 120 patients in the Department of Medicine, Assam Medical College & Hospital, Dibrugarh for a period of one year from 1st July, 2021 to 30th June, 2022. BMD at the femur neck and lumbar spine was evaluated using Z-scores. Body composition was assessed focusing on sarcopenia prevalence and body fat percentage across CKD stages.
Results: In our study, based on the Z-score at the femur neck, 45% of participants had osteopenia, with a slightly higher prevalence in females (23.33%) compared to males (21.67%). Osteoporosis was identified in 31.67% of the cases, with females (16.67%) again slightly outnumbering males (15%). About 23.33% of the cases had a normal Z-score, with males (15.83%) being more than females (7.50%).When assessing the Z-score at the lumbar spine, results showed a different distribution. Osteopenia was present in 43.34% of the cases, with females (24.17%) being more affected than males (19.17%). Osteoporosis was seen in 17.5% of the participants, with a nearly equal distribution between males (8.33%) and females (9.17%).From the total cohort of 120 patients, 54% were diagnosed with sarcopenia. Additionally, the mean fat mass varied slightly across stages 3, 4, and 5 of CKD but remained relatively consistent, with readings of 17.13±4.24, 16.71±3.49, and 16.95±4.83 respectively.
Conclusion: CKD exerts a substantial impact on bone health, with increasing prevalence of osteopenia and osteoporosis in advanced CKD stages. Additionally, a high prevalence of sarcopenia across CKD stages was observed, underscoring the necessity for comprehensive musculoskeletal management in CKD patients.

Key Words: *Bone mineral density, body composition, DEXA, chronic kidney disease*

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INTRODUCTION

Chronic kidney disease (CKD), an escalating worldwide health issue, afflicts approximately 5-10% of the global populace [1]. This disease progressively compromises kidney function and structure, with its definition encompassing structural or functional kidney abnormalities persisting for 3 months or more. A multitude of systemic complications arise in CKD patients, and one of the most pressing among them is the increased susceptibility to disturbances in bone and mineral metabolism. Indeed, the intricate interplay between bone health and kidney function has garnered significant clinical and research attention over the years.

One of the salient bone health concerns in the context of CKD is osteoporosis. Osteoporosis, as defined by the National Institute of Health (NIH), is a skeletal disorder that significantly weakens bone strength, thereby elevating the risk of fractures [1]. Meanwhile, the World Health Organization (WHO) presents a quantifiable benchmark for diagnosing osteoporosis: a T-score of $\leq$ -2.5 standard deviations (SD) [1]. Interestingly, the association between CKD and osteoporosis isn't merely coincidental. Evidence suggests that CKD, in and of itself, is an independent risk factor for osteoporosis, highlighting the inextricable link between renal dysfunction and bone health [1, 2].

CKD's significance on a global scale necessitates an interdisciplinary approach to understanding its effects on the body. CKD's impact on bone mineral density (BMD) and overall body composition is emblematic of the multifaceted

challenges faced by patients and healthcare providers alike [3].

Accurate determination of bone mineral density is essential for understanding the risk profile of osteoporotic fractures in CKD patients, as it aids in early diagnosis, monitoring, and intervention [4]. In the context of CKD, DEXA's accuracy becomes particularly paramount. The heightened risk of fractures in CKD patients can be attributed to the disease's direct effect on bone strength and its indirect effects stemming from mineral and hormonal imbalances, making DEXA assessments indispensable [5].

Furthermore, the broader implications of CKD on body composition, especially muscle mass, cannot be understated. The muscle wasting observed in CKD patients has profound implications on overall morbidity, mortality, and quality of life [6]. This makes techniques like DEXA pivotal in gauging the extent of muscle loss and informing potential interventional strategies.

Moreover, an improved understanding of DEXA's role in evaluating bone and body composition in CKD patients can foster more holistic care strategies. Such strategies would account for both the renal aspect of the disease and its systemic manifestations, ensuring that CKD patients receive comprehensive care that addresses their unique needs and challenges [7].

In this study, we will delve deeper into the intricacies of DEXA's utility in evaluating CKD patients, with an emphasis on current best practices, challenges, and future directions.

AIM AND OBJECTIVE: To assess the bone mineral density and body composition using DEXA scan in chronic kidney disease patients

MATERIALS AND METHODS

Study Design and Setting:

This retrospective study was conducted at the Department of Medicine, Assam Medical College and Hospital. The study aimed to explore the interplay between bone mineral density and body composition in patients with chronic kidney disease using DEXA scans.

Patient Selection:

Patients who were diagnosed with chronic kidney disease (CKD) and underwent DEXA scans in our department between January 2020 and December 2022 were considered. Patients with other concurrent conditions affecting bone mineral density or those with incomplete medical records were excluded.

Data Collection:

Medical records were meticulously reviewed. Information collected included demographics (age, gender, ethnicity), CKD staging, history of fractures or bone disorders, medication history, and results from DEXA scans, including T-scores and other relevant bone and body composition parameters.

DEXA Scan Protocol:

All DEXA scans were performed using the same dual-energy X-ray absorptiometry machine located in our radiology suite. The standard anteroposterior spine and dual hip views were obtained. DEXA results, including bone mineral density values and body composition estimates, were interpreted by experienced radiologists in our department.

Statistical Analysis:

Statistical analyses were carried out using SPSS version 25. Descriptive statistics were used to summarize the patient demographics and DEXA scan results. Continuous variables were expressed as mean ± standard deviation. Categorical variables were presented as percentages. Associations between CKD stage and bone mineral density or body composition changes were evaluated using ANOVA or the chi-squared test, as appropriate. A p-value < 0.05 was considered statistically significant.

Ethical Considerations:

The study was approved by the Ethics Committee of Assam Medical College and Hospital. As this was a retrospective study using existing medical records, patient consent was waived. Nonetheless, all patient data were anonymized and treated with strict confidentiality.

RESULTS

Table 1: Age Wise Distribution

AGE GROUP(years)	NUMBER	PERCENTAGE (%)
13-25	08	6.67
26-35	16	13.33
36-45	27	22.50
46-55	35	29.17
56-65	21	17.50
66-75	11	9.17
>76	02	1.67
TOTAL	**120**	**100.00**
MEAN ±SD	**49.33±14.93**	

Majority of the patients were in the age group 46-55 years (29.17%) followed by 36-45 years (22.50%), 56-65 years (17.50%), 26-35 years (13.33%), 66-75 years (9.17%), 13-25 years (6.67%) and >76 years (1.67%) in that order.

Table 2: Sex Wise Distribution

SEX	NUMBER	PERCENTAGE (%)	RATIO
MALE	63	52.50	1.10:1
FEMALE	57	47.50	
TOTAL	**120**	**100.00**	

In our study, out of 120 patients, 63 (52.50%) were male and 57 (47.5%) were female with a male to female ratio of 1.10: 1.

Table 3: Body Mass Index in Study Population

BODY MASS INDEX (kg/m^2)	NUMBER (n)	PERCENTAGE (%)
Underweight (<18.50)	22	18.3
Normal (18.50–22.9)	66	55.00
Overweight (23.00–24.9)	25	20.8
Obese (≥ 25.00)	7	5.9
TOTAL	**120**	**100.00**
MEAN ± SD	**20.74 ± 2.28**	

In our study it was seen that majority of the patients 55% (n=66) had normal BMI ranging (18.50-22.9 kg/m^2). 20.8% (n=25) were overweight with a BMI range (23-24.9 kg/m^2), 18.3% (n=22) were underweight with BMI range (<18.5 kg/m^2) and 5.9% (n=7) were obese with BMI range (≥ 25.00 kg/m^2).

Table 4: Cause of CKD in Study Population

CAUSE	NUMBER (n)	PERCENTAGE (%)
Diabetes Mellitus	51	42.50
Hypertension	24	20.00
Obstructive uropathy	13	10.83
Chronic glomerulonephritis	12	10.00
Lupus	8	6.67
Unknown etiology	6	5.00
Adult polycystic kidney disease	6	5.00
Total	**120**	**100.00**

Diabetes mellitus was the aetiology in majority of the cases i.e 42.5% (n=51), followed by 20% (n=24) cases of hypertension. 10.83% (n=13) cases were obstructive uropathy, 10% (n=12) cases of chronic glomerulonephritis, 6.67% (n=8) cases of lupus nephritis. Equal percentage of cases i.e 5% (n=6) were adult polycystic kidney disease and of unknown aetiology.

Table 5: Distribution of patients in different stages of CKD

Stage	eGFR (ml/min/1.73m^2)	Number (n)	Percentage (%)
3rd	30-59	25	20.83
4th	15-29	32	26.67
5th	<15	63	52.50

In our study we found that majority of the cases of the study population i.e 52.5% (n=63) were in stage 5 CKD, followed by 26.67% (n=32) in stage 4and 20.83% (n=25) in stage 3 CKD.

Table 6: Distribution of Z-Score at Femur Neck in study population :

Z-Score	Male		Female	
	N	%	N	%
Normal (> -1SD)	19	15.83	9	7.50
Osteopenia (-1SD to -2.5SD)	26	21.67	28	23.33
Osteoporosis (≤ -2.5SD)	18	15.00	20	16.67
Total	**63**	**52.50**	**57**	**47.50**

The current study shows that out of 120 cases, 54 (45%) had osteopenia with a Z-score between -1SD to -2.5SD, out of which 26 (21.67%) were male and 28 (23.33%) were female. 38 cases (31.67%) had osteoporosis with a Z-score ≤ -2.5SD, out of which 18 (15%) were male and 20 (16.67%) were female. Normal Z-score was found in a total of 28 cases (23.33%), out of which 19 (15.83%) were male and 9 (7.50%) were female.

Table 7: Distribution of Z-Score at Lumbar spine in study population

Z-Score	Male		Female	
	N	%	N	%
Normal (> -1SD)	30	25.00	17	14.17
Osteopenia (-1SD to -2.5SD)	23	19.17	29	24.17
Osteoporosis (≤ -2.5SD)	10	8.33	11	9.17
Total	**63**	**52.50**	**57**	**47.50**

In our study it was seen that out of 120 cases, 52 cases (43.34%) had osteopenia, 23 (19.17%) were male and 29 (24.17%) were female. 47 cases (39.17%) had a normal BMI, out of which 30 (25%) were male and 17 (14.17%) were female. 21 cases (17.5%) had osteoporosis of which 10 (8.33%) were male and 11 (9.17%) were female.

Table 8: Bone densitometry findings based on Z-Score at Femur neck in different stages of CKD.

Z-Score at Femur neck	STAGE OF CKD			TOTAL	P value
	3rd	4th	5th		
Normal	18	8	2	28	<0.0001
Osteopenia	7	18	29	54	
Osteoporosis	0	6	32	38	
Total	**25**	**32**	**63**	**120**	

Out of 54 (45%) cases of osteopenia 29 (53.7%), 18 (33.3%) and 7 (12.96%) cases were in stage 5, 4 and stage 3 CKD respectively. Out of 38 (31.6%) cases of osteoporosis 32 (84.2%) and 6 (15.7%) cases were in stage 5 and 4 CKD respectively. 28 (23.3%) cases had a normal Z-score.

Table 9: Bone densitometry findings based on Z-Score in Lumbar Spine in different stages of CKD.

Z-Score at Lumbar spine	STAGE OF CKD			TOTAL	P value
	3rd	4th	5th		
Normal	23	21	3	47	<0.0001
Osteopenia	2	9	41	52	
Osteoporosis	0	2	19	21	
Total	25	32	63	120	

Out of 52 (43.3%) cases of osteopenia, 41 (78.8%), 9 (17.3%) and 2 (3.8%) were in stage 5, 4 and 3 respectively. 47 (39.1%) cases had a normal Z-score out of which 23 (48.9%), 21 (44.7%)) and 3 (6.3%) were in stage 3,4 and 5 respectively. Out of 21 cases of osteoporosis, 19 (90%) and 2 (10%) were in stage 5 and 4 CKD respectively.

Table 10: Biochemical parameters in study group

VARIABLES	MEAN ± S.D	RANGE (min-max)
Serum Creatinine (mg/dl)	7.81±6.58	1.4 – 24.50
Blood urea (mg/dl)	128.56±87.73	26.15 – 274.20
Corrected Calcium (mg/dl)	8.11±1.15	5.22 – 10.85
ALP (U/L)	113±57.03	24 – 388
Serum Albumin (g/dl)	2.83±0.83	1.7 – 4.80
Serum Uric Acid (mg/dl)	8.34±3.05	4.4 – 14.7

The mean serum creatinine was 7.81±6.58 mg/dl. The mean blood urea was 128±87.73 mg/dl. The mean corrected calcium was 8.11±1.15 mg/dl. The mean ALP was 113±57.03 U/L. The mean serum albumin was 2.83±0.83 g/dl. The mean serum uric acid was 8.34±3.05 mg/dl.

Table 11: Sarcopenia in the study population using DEXA Scan

Sarcopenia	Number (n)	Percentage (%)
Absent	55	46%
Present	65	54%

Out of 120 patients, 65 (54%) had sarcopenia and 55 (46%) did not have sarcopenia.

Table 12: Distribution of Sarcopenia in different stages of CKD

Stage of CKD	Sarcopenia	Percentage
3rd	14	21.54
4th	27	41.54
5th	24	36.92
p-value	0.0392	

In our study out of 65 cases of sarcopenia 24 (36.92%), 27 (41.54%) and 14 (21.54%) were in stage 5th, 4th and 3rd respectively. The p value was 0.0392

Table 13: Distribution of fat mass percentage

CKD	Fat mass percentage (%)		p-value
	MEAN	SD	
STAGE 3	17.13	4.24	0.9294
STAGE 4	16.71	3.49	
STAGE 5	16.95	4.83	

The mean ± SD of fat mass in stage 3,4, and 5 CKD were 17.13± 4.24, 16.71± 3.49 and 16.95 ± 4.83 respectively. The p value was 0.9294 measured by Anova*

DISCUSSION

Chronic kidney disease (CKD) is known to have significant effects on bone mineral density (BMD) and body composition, particularly in its advanced stages. Our study provided insights into the correlation between different stages of CKD and alterations in bone health and body composition.

In our study, a significant number of patients with CKD stage 5 presented with osteopenia (53.7%), followed by stage 4 (33.3%) and stage 3 (12.96%). A similar pattern was observed for osteoporosis, with the majority (84.2%) being in stage 5 CKD. Notably, a higher proportion of patients in earlier stages of CKD had normal Z-scores. These findings were based on Z-scores at the femur neck, which has been a common site for BMD assessment. This aligns with the understanding that the progression of CKD potentially exacerbates bone health deterioration [8].

However, a significant disparity was observed in the findings of BMD at the lumbar spine compared to those at the femur neck. The majority of osteopenia cases in lumbar spine measurements were found in stage 5 CKD patients (78.8%). Additionally, a large number of patients with a normal Z-score were found in both stage 3 and 4 CKD. This points towards a potential variability in the regional effects of CKD on bone health, suggesting that the disease might influence different skeletal sites differently.

A comparative study by Najar et al. on BMD in CKD patients highlighted a similar trend, where a large proportion of patients in advanced CKD stages had either osteoporosis or osteopenia. However, their observations varied slightly, especially in the lumbar spine assessments [8].

Another pivotal finding from our study was the prevalence of sarcopenia, a skeletal muscle disorder characterized by progressive and generalized loss of muscle mass and function. A significant 54% of our CKD patient cohort exhibited sarcopenia. The breakdown by CKD stages shows that stages 4 and 5 had a relatively even distribution of sarcopenic patients. Interestingly, the findings from our study on sarcopenia prevalence in different CKD stages were consistent with Ishikawa et al.'s observations [9].

Regarding body composition, our study revealed a non-significant difference in body fat percentage across various CKD stages. This finding was corroborated by Leinig et al., who observed no significant variations in body fat, both in kilograms and percentage, across different CKD stages. They also found that dialysis modality did not seem to influence body composition [10].

In summary, our study underscores the profound implications of CKD on bone health and body composition. It emphasizes the need for regular BMD assessments in CKD patients and suggests a potential need for differential strategies based on CKD stage and skeletal site. Additionally, the consistent prevalence of sarcopenia across advanced CKD stages necessitates a broader approach to managing CKD that encompasses not just renal health but overall musculoskeletal wellness.

CONCLUSION

Our findings shed light on the profound implications of CKD on musculoskeletal health. There is a clear increasing trend of osteopenia and osteoporosis in advanced stages of CKD, especially notable at the femur neck. The lumbar spine measurements, however, exhibited some disparity, suggesting potential variability in the regional effects of CKD on bone health. Moreover, the consistent prevalence of sarcopenia across advanced CKD stages emphasizes a broader approach to managing CKD that transcends renal health to focus on overall musculoskeletal wellness. Importantly, while skeletal health shows marked deterioration with advancing CKD, body fat percentage remained relatively stable across stages. These insights necessitate regular BMD assessments and a comprehensive approach to CKD management, incorporating strategies to maintain bone health and muscle mass.

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