

Assessment of Osteoporosis Risk Factors in Low Socioeconomic Status Hemodialysis Patients in Jeddah

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Abstract: Osteoporosis is common in hemodialysis patients and closely related to fracture. This study was carried out in the dialysis center of Al-Bir society, Jeddah, King Saudi Arabian, to determine the frequency and severity of osteoporosis risk factors in dialysis patients. In a cross-sectional analytical study, a group of 56 patients were assessed using demographic, medical history and anthropometric measurements including (height, weight and body mass index (BMI)). A biochemical measurement including [parathyroid hormones (PTH), calcium (Ca), phosphorus (P) and vitamin D (Vit. D)] levels were examined. As well as hemodialysis status and estimation of dietary pattern plus food intake using a 4 days dietary record were estimated. It has been found that (57.1% and 55.4%) of the total patients have high PTH and P levels, respectively. Around 5% of the patients showed low serum Ca level and 75% showed low Vit. D level. Parathyroid problems were found in 67.9% after starting of H.D treatment. Seventy percent of the patients indicated that they suffered from bone problems while 5.4% have been diagnosed with osteoporosis. The 4-days dietary record showed that most of the patients (44.6%) did not attained the recommended intake of Ca and Vit. D. However, about 21.4% of the patients showed a high P intake. Serum Vit. D level was significantly related with gender ($p < 0.001$) and it was higher in males than females. In addition, a significant positive correlation was found between serum P and dietary P intake ($r = 0.379$, $P = 0.004$). Negative significant relationship was showed between serum P and Ca intake ($r = -0.267$, $P = 0.046$). The study suggested that some risk factors for osteoporosis found in H.D. patients, such as, low BMI and dialysis status may relate to bone problems and abnormal nutrients intake (Ca, Vit. D, P and K).

Key words: Hemodialysis • Osteoporosis • Risk factors • Bone problems • Parathyroid hormones

INTRODUCTION

People with two healthy kidneys have 100% organ functions, including remove extra-fluid and waste from the blood through the urine, help keep chemicals (such as sodium, potassium and calcium) balanced in the body, make hormones that help control blood pressure, stimulate bone marrow to make red blood cells, control calcium metabolism and produce an active form of Vit. D [1, 2]. Mild declines in kidney functions by as much as 30 to 40 % are rarely noticeable and even people who are born with only one kidney or donate one of theirs can still lead normal healthy lives. Kidney functions are now estimated by glomerular filtration rate (eGFR) [1, 3]. Most kidney problems develop slowly. Gradual loss of kidney

function is called chronic kidney disease (CKD) or chronic renal insufficiency. People with CKD may go on to develop permanent kidney failure and also experience a high risk of death from a stroke or heart attack [4]. Serious kidney problems occur when there is less than 25 % of kidney functions; total or nearly total permanent kidney failure is also called end-stage renal disease (ESRD) occurs when it drops below 10 to 15 %, people with it must undergo some form of renal replacement therapy either by blood-cleansing treatment hemodialysis (H.D.), or a kidney transplant to sustain life [3].

In Saudi Arabia there were 14171 renal failure patients in 2012, out of them; 12844 patients were being treated *via* HD and 1327 patients *via* peritoneal dialysis. The western region of Saudi Arabia recorded the largest density of

patients treated *via* the HD method, the distribution indicating that 47% of them aged 26-55 years [5]. Osteoporosis "porous bone," is a disease in which the bones gradually become weak and brittle, leading to fractures, especially of the hip, wrist and spine even from simple activities like lifting a chair or bending over. Osteoporosis is a silent disease, as bone loss occurs without symptoms. There are no warning signs until a fragility fracture occurs. Osteoporosis-related fractures may occur in any bone, but are most likely to occur at sites of low bone mass, namely the vertebrae, distal radius, proximal femur and ribs. Osteoporosis is common among the elderly, but the disease can strike any age [6].

Bone histology is abnormal in the majority of patients with kidney failure [7]. The abnormalities that lead to bone disease begin to occur at earlier stages of chronic kidney disease. In the patients on HD, the risk factors for bone fractures were older age, female gender, low body mass index (BMI), peripheral vascular disease, increasing dialysis vintage, elevated parathyroid hormone (PTH) levels (exceeding 300 pg/ml) and phosphorus, abnormal Vit. D, reduced levels of calcium and urinary phosphate excretion have been described among patients with GFR<70 ml/min or lower and usage of drugs such as selective serotonin uptake inhibitors, antidepressants, benzodiazepines, narcotics and β -2 microglobulin amyloidosis [8-11].

Many studies have shown the presence of osteoporosis in patients on renal HD therefore, special attention should be given to the identification of nutrients conducive to better health in their condition. Thus, the main objective of this study was to identify the nutritional and other risk factors associated with osteoporosis of hemodialysis patients in Jeddah, Saudi Arabia.

Methodology

Study Population: A cross sectional analytical study was done in two charity hemodialysis centers. There are 120 End Stage Renal Disease patients (ESRD) in both centers. Almost 50% of the patients were chosen *via* random sampling technique, therefore our study sample was (n=56).

Data Collection Tools and Techniques: Many data collection tools and techniques were used; a questionnaire asking about demographic data, health information related to osteoporosis risk factors; medical and family history, bone health and hemodialysis status. The information was collected *via* both patient interviewing and using information in the medical record.

Anthropometric Assessments: Its directly obtained from the patients after HD procedure; measuring weight and height to calculated body mass index (BMI), which classified to thirds ranges (tertiles); small (<23.2 kg/m²), medium (23.2 to 27.8 kg/m²) and large (>27.8 kg/m²) [8].

Biochemical Assessments: Its taken from the medical records of each patient, including alkaline phosphatase (ALP), calcium (Ca), Phosphors (P), Vitamin D (Vit. D) and parathyroid hormone levels (PTH).

Dietary Assessment: The forms used for this study including both a 24-hour record for 4 days; two days during week, one weekend and one day when were having HD procedure. Other dietary habits questions (Medical Condition and Adequate Food Intake) were asked too. The respondent recorded foods and beverages plus the amount consumed by them. The amount consumed was asked to be measured using house-hold measures (e.g., cups or tablespoons).

Statistical Analysis: Statistical analyses of data were carried out using SPSS version 21. Variables were represented by percentile, frequency and mean values. Chi-square, person Test for measuring the difference between discrete variables and the association between continuing variables, confidence degree was 95% [12].

RESULTS AND DISCUSSION

The response rate was 100%. Half of the respondents were females. The mean age was 49.3±14.9 year with a range from 21 to 84 years. Almost one half (48.2%) in the age group of 41-60 year and (17.9%) of them in the age group more than 60 years old. Nearly about 41.1% of the patients have had a small BMI (< 23.2 kg/m²) and 17.9% their BMI more than 27.8 kg/m² (Table 1). Weight and fat mass loss may be an important point in bone loss [13], a higher BMI may independently influence the characteristics of bone by increasing the mass of adipose tissues, in of patients with ESRD lower BMI and female gender were independent associated with an increase rate of hip fracture [14]. The biochemical indicators reveled that almost 57.1% of the patients showed abnormal PTH (>300 pg/ml). Formerly, all of the sample have had abnormal blood urea nitrogen (BUN) (>20 mmol/L) while, about 53.6% of them have had abnormal albumin (<4.0 mg/dl) and 35.7 % of them got abnormal ALP (>115U/l). Only 5.4 % of the sample have had serum calcium of < 8.4 mg/dl and 31 of them have had serum phosphorus of

Table 1: Demographic characteristics and BMI of the patients.

Parameters	N=56	%
Gender		
Male	28	50.0
Female	28	50.0
Age Groups		
21-40	18	32.1
41-60	27	48.2
61-80	10	17.9
>80	1	1.8
BMI (kg/m ²)*		
Small (<23.2)	23	41.1
Medium (23.2 to 27.8)	23	41.1
Large (>27.8)	10	17.9

*[8]

Table 2: Serum biochemical indicators for osteoporosis.

Parameters	Abnormal renal range	N=56	%
PTH	>300 (pg/ml) ^[15]	32	57.1
BUN	>20 mmol/L ^[16]	56	100
Calcium	<8.4 mg/dL ^[15]	3	5.4
Phosphorus	>5.5 mg/dL ^[15]	31	55.4
Vitamin D	<16 ng/mL ^[17]	42	75.0
Potassium	>5mg/dL ^[17]	28	50.0
Albumin	<4.0 g/dL ^[17]	30	53.6
Alkaline Phosphate	>115U/l ^[18]	20	35.7

>5.5 mg/dl. Additionally, 42 of the patients have had Vit. D (<16 ng/dl) and 28 of them showed serum potassium of (>5 mg/dl) (Table 2).

One third of the patients had only one CRD as a one health problem (35.7%), while 33.9% of them had two health problems and 14.3% of our patients had three health problems. Almost 53.6% of the patients had previous surgery. Parathyroid hormone was increased in 66.1% of the patients after HD. Parathyroid gland surgery was done in 12.5% of the patients (Table 3). Only 8.9% of the patients have a family history of CKD and 12.5% of them had at least one family member on HD. One third of the sample (35.7%) did hemodialysis for more than 8 years and another one third (33.9%) were doing HD less than 4 years (data not shown). Almost tow third of the patients (70%) had bone problem; about 41.1% of them feels pain in the bone. Most of the problems associated with the bones of one causes 42.9%, 19.7% more than one cause and more reasoned it was after the start H.D. 30.4% of the patients have more than 34 months are suffering from problems in the bone, 30.4% of the patients suffering from bone problems in one area and 39.3% in two or more places. More places where the patient complains of them are: Right and Left/Patella, Spine (Thoracic Vertabria) and Right and Left/Foot (28%, 12% and 9%, respectively) (Table 4).

Table 3: Health status and parathyroid problems for the patients

Health status		N=56	%
Health problem	No	2	3.6
	1 Problems	20	35.7
	2 Problems	19	33.9
	3 Problems	8	14.3
	4 Problems	6	10.7
	5 Problems	1	1.8
Surgical	Yes	30	53.6
	No	26	46.4
Parathyroid problems.	Yes	--	--
	After H.D	18	67.9
	Before H.D	1	1.8
	No	17	30.4
Rise in PTH	Yes	--	--
	After H.D	37	66.1
	Before H.D	1	1.8
	No rise	18	32.1
Surgery to parathyroid gland			
	Yes	--	--
	After H.D	7	12.5
	Before H.D	2	3.6
	No	47	83.9

Table 4: Bone health problems in patients.

Measure		N=56	%
Family history of bone problem	Yes	5	8.9
	No	51	91.1
Problem in the bone	Yes	39	70
	No	17	30
Type of problem	No	7	30.4
	Pain	23	41.1
	Weakness	2	3.6
	Fracture	2	3.6
	Osteoporosis	3	5.4
	Osteoarthritis knee	1	1.8
	Broken foot and Pain	1	1.8
	Pain and Weakness	6	10.7
	Pain and Osteoporosis	1	1.8
Causes bone problems	No	17	30.4
	Unknown	4	7.1
	1 Reason	24	42.9
	2 Reasons	9	16.1
	3 Reasons	2	3.6
Length of bone problems (Month)	No	17	30.4
	1-11	11	19.6
	12-22	6	10.7
	23-33	5	8.9
	>34	17	30.4
Number of problem places	No	17	30.4
	1 location	17	30.4
	2 locations	13	23.2
	3 locations	7	12.5
	4 locations	2	3.6

Table 5: Dietary habits among H.D. patients

Measure		N=56	%
Appetite	Change	30	53.6
	Not Change	26	46.4
Satiety	Change	18	32.1
	Not Change	38	67.9
Discomfort after eating	Change	21	37.5
	Not Change	35	62.5
Chewing	Change	3	5.4
	Not Change	53	94.6
Swallowing ability	Change	5	8.9
	Not Change	51	91.1
Taste	Change	9	16.1
	Not Change	47	83.9
Diarrhea	Change	4	7.1
	Not Change	52	92.9
Constipation	Change	9	16.1
	Not Change	47	83.9
Other Complication	Change	30	53.6
	Not Change	26	46.4

Table 6: Mean of Nutrient Intake/Day (Food + Supplement)

Nutrients	Mean \pm SD	Normal range
Calcium mg/day	1915.48 \pm 1029.486	2500
Vitamin D mcg/day	1.93 \pm 2.244	20
Phosphorus mg/day	832.95 \pm 227.911	1000
Potassium mg/day	1182.59 \pm 936.015	3000

The main risk factors for persistent PTH are dialysis treatment [19]. Hyperparathyroidism and hyperphosphatemia were significantly associated with disorders of mineral metabolism [20], emerged as an important predictor of bone and muscle concerns [21] and fracture in HD. patients [20]. The excessive of PTH has

significant impact on bone remodeling by bone turnover increases about 50%, leading to increase resorption at the endosteal envelope, increased cortical porosity and thinning of cortical bone and anabolic effects on trabecular bone [22]. Numerous changes in the dietary habits of the patients' occurred; decreased appetite (53.6%), satiety (32.1%), discomfort after eating (37.5%), chewing change (5.4), swallowing problem (8.9%), taste change (16.1%), diarrhea (7.1%) and constipation (16.1%) (Table 5). Analysis of 4 days dietary and supplement intake showed that, about 78.6% of the patients were taking less than 2500 mg/day of calcium and the mean calcium intake was 1915.48 \pm 1029.49 mg/day. All of the patients took less than 20 mcg/day of Vit. D (mean of Vit. D intake was 1.93 \pm 2.244). Majority of the patients (91.1%) their potassium intake was less than 3000 mg/d (1182.59 \pm 936.015). Only 1.8% of the patients were with a normal dietary potassium intake of more than 3000 mg/d. One fifth of the patients (21.4%) their dietary phosphorus intake of more than 1000 mg/day (the mean intake was 832.95 \pm 227.911) as shown in Tables 6 and 7.

The biochemical tests of some bone health parameters revealed that the mean of Vitamin D level was higher among males than females (15.8 vs. 10.9 ng/mL) and this difference was statistically significant. The other biochemical tests did not differ significantly between males and females as shown in Table 8. Table 9 revealed that the mean albumin level was lower among those with bone problems than those without (3.8 g/dl vs. 4.0 g/dl) and this difference was statistically significant. However; the mean Alkaline phosphate level was higher among those with bone problems than those without (105.1U/l vs. 81.0 U/l) and this differences was statistically

Table 7: Dietary indicators for osteoporosis

Nutrients	Categories	Food		Food and Supplement	
		N=56	%	N=56	%
Calcium ^[23] mg/day	<2500	56	100	44	78.6
	2500	0	0	0	0
	>2500	0	0	12	21.4
Vitamin D ^[24] mg/day	<20	56	100	56	100
	20-25	0	0	0	0
	>25	0	0	0	0
Phosphorus ^[15] mg/day	<800	19	33.9	19	33.9
	800-1000	25	44.6	25	44.6
	>1000	12	21.4	12	21.4
Potassium ^[25] mg/day	<2000	51	91.1	51	91.1
	2000-3000	4	7.1	4	7.1
	>3000	1	1.8	1	1.8

Table 8: Serum some biochemical tests according to sex of the patients (n=56)

Parameters	Sex		P-value*
	Male	Female	
PTH pg/ml	551.6 ± 441.34	565.1 ± 566.55	0.921
BUN mmol/L	56.9 ± 12.10	58.6 ± 15.60	0.641
Calcium mg/dL	9.7 ± 1.00	9.6 ± 1.00	0.539
Phosphorus mg/dL	6.1 ± 1.67	5.8 ± 1.94	0.566
Vitamin D ng/mL	15.8 ± 6.04	10.9 ± 3.78	0.001 [^]
Potassium mg/dL	5.2 ± 0.83	5.1 ± 0.64	0.628
Albumin g/dL	3.9 ± 0.37	3.9 ± 0.35	0.950
Alkaline Phosphate U/l	102.5 ± 60.00	97.5 ± 78.00	0.974

* Mann-Wittney test

Table 9: Biochemical tests according to bone problems in H.D. patients

Parameters	Bone problems		P-value*
	Yes	No	
PTH (pg/ml)	550.9 ± 496.64	575.5 ± 533.15	0.869
BUN mmol/L	57.3 ± 12.81	58.8 ± 16.40	0.710
Calcium mg/dL	9.7 ± 1.00	9.5 ± 1.00	0.357
Phosphorus mg/dL	5.9 ± 1.86	6.1 ± 1.70	0.780
Vitamin D ng/mL	13.8 ± 5.84	12.3 ± 4.93	0.361
Potassium mg/dL	5.1 ± 0.76	5.3 ± 0.70	0.560
Albumin g/dL	3.8 ± 0.36	4.0 ± 0.31	0.024 [^]
Alkaline Phosphate U/l	105.1 ± 85.00	81.0 ± 56.00	0.022 [^]

Mann-Wittney test

Table 10: Correlation between total intakes of calcium, phosphorus, Vit. D, potassium and their biochemical blood levels

Test	Calcium mg/dL		Phosphorus mg/dL		Vitamin D ng/mL		Potassium mg/dL	
	R	p-value	r	p-value	R	p-value	R	p-value
Nutrients intake								
Calcium	-0.329	0.013	-0.267*	0.046	0.064*	0.640	0.150*	0.271
Vitamin D	0.186	0.170	-0.014**	0.918	-0.107	0.432	-0.093**	0.493
Phosphorus	-0.038	0.782	0.379*	0.004	0.015*	0.913	0.036*	0.792
Potassium	-0.074	0.590	0.181**	0.182	-0.171**	0.209	-0.011**	0.938

* Pearson correlation test, ** Spearman correlation test.

significant. The other biochemical tests did not differ significantly between males and females. This study revealed that there was fair negative significant correlation between total intake of Calcium and its blood level. In addition, there was a weak negative significant correlation between total intake of Calcium and blood level of Phosphorus. Moreover, there was fair positive significant correlation between total intake of phosphorus and its blood level. Other correlation between total intake of some micronutrients and their biochemical blood level showed non-significant association as shown in Table 10.

CONCLUSION

It can be concluded that most of the study patients were under osteoporosis risk factors. Therefore it is recommended that H.D. patients need intensive nutritional and physician counseling to prevent osteoporosis.

REFERENCES

1. National Kidney Foundation (NKE), 2006. How Your Kidneys Work. <http://www.kidney.org/kidneydisease/howkidneyswork.cfm>.
2. Timiras, P.S. 2007. Kidneys, <http://mcb.berkeley.edu/courses/mcb135e/kidneys.html>.
3. Bethesda, M.D., 2014. The Kidneys and How They Work. <http://kidney.niddk.nih.gov/kudiseases/pubs/yourkidneys/>.
4. Judith, B. and S. Farrokh, 2012. End Stage Renal Disease (ESRD). http://myhealth.ucsf.edu/Library/DiseasesConditions/Pediatric/Transplantation/85_P01474.
5. Saudi Center for Organ Transplantation 2013. Annual Report 2013, KSA: SCOT. <http://umm.edu/health/medical/altmed/condition/osteoporosis>.
6. Ehrlich, S.D., 2013. Osteoporosis. <http://umm.edu/health/medical/altmed/condition/osteoporosis>.
7. National Kidney Foundation (NKF), 2002. KDOQI Clinical Practice Guidelines for Bone Metabolism and Disease in Chronic Kidney Disease, Guideline 4. Restriction of Dietary Phosphorus in Patients with CKD. http://www2.kidney.org/professionals/KDOQI/guidelines_bone/Guide4.htm.
8. Port, F.K., V.B. Ashby, R.K. Dhingra, E.C. Roys and R.A. Wolfe, 2002. Dialysis dose and body mass index are strongly associated with survival in hemodialysis patients, Journal of the American Society of Nephrology, 13: 1061-1066.
9. Jadoul, M., 2007. Towards the prevention of bone fractures in dialyzed patients?, Nephrology Dialysis Transplantation, 22: 3377-3380.

10. Levin, A., G.L. Bakris, M. Molitch, M. Smulders, J. Tian, L.A. Williams and D.L. Andress, 2007. 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*, 71(1): 31-38.
11. Schwarz, S., B.K. Trivedi, K. Kalantar-Zadeh and C.P. Kovesdy, 2006. Association of disorders in mineral metabolism with progression of chronic kidney disease. *Clinical Journal of the American Society of Nephrology*, 1(4): 825-831.
12. Alsuwaida, A.O., Y.M. Farag, A.A. Al Sayyari, D. Mousa, F. Alhejaili, A. Al-Harbi, A. Housawi, B.V. Mittal and A.K. Singh, 2010. Epidemiology of chronic kidney disease in the Kingdom of Saudi Arabia (SEEK-Saudi Investigators)-A pilot study. *Saudi Journal of Kidney Diseases and Transplantation*, 21(6): 1066-1072.
13. Uren, P., O. Bernard-Poenaru, A. Ostertag, C. Baudoin, M. Cohen-Solal, T. Cantor and M.C. Vernejoul, 2003. Bone mineral density, biochemical markers and skeletal fractures in haemodialysis patients. *Nephrology Dialysis Transplantation*, 18: 2325-2331.
14. Stehman-Breen, C.O., D.J. Sherrard, A.M. Alem, D.L. Gillen, S.R. Heckbert, C.S. Wong, A. Ball and N.S. Weiss, 2000. Risk factors for hip fracture among patients with end-stage renal disease. *Kidney International*, 58: 2200-2205.
15. National Kidney Foundation (NKF) 2003. KDOQI Clinical Practice Guidelines for Bone Metabolism and Disease in Chronic Kidney Disease, Guideline 1. Evaluation of Calcium and Phosphorus metabolism. https://http://www2.kidney.org/professionals/KDOQI/guidelines_bone/guidestate.htm.
16. National Kidney Foundation, 2014. Tests to Measure Kidney Function, Damage and Detect Abnormalities, <http://www.kidney.org/atoz/content/kidneytests.cfm>.
17. National Kidney Foundation, Inc. 2004. Potassium and Your CKD Diet. <http://www.kidney.org/atoz/content/potassium.cfm>.
18. Jarava, C., J.A. Armas, M. Salgueira and A. Palma, 1996. Bone alkaline phosphatase isoenzyme in renal osteodystrophy. *Nephrology Dialysis Transplantation*, 11(3): 43-46.
19. Sperschneider, H. and G. Stein, 2003. Bone disease after renal transplantation. *Nephrology Dialysis Transplantation*, 18(5): 874-877.
20. Block, G.A., P.S. Klassen, J.M. Lazarus, N. Ofsthun, E.G. Lowrie and G.M. Chertow, 2004. Mineral Metabolism, Mortality and Morbidity in Maintenance Hemodialysis. *Journal of the American Society of Nephrology*, 15(8): 2208-2218.
21. Young, E.W., T. Akiba, J.M. Albert, H.T. Mcarthy, P.G. Kerr, D.C. Mendelssohn and M. Jadoul, 2004. Magnitude and impact of abnormal mineral metabolism in hemodialysis patients in the dialysis outcomes and practice patterns study (DOPPS). *American Journal of Kidney Diseases*, 44(2): 34-38.
22. Eriksen, E.F., 2002. Primary hyperparathyroidism: lessons from bone histomorphometry. *Journal of Bone and Mineral Research*, 17(2): 95-97.
23. National Kidney Foundation (NKF), 2005. KDOQI Clinical Practice Guidelines for Bone Metabolism and Disease in Children with Chronic Kidney Disease, Guideline 8. Prevention and Treatment of Vitamin D Insufficiency and Vitamin D Deficiency in CKD Patients. http://www2.kidney.org/professionals/KDOQI/guidelines_pedbone/guide8.htm.
24. Steiber, A.L. and J.D. Kopple, 2011. Vitamin status and needs for people with stages 3-5 chronic kidney disease. *Journal of Renal Nutrition*, 21(5): 355-368.
25. Jadeja, Y.P. and V. Kher, 2012. Protein energy wasting in chronic kidney disease: An update with focus on nutritional interventions to improve outcomes. *Indian Journal of Endocrinology and Metabolism*, 16(2): 246-251.