

# Total Body Mass Is Better Than Body Mass Index As a Prognostic Parameter for Bone Mineral Density in Dialyzed Patients

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*Assuming that nutrition status also influences bone mineral density (BMD) in dialyzed patients, we compared BMD in two groups of dialyzed patients: those with a body mass index (BMI) above 25 kg/m<sup>2</sup> [group I: n = 20; 11 women; 19 on peritoneal dialysis (PD), 1 on hemodialysis (HD); age: 60.9 ± 13.6 years; time on dialysis: 19.3 months (range: 6.5 – 45.7 months)], and those with a BMI below 25 kg/m<sup>2</sup> [group II: n = 10; 7 women; 7 on PD, 3 on HD; age: 46.6 ± 21.8 years; time on dialysis: 21.3 months (range: 6.3 – 59.6 months)].*

*Anthropometric indices of nutrition status and body composition by bioimpedance analysis were checked in all patients. We measured BMD in the femoral neck (FN) and lumbar spine by dual-energy X-ray absorptiometry. Laboratory parameters of nutrition, inflammatory status, and Ca–P balance were simultaneously measured. Influence of age and sex on BMD was taken into consideration.*

*The patients in group I were significantly older than the patients in group II ( $p = 0.035$ ), but they had significantly higher BMD parameters. After regression analysis, which included age, sex, hip and waist circumferences, total body mass, lean and fat body mass, and BMI in all dialyzed patients, age ( $\beta = -0.558$ ,  $\Delta R^2 = 0.131$ ,  $p = 0.003$ ) and total body mass ( $\beta = 0.408$ ,  $\Delta R^2 = 0.131$ ,  $p = 0.024$ ) were the only independent variables that predicted FN BMD, age being the stronger predictor.*

*In dialysis patients, BMI is associated with BMD, but the only important parameter of body composition for predicting FN BMD in this group is total body mass.*

## Key words

Total body mass, body mass index, bone mineral density

## Introduction

Recent data indicate an association between bone mineral density (BMD) and body mass index (BMI) in dialysis patients (1,2). In hemodialysis (HD) patients, the main determinants of low total-body BMD were, in order of importance, immobility, high intact parathyroid hormone levels, low BMI, and low serum albumin (2). In peritoneal dialysis (PD) patients, BMI showed positive correlations with lumbar spine (LS) and femoral neck (FN) T-score, and with FN Z-score (1).

Assuming that nutrition status is associated with BMD in dialyzed patients, we decided to compare BMD in two groups of such patients: those with a BMI above 25 kg/m<sup>2</sup> (group I) and those with a BMI below 25 kg/m<sup>2</sup> (group II). We also checked for the better predictor of BMD: total body mass (TBM) and its components [fat body mass (FBM) and lean body mass (LBM)] or BMI.

## Patients and methods

Group I (BMI > 25 kg/m<sup>2</sup>) included 20 patients [11 women, 9 men; 19 on PD, 1 on HD; age: 60.9 ± 13.6 years; time on dialysis: 19.3 months (range: 6.5 – 45.7 months)]. Group II consisted of 10 patients [7 women, 3 men; 7 on PD, 3 on HD; age: 46.6 ± 21.8 years; time on dialysis: 21.3 months (range: 6.3 – 59.6 months)]. The patients in group I were significantly older than those in group II ( $p = 0.035$ ).

Anthropometric indices of nutrition status and bioimpedance records of body composition were checked in all patients. Body mass index was calculated as weight in kilograms divided by the square of the standing height in meters. In the FN and LS, BMD

was measured by dual energy X-ray absorptiometry. Laboratory parameters of nutrition, inflammation status, and Ca-P balance were simultaneously measured.

The normality of distribution of variables was checked for each group separately using the Shapiro-Wilks test. Results are expressed as a mean  $\pm$  1 standard deviation or as a median and range, as appropriate. Comparisons between the two study groups for nonadjusted results were performed using the Student *t*-test for unpaired data if the distribution in both groups was normal; otherwise, the Mann-Whitney test was used. Comparisons of the results adjusted for sex and age used the analysis of covariance methodology. Stepwise regression analysis was used to reveal independent variables that predict BMD. A *p* value below 0.05 was judged to be significant. The statistical analyses were performed using Statistica PL 8.0 (StatSoft, Tulsa, OK, U.S.A.).

## Results

Body mass index was  $29.2 \pm 4.5$  kg/m<sup>2</sup> in group I and  $21.6 \pm 2.1$  kg/m<sup>2</sup> in group II. As expected, waist circumference ( $101.7 \pm 10.5$  cm vs.  $86.4 \pm 11.3$  cm) and hip circumference ( $106.1 \pm 7.9$  cm vs.  $91.6 \pm 8.7$  cm) were both significantly greater in group I than in group II (*p* = 0.001 for both differences), but waist/hip ratios ( $0.96 \pm 0.07$  for group I and  $0.94 \pm 0.05$  for group II) did not differ significantly between the groups, indicating a similar distribution of abdominal fat in both groups. The results of the statistical analyses (*p* < 0.05 or *p*  $\geq$  0.05) did not change after adjustment for age and sex.

The values for TBM ( $78.1 \pm 9.7$  kg vs.  $60.3 \pm 5.9$  kg, *p* = 0.000), FBM ( $25.2 \pm 6.3$  kg vs.  $15.2 \pm 5.3$  kg, *p* = 0.000), and LBM ( $52.9 \pm 10.3$  kg vs.  $44.2 \pm 8.1$  kg, *p* = 0.027) were greater in group I than in group II. The FBM as a percentage of TBM was greater in group I ( $32.6\% \pm 8.0\%$  vs.  $25.2\% \pm 6.2\%$ , *p* = 0.024). Thus, the FBM was greater not only in absolute terms, but also in relative terms. The LBM as a percentage of TBM was greater in group II ( $67.4\% \pm 8.0\%$  vs.  $74.8\% \pm 8.2\%$ , *p* = 0.024), despite the lower LBM in kilograms in this group. These findings indicate a different body composition in the two groups. All the aforementioned differences remained significant after adjustment for age and sex.

Serum biochemical data, related either to protein nutrition (such as concentrations of total protein and albumin), or to body fat content (such as serum lipid

profile) were similar in both groups, before and after adjustment for age and sex (Table I).

As compared with group II, group I showed a significantly higher BMD ( $0.842 \pm 0.146$  g/cm<sup>2</sup> vs.  $0.758 \pm 0.145$  g/cm<sup>2</sup>, *p* = 0.004) and other parameters related to bone mass measured in the FN: for example, BMD as a percentage of age norm ( $102.9\% \pm 21.3\%$  vs.  $86.4\% \pm 19.5\%$ , *p* = 0.001), BMD as a percentage of peak BMD ( $84.9\% \pm 17.5\%$  vs.  $77.8\% \pm 20.6\%$ , *p* = 0.000), T-score [ $-1.11$  (range:  $-3.47$  to  $2.37$ ) vs.  $-2.20$  (range:  $-4.06$  to  $1.15$ ), *p* = 0.000], and Z-score [ $0.26$  (range:  $-4.41$  to  $4.49$ ) vs.  $-1.59$  (range:  $-2.36$  to  $2.01$ ), *p* = 0.001]. The results presented were adjusted for age and sex.

In the LS, BMD ( $1.158 \pm 0.272$  g/cm<sup>2</sup> vs.  $0.907 \pm 0.128$  g/cm<sup>2</sup>, *p* = 0.013) was greater in group I than in group II, and BMD as a percentage of age norm ( $102.9\% \pm 21.3\%$  vs.  $84.3\% \pm 13.8\%$ , *p* = 0.038) showed higher values in group I after adjustment for age and sex.

In the stepwise regression analysis, which included BMI, age, sex, hip and waist circumferences, TBM, LBM, and FBM in all dialyzed patients, age ( $\beta = -0.558$ ,  $\Delta R^2 = 0.131$ , *p* = 0.003) and TBM ( $\beta = 0.408$ ,  $\Delta R^2 = 0.131$ , *p* = 0.024) were the only independent variables that predicted BMD in the FN, with age being the stronger predictor.

## Discussion

An overview of the scientific literature indicates that, in some studies, BMI is associated mainly with BMD (1–3), but in others, the data show a relationship between BMD and total weight or its components, especially LBM (4,5). For example, in a stepwise

TABLE I Selected laboratory parameters in the dialysis patients studied

Parameter	Group I	Group II
	BMI > 25 kg/m <sup>2</sup>	BMI < 25 kg/m <sup>2</sup>
Total protein (g/dL)	6.79 $\pm$ 0.68	7.17 $\pm$ 0.35
Albumin (g/dL)	3.48 $\pm$ 0.44	3.72 $\pm$ 0.50
Total cholesterol (mg/dL)	209 $\pm$ 51	213 $\pm$ 38
LDL cholesterol (mg/dL)	126 $\pm$ 38	127 $\pm$ 39
HDL cholesterol (mg/dL)	38.8 $\pm$ 9.6	43.7 $\pm$ 10.1
HDL/total cholesterol (%)	19.0 $\pm$ 4.5	20.9 $\pm$ 5.2
Triglycerides (mg/dL)	199 $\pm$ 96	151 $\pm$ 56

BMI = body mass index; LDL = low-density lipoprotein; HDL = high-density lipoprotein.

regression analysis, BMI and serum levels of creatinine and  $\beta_2$ -microglobulin were selective for ultradistal radial BMD in diabetic patients but not in chronic glomerulonephritis patients undergoing HD (3). Patients on PD showed a very significant positive correlation between total bone mineral content (TBMC) and weight, height, and LBM. In a multiple regression analysis, LBM was the only parameter of body composition that had a significantly positive correlation with TBMC in men (5). Clinical risk factors for osteopenia and osteoporosis identified in a univariate analysis in the HIV population included low free testosterone ( $p = 0.0007$ ), low weight ( $p = 0.014$ ), and oligomenorrhea ( $p = 0.0006$ ). In a multivariate regression analysis, LBM was the parameter most significantly associated with BMD among HIV-infected women (4).

### Conclusions

To our knowledge, there are no data evaluating the better predictor of BMD: TBM or body weight normalized to height minus BMI. According to the results of our study, dialyzed patients with a higher BMI have a greater BMD, but TBM, and not BMI, is the most important parameter for predicting BMD, at least in the FN.

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