Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1679-9291
ISSN on-line: 1807-8648
Doi: 10.4025/actascihealthsci.v36i1.14930

Factors associated with bone mineral density in women who underwent bariatric surgery

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ABSTRACT. To analyze factors associated with bone mineral density (BMD) of candidates and patients admitted to Bariatric Surgery (BS). This study included 61 women who had done or were waiting for BS. Anthropometric variables, body composition and BMD from the femur, femoral neck, lumbar spine and the whole body were measured. The factors associated with changes in BMD, such as smoking, alcohol ingestion, sedentary lifestyle, BS, nutritional supplementation and age were evaluated. The statistical significance was set at 5%. Age and BS were associated with changes in BMD. Among the individuals who had BS done, the rates of osteopenia/osteoporosis were greater in the femur (OR 3.34; CI [1.52 - 1.83]) and femoral neck (OR 3.69; CI [1.34 – 2.08]). Subjects older than 50 years also had greater rates of BMD in the lumbar spine (OR 4.12; CI [2.09 – 22.33]), the whole body (OR 4.77; CI [1.34 – 28.14]), femur (OR 16.94; CI [2.16 - 124.32]) and femoral neck (OR 14.95; CI [1.86 - 110.66]). Patients who have had BS and are over 50 years of age showed higher rates of osteopenia/osteoporosis, which demonstrate the necessity of further studies exploring the effects of BS and its impact on bone metabolism.

Keywords: bone density, obesity, bariatric surgery, osteoporosis.

Fatores associados à densidade mineral óssea em mulheres submetidas à cirurgia bariátrica

RESUMO. Analisar fatores associados à densidade mineral óssea (DMO) de candidatas e de pacientes submetidas à cirurgia bariátrica (CB). Neste estudo transversal foram avaliadas variáveis antropométricas, composição corporal e DMO do fêmur, colo do fêmur, coluna lombar e corpo inteiro, além dos fatores associados às alterações na DMO: tabagismo, consumo de álcool, sedentarismo, CB, suplementação e idade em 61 mulheres com média de idade de 43,97 (± 10,73) anos. Significância pré estabelecida em 5%. A idade e CB apresentaram associação com alterações na DMO. Os sujeitos operados apresentaram maiores chances de apresentar osteopenia/osteoporose no fêmur (RC 3,34; IC [1,52 – 1,83]) e no colo do fêmur (RC 3,69; IC [1,34 - 2,08]) e os sujeitos com idade superior a 50 anos apresentaram maiores chances de apresentar alterações na DMO na coluna lombar (RC 4,12; IC [2,09 - 22,33]), no corpo inteiro (RC 4,77; IC [1,34 - 28,14]), fêmur (RC 16,94; IC [2,16 – 124,32]) e no colo do fêmur (RC 14,95; IC [1,86 – 110,66]). Pacientes submetidos à CB e com idade superior a 50 anos apresentam maiores alterações na DMO, demonstrando a importância de mais estudos que explorem os efeitos da CB e suas repercussões sobre o metabolismo ósseo.

Palavras-chave: densidade óssea, obesidade, cirurgia bariátrica, osteoporose.

Introduction

Osteoporosis is a disease characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to bone fragility and therefore an increased risk of fracture (NIH, 2001; WHO, 1994; PINTO NETO et al., 2002). In Brazil, a critical review of studies conducted between 1996 and 2005, found a prevalence of osteoporosis in women ranging from 0.4% in premenopausal and 40% in women aged over 70 years (FRAZÃO; NAVEIRA, 2006).

There are many factors associated with disease in the bone tissue, among which we can mention: diabetes mellitus, pregnancy, malabsorption syndromes, liver disease, deficiency of calcium and vitamin D, alcoholism, gastric bypass surgery, arthritis rheumatoid, smoking and sedentary lifestyle (WHO, 1993).

On the other hand, some studies suggest that obesity is a protective factor against osteoporosis (BARRERA et al., 2004; PUZZIFERRI et al., 2006), since there is a significant relationship between body weight and bone mineral density (REID, 2002). This increase in bone mass can be explained by a greater effect on bone structures, provided by the increase in body fat observed in obesity (OLMOS et al., 2008).

However, weight loss can lead to a decrease in bone mass, which has been observed in other studies (REID, 2002; DIGIORGI et al., 2008; FLEISCHER et al., 2008).

Obese individuals who have a restriction in food consumption, in order to promote weight loss, may be subject to a greater risk of reduced bone mass (BACON et al., 2004). Thus, individuals undergoing bariatric surgery may be exposed to an increased risk of developing bone problems before and after the surgery, mainly due to food restriction caused by the surgery and also through a reduced absorption of nutrients (SHAPSES, 2001).

Therefore, the objectives of this study were to analyze the factors associated with bone mineral density of bariatric surgery candidates and patients in the Brazilian public Health System (SUS), and to determine the prevalence of osteopenia/osteoporosis among patients who have undergone Bariatric Surgery.

Material and methods

Population and sample

This is a cross-sectional observational study, conducted in Maringá, Paraná State, and region with 61 women who underwent bariatric surgery or who were waiting for bariatric surgery in the Brazilian public Health System (SUS). Patients included in this study were part of a larger project which assessed the quality of life of patients undergoing bariatric surgery. This larger study included measurements of anthropometric variables, body composition, as well as biochemical and psychological parameters of the participants. The participants were contacted from their records obtained through the University Hospital of Maringá and from the Association of Obesity and Bariatric Patients of Paranavaí, Paraná State.

The criteria for inclusion were: a) have undergone bariatric surgery or are awaiting for the surgery through SUS; b) be older than 18 years, c) have provided all the measures included in this study, d) are female. The subjects who did not meet these criteria were not included in the study.

Patients included in the study were classified into 4 groups: Group 1 (G1 - n = 21) - non-operated patients, Group 2 (G2 - n = 20) - patients operated up to 16 months, Group 3 (G3 - n = 12) - patients operated 17-36 months and Group 4 (G4 - n = 8) - patients operated over 37 months ago. To perform the chi-square test and Odds Ratio calculation, patients were categorized in operated and non-operated groups.

Data collection

Data collection was performed at the department of Physical Education, from the State University of Maringá and in a laboratory specialized in imaging evaluations in the same city. The study was approved by the Committee on Ethics in human research from the State University of Maringá, with register no. 318/2007. All subjects signed the informed consent form after having received detailed information about the research protocol.

Anthropometric assessment

All the anthropometric measurements were performed by a single examiner who was trained to perform them according to standardization. Height was measured with a precision of 0.1 cm while the individual inspired with a stadiometer. Weight was measured by means of a multifrequential bioimpedanciometer octapolar, model InBody 520, Biospace brand (Korea), with a maximal capacity of 250 kg and a precision of 100 g. With these measurements, we calculated Body Mass Index (BMI), through the ratio of body weight (kg) on height (m) squared.

Waist and hip circumferences was measured with a tape. The midpoint between the last rib and the top of the iliac crest and greater portion of the gluteal region were used as reference points to measure waist and hip circumferences, respectively. All anthropometric measurements were performed according to international procedures (WHO, 1995).

Assessment of body composition and bone mineral density

Dual-energy x-ray absorptiometry (DXA) brand Lunar GE model Prodigy Advanced was used to assess body composition and bone mineral density. The analysis of this data was performed with the Encore Software version 8.0. This procedure is considered to be the gold standard in the evaluation of BMD (PICKHARDT et al., 2011). It is based on the attenuation, by the patient's body, of a radiation beam generated by an X-ray source with two energy levels (40 and 70 kV). This beam passes through the individual in the anteroposterior direction and is captured by a detector. The software calculates the density of each sample from the radiation reaching the detector in each peak power. For this evaluation, patients were instructed to wear light clothing and to remove all metal accessories.

This method was also used to assess body fat mass, body fat percentage and lean mass, as well as the BMD of the lumbar spine, femoral neck, total femur and whole body. After obtaining the BMD results, the z-score for each patient, i.e., the number of standard deviations (SD) which are far from the average young population of the same sex, were calculated. Osteopenia and osteoporosis were diagnosed, based on international standards (NIH, 2001) and the DXA results. Values up to (-1) SD below the mean were considered normal, values between (-1,1) and (-2.4) SD were defined as osteopenia, and values (-2.5) SD were diagnosed as being osteoporosis (PINTO NETO et al., 2003). The patients who presented results within the osteopenia and osteoporosis ranges were classified as having altered BMD. Those patients whose BMD values were up to -1 SD from the reference values were categorized as unchanged.

Evaluation of factors associated

Information about factors associated with BMD were obtained through a self-administered questionnaire, which collected information about personal aspects, surgery technique and patients' behavior. In this questionnaire, the patients answered questions related to using or not some types of nutritional supplements such as calcium and vitamin D. Other risk behaviors were also assessed, such as physical inactivity, alcohol consumption and smoking. For the assessment of physical inactivity, we used the classification of the American College of Sports Medicine (HASKELL et al., 2007), which classifies inactive individuals as those who do not perform any type of physical activity (walking, swimming, cycling etc.) continuously for at least 5 days per week at 30 minutes per session, or more vigorous exercise like running at least three times per week for 20 minutes.

Statistical procedures

The data was tabulated and organized in Excel spreadsheets for Windows 2007, while the statistical analysis was performed using the statistical package STATA version 15.0. To evaluate the homogeneity of the data the Levene test was used, while One-Way ANOVA and Kruscall Wallis tests were used to detect possible differences between continuous variables in regard to the time of surgery. When differences between groups were indicated, the Scheffe post hoc test and Man Whitney test were used to verify which groups had such differences.

Comparisons between the distribution of patients regarding the change in BMD and factors associated with age, smoking, sedentary lifestyle, alcohol consumption, use of nutritional supplements and bariatric surgery were performed using the chi-square and Fisher exact tests. To analyze the magnitude of these associations, a Poisson regression with robust adjustment of variance was used. In all analyzes a significance level of 5% was adopted.

Results

The average age of patients included in this study was 43.97 (± 10.73) years. From the 61 subjects included in the present study, 40 underwent BS. Regarding the type of BS performed, 25 subjects (62.5%) were unable to answer the question, while 15 subjects (37.5%) reported having undergone the gastric bypass of Fobi-Capella.

Table 1 presents the means and standard deviations of anthropometric and body composition measurements of the different groups. The One-Way ANOVA and Krusckall Wallis tests indicated differences between all variables except for age between groups, with the G1 (non-operated group) showing differences in relation to the G2, G3 and G4 (operated groups).

Table 1. Comparison of anthropometric characteristics and body composition between the groups.

	G1 (n = 21)	G2 (n = 20)	G3 (n = 12)	G4 (n = 8)	P
Age (years)**	43.40 (15.70)	36.85 (26.5)	45.8 (10.18)	51.75 (12.15)	0.260
Weight (kg)	104.71 (21.22)	75.32 (10.43)[1]	71.49 (18.81)[1]	77.56 (7.98)[1]	0.000
BMI (kg m^{-2})	41.28 (4.92)	30.54 (5.97)[1]	30.29 (7.90)[1]	32.66 (4.34)[1]	0.000
WC (cm)	108.73 (7.38)	90.95 (11.79)[1]	86.75 (11.25)[1]	92.87 (10.92)[1]	0.000
HC (cm)	133.10 (10.9)	112.07 (13.07)[1]	110.04 (16.05)[1]	111.19 (6.55)[1]	0.000
Fat Weight (kg)	51.81 (9. 16)	31.62 (12.83)[1]	29.44 (14.70)[1]	35.56 (7.38)[1]	0.000
% Fat**	51.20 (6.4)	40.40 (14.83)[1]	39.60 (15.6)[1]	48.05 (10.4)[1]	0.001
Lean Mass	47.74 (5.61)	41.81 (4.98)[1]	39.42 (4.52)[1]	39.42 (2.13)[1]	0.000

**nonparametric variables; [1] significant differences as compared to G1. Values expressed as mean and standard deviation; WC - Waist Circunference; HC - Hip Circunference.

Table 2 presents the mean and standard deviations of bone mineral density (BMD) in all groups. The highest values of BMD were found among non-operated patients (G1), and the statistical tests indicated a significant difference in whole body and femoral neck BMD in all groups when compared to G4 (operated for over 36 months).

Table 2. Comparison of bone mineral density between the groups.

Bone mineral density	G1 (n = 21)	G2 (n = 20)	G3 (n = 12)	G4 (n = 8)	P
Whole Body (g cm^{-3})	1.24 (0.10)	1.17 (0.91)	1.15 (0.12)	1.09 (0.10)[1]	0.005
Lumbar Spine (g cm^{-3})	1.22 (0.15)	1.17 (0.14)	1.23 (0.26)	1.08 (0.16)	0.167
Femoral Neck (g cm^{-3})	1.15 (0.12)	1.06 (0.12)	1.04 (0.18)	0.95 (0.13)[1]	0.004
Femur (g cm^{-3})	1.10 (0.16)	1.05 (0.15)	1.00 (0.16)	0.96 (0.13)	0.119

[1]significant differences as compared to G1. Values expressed as mean and standard deviation.

When considering only the operated patients, there was a prevalence of osteopenia at the femoral neck, femur and whole body of 20, 22.5 and 17.5%, respectively. As for the lumbar spine (L1 - L4) a prevalence of 17.5% osteopenia and 10% of osteoporosis was observed.

Table 3 presents the results of the Chi-Square and Fisher Exact tests considering the values of BMD in whole body and the associated factors, as well as the magnitude of the associations calculated using a Poisson regression. The tests indicated that there is an association between changes in whole body BMD and age over 50 years, where women older than 50 years had a ratio of 4.77 greater chance of having decreased values of BMD in whole body compared to women younger than 50 years. The other evaluated factors were not associated with changes in whole body BMD.

Table 3. Bone Mineral Density of the whole body and associated risk factors.

Associated Factors	Whole Body BMD changes Presence	Absence	P	OR (CI)
Smoking				
Yes	1 (1.63%)	3 (4.92%)		
No	7 (11.47%)	50 (81.97%)	0.451	0.46 [0.07 – 9.85]
Alcohol consumption				
Yes	2 (3.28%)	19 (31.14%)		
No	6 (9.83%)	36 (59.01%)	0.58	1.22 [0,34 – 7.22]
Sedentary Lifestyle				
Yes	5 (8.20%)	45 (73.77%)		
No	3 (4.92%)	8 (13.11%)	0.126	1.78 (0.75 – 9.85)
Bariatric Surgery				
Yes	7 (11.47%)	33 (54.10%)		
No	1 (1.63%)	20 (32.80%)	0.212	0.27 (0.03 – 2.10)
Supplementation				
Yes	6 (9.83%)	21 (34.43%)		
No	2 (3.28%)	32 (52.46%)	0.089	0.20 (0.06 – 1.22)
Age				
>50 years	6 (9.83%)	14 (22.95%)		
<50 years	2 (3.28%)	39 (63.93%)	0.019*	4.77 (1.34 – 28.14)*

*Significant values p < 0.05; [1]Fisher`s exact test results.

The results of the Chi-Square and Fisher Exact test considering the values of BMD in lumbar spine and associated factors are presented in Table 4. As seen in whole body BMD, the age was the only factor to show association with lumbar spine BMD. Patients older than 50 years had a 4.12 greater chance of presenting decreased values of BMD in the lumbar spine when compared to patients under the age of 50 years.

Table 4. Bone Mineral Density of Lumbar spine and associated risk factors.

Associated Factors	Lumbar spine BMD changes Presence	Absence	P	OR (CI)
Smoking				
Yes	2 (3.28%)	2 (3.28%)		
No	12 (19.67%)	45 (73.77%)	0.097[1]	0.22 (0.12 - 1.18)
Alcohol consumption				
Yes	11 (18.03%)	18 (29.50%)		
No	6 (9.83%)	29 (47.54%)	0,144[1]	2.09 (0.69 - 11.97)
Sedentary Lifestyle				
Yes	12(19.67%)	38 (62.30%)		
No	2 (3.28%)	9 (14.75%)	0.720[1]	0.22 (0.12 - 1.18)
Bariatric Surgery				
Yes	11 (18.03%)	29 (47.54%)		
No	3 (4.92%)	18 (29.50%)	0.144	0.251 (0.08 - 1,44)
Supplementation				
Yes	8 (13.11%)	19 (31.14%)		
No	6 (9.83%)	28 (45.90%)	0.172	0.25 (0.18 - 1.35)
Age				
>50 years	11 (18.03%)	9 (14.75%)		
<50 years	3 (4.92%)	38 (62.30%)	0.001*[1]	4.12 (2.09 – 22.33)*

*Significant values p < 0,05; [1]Fisher`s exact test results.

Tables 5 and 6 present the results of association tests between risk factors and femoral neck and femur BMD. The Poisson regression indicated that patients who were operated had a 3.69 greater chance of being diagnosed as having altered femoral neck BMD and a 3.34 greater chance of having altered BMD in the femur when compared to the non-operated group. Related to these same parameters, patients older than 50 years of age had a ratio 14.95 and 16.94 greater chance of having an altered BMD in femoral neck and femur, respectively, when compared to the younger subjects.

Table 5. Bone Mineral Density of Femoral neck and associated risk factors.

Associated Factors	Femoral neck BMD changes Presence	Absence	P	OR (CI)
Smoking				
Yes	1 (1.63%)	3 (4.92%)		
No	7 (11.47%)	50 (81.97%)	0.450[1]	0.46 (0.08 – 3.12)
Alcohol consumption				
Yes	3 (4.92%)	18 (29.50%)		
No	5 (8.20%)	35 (57.37%)	0.560[1]	1.22 (0.34 – 7.22)
Sedentary Lifestyle				
Yes	3 (4.92%)	45 (73.77%)		
No	5 (8.20%)	8 (13.11%)	0.120[1]	1.78 (0.75 – 9.85)
Bariatric Surgery				
Yes	8 (13.11%)	32 (52.46%)		
No	0	21 (34.43%)	0.000[1]	3.69 (1.34 – 2.08)*
Supplementation				
Yes	7 (11. 47%)	20 (32.80%)		
No	1 (1.63%)	33 (54.10%)	0.090[1]	0.21 (0.06 - 1.22)
Age				
>50 years	7 (11. 47%)	13 (21.31%)		
<50 years	1 (1.63%)	40 (65.57%)	0.010*[1]	14.95 (1.86 - 110.66)*

*Significant values p < 0.05; [1]Fisher`s exact test results.

Table 6. Bone Mineral Density of Femur and associated risk factors.

Associated Factors	Femur BMD changes Presence	Absence	P	OR (CI)
Smoking				
Yes	1 (1.63%)	3 (4.92%)		
No	8 (13.11%)	49 (80.32%)	0.536[1]	0.52 (0.09 – 3.49)
Alcohol consumption				
Yes	3 (4.92%)	18 (29.50%)		
No	6 (9.83%)	34 (55.73%)	0.941[1]	0.69 (0.29 – 3.82)
Sedentary lifestyle				
Yes	6 (9.83%)	44 (72.13%)		
No	3 (4.92%)	8 (13.11%)	0.190[1]	1.42 (0.66 – 7.79)
Bariatric surgery				
Yes	9 (14.75%)	31 (50.82%)		
No	0	21 (34.43%)	0.000[1]*	3.34 (1.52 - 1.83)*
Supplementation				
Yes	7 (11.47%)	20 (32.80%)		
No	2 (3.28%)	32 (52.46%)	0.053[1]	0.17 (0.05 - 1.01)
Age				
>50 years	1 (1.63%)	12 (19.67%)		
<50 years	8 (13.11%)	40 (65.57%)	0.007*[1]	16.94 (2.16 - 124.32)*

*Significant values p < 0,05; [1]Fisher`s exact test results.

Discussion

Concerning anthropometric and body composition parameters, significant differences in all variables were noted when comparing the operated and non-operated groups. These differences have been previously reported in the literature since BS promotes significant changes in these parameters in a short period of time (BENEDETTI et al., 2000; GARZA et al. 2010; PEDROSA et al., 2009).

However, when comparisons were made among the operated groups (G2, G3 and G4) only, there were no significant differences in any of the variables. These results indicate that major changes in anthropometric parameters and body composition in the patients of this study occurred within 16 months after the bariatric surgery and that these changes were extended for a period exceeding 36 months. These results corroborate the literature which reports that the greatest weight loss among BS patients occurs within one year, with annual incremental gains until the 6th year followings (SJÖSTRÖM et al., 2004).

According to WHO (1993), there are many risk factors associated with the development of osteoporosis such as tobacco use, alcohol abuse, bulimic or anorexic behaviors, older age, etc. However, the most important factors for the development of osteoporosis are: poor diet, lack of exercise and having gone through or currently experiencing the menopausal transition (WHO, 1994). Vilarrasa et al. (2009) followed obese women who underwent bariatric surgery and found that the prevalence of osteopenia among them increased after BS, especially among post-menopausal women. These changes probably occurred due to the lack of estrogen in these women (WHO, 1993), and also as a function of the relationship between osteocalcin levels and post-menopausal status (NAMS, 2010). In the present study, hormonal markers were not evaluated. However, an association between older age (50 years or more) and changes in BMD of the femur, femoral neck, lumbar spine and whole body were found. These results are consistent with other studies in which age is considered a risk factor for the development of osteoporosis. Vage et al. (2002) in a 25 year follow-up study with patients who underwent jejunoileal bypass surgery noted a prevalence of osteoporosis in 9.5% of subjects, all of whom were older than 50 years.

In a previous study, Bano et al. (1999) found differences in the BMD of patients who underwent jejunoileal bypass surgery, when comparing pre and post-surgical measurements. However, no differences between age groups were found.

The highest values of BMD found in individuals who did not undergo the surgical procedure corroborate data from Puzziferri et al. (2006), which suggests that obesity may be a protective factor against osteoporosis, possibly being explained by the mechanical stress caused by overloading on bone structure. Thus, Fleischer et al. (2008) observed a very strong association ($r = 0.90$, $p < 0.0001$) between the decline in BMD of the femoral neck and the extent of weight loss promoted by bariatric surgery.

In the present study, an association between bariatric surgery and BMD of the femur and femoral neck was observed, with the operated patients showing greater ratios to alterations in BMD compared with non-operated subjects.

International studies indicate that BS interferes with BMD, especially when disabsortive techniques are performed (COATES et al., 2004; VON MACH et al., 2004). Thus, in a follow-up study, Vilarrasa et al. (2009) found that after 1 year of surgery, the women showed a significant decrease in BMD of the femur and lumbar spine, suggesting a greater prevalence of osteopenia in the lumbar spine (19.3%) and femoral neck (16.1%) in these women. Duran et al. (2008), in a study of Brazilian women undergoing bariatric surgery, found a prevalence of osteoporosis of 13% in the femur. While the prevalence of osteopenia was 67% and 40% for lumbar spine and femoral neck, respectively, a higher prevalence of changes in BMD from the lumbar spine was also observed in our study (27.5% vs 22.5%). In relation to this, Bacon et al. (2004) highlights the importance of evaluating the lumbar spine, claiming that this is an important factor for defining the risk for developing osteopenia and osteoporosis.

Regarding the association between BS and the development of osteoporosis, Coates et al. (2004) observed a significant increase in bone turnover one year post-surgery. The bone turnover is understood as the result of two opposing processes in order to renew the bone tissue; the production of a new bone matrix by the action of osteoblasts and the destruction of old tissue by osteoclasts. However, in diseases such as osteoporosis, this process suffers an imbalancement, leading to alterations in the ratio of bone formation and/or absorption, thus promoting bone loss (GARNERO et al., 2004). Coates et al. (2004) also found that there was a significant reduction in BMD values at the hip, femur and whole body in the surgery group compared to the non-operated group. Von Mach et al. (2004) also observed a decrease in bone mineral content following surgical procedure.

In the present study, no association was found between supplementation reported by patients (calcium, vitamin D, multivitamins and iron) and changes in BMD. Although there is evidence that supplementation after BS may be a protective factor in the development of osteoporosis (MAHDY et al., 2008), the major evidence points out that even with the use of supplements, the patients who underwent BS were more likely to develop changes in BMD, which is mainly due to the malabsorption of nutrients (VILARRASA et al., 2009, YOUSSEF et al., 2007; MOREIRO et al., 2007; VALDERAS et al., 2009).

In the present study, no association was found between sedentary lifestyle and changes in BMD. This result corroborates the findings of other studies which found no significant differences in lumbar spine (McCARTNEY et al., 1995; STENGEL et al., 2005) and femoral neck BMD (PRUITT et al., 1992; STENGEL et al., 2005), in older women who took part in an exercise program vs. control.

Despite these results, there is evidence that physical activity improves several clinical parameters including resting heart rate, blood pressure levels and adiposity (ERIKSSON et al., 2009) as well as acts as a protective agent on BMD (RYAN et al., 1998; MADDALOZZO et al., 2007; NAGATA et al., 2002; KATO et al., 2006; BOCALINI et al., 2009; BOCALINI et al., 2010). The results of Bocalini et al. (2010) suggest that a moderate exercise program is able to preserve lumbar spine and femoral neck BMD in postmenopausal women, even in the absence of hormone replacement therapy, preventing or reducing bone loss. Beyond the maintenance of BMD, Kato et al. (2006) observed significant improvement in femoral neck BMD after a 6 month intervention with training jumps (10 vertical jumps per day, 3 times per week).

One possibility which may explain the discrepancy between our results and those noted in the literature which describe exercise as being a protective factor, may be related to the instrument used to assess the level of physical activity, which may not have been sensitive enough for the purpose of this study.

Our study has some limitations that should be considered before generalizing these results: the sample selection was not random and the study design was cross sectional. The fact that there was no previous monitoring until the start of data collection with the patients represents a limitation since the post-operative period exceeding 37 months in some cases is dependent on the prior condition, before the BS. Considering these results, we could state that further studies with greater control over these aspects, as well as long-term follow-up evaluations of the measured factors in this study, may help to further explain the present results.

Conclusion

This study shows a higher prevalence of osteopenia/osteoporosis among patients who underwent BS. The subjects who underwent BS also had greater ratios of alterations in BMD, especially in the femur and femoral neck. Another factor which was associated with alterations in BMD was age. Subjects older than 50 years had higher risks of osteopenia/osteoporosis compared to younger subjects. Further studies are thus needed to more deeply investigate the relationship between age, BS, quality weight loss after surgery and its impact on the body and bone metabolism.

Acknowledgements

The authors thank the Fundacao Araucaria, the Financier of Studies and Projects - FINEP and the Ministry of Health for financial support. We also thank the Coordination of Improvement of Higher Education Personnel - CAPES for the scholarship provided. Finally we wish thank Ph.D.(c), M.Sc., Bsc. Jessica McNeil of School of Human Kinetics, University of Ottawa – Canada, for the final revision at this paper English version.

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Received on September 30, 2011.
Accepted on December 16, 2011.