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Does the level of leisure-time physical activity after bariatric surgery affect bone parameters?

Nível de atividade física no lazer após a cirurgia bariátrica afeta parâmetros ósseos?

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Abstract – Bariatric surgery (BS) causes an exacerbated loss of body weight and fat, and can promote changes in other body tissues such as bone tissue. The aim of this study was to compare the profile of serum and urinary bone markers and bone mineral density (BMD) of active and sedentary patients after BS. The sample consisted of 89 patients, of both sexes, who underwent BS through the gastric bypass in Roux-Y, between years 2003 and 2013. Anthropometry, body composition, spine and femur BMD was evaluated by dual energy x-ray absormetry (DEXA), as well as biochemical variables through serum collected for the dosage of calcium, osteocalcin and PTH levels, and also 24-hours urine for deoxypyridinoline and calcium. The level of leisure-time physical activity was assessed by questionnaire. Statistical significance was set at 5%. The average age of active and sedentary groups was [51.76 (9.66)] and [47.06 (12.16)] and body mass index [34.98 (6.90)] and [29,26 (5.92)], respectively. There are statistically significant differences in osteocalcin levels between groups (p = 0.021), as well as small effect size observed in the following variables: BMD of the total femur, osteocalcin, deoxypyridinoline and serum calcium (respectively d = 0:36; d = 0:39; d = 00:41 d = 0.3). The incorporation of an active lifestyle demonstrated a positive impact on circulating levels of osteocalcin and other bone parameters, thereby indicating a possible preservation of BMD during the aging process.

Key words: Bariatric Surgery; Bone Density; Sedentary lifestyle.

Resumo – *A cirurgia bariátrica (CB) ocasiona uma perda acentuada de massa corporal e gordura, com reflexos em outros tecidos corporais como o ósseo. Objetivou-se comparar o perfil de marcadores ósseos séricos e urinários e a densidade mineral óssea (DMO) de pessoas submetidas a CB classificadas como ativas ou sedentárias. A amostra foi composta por 89 pacientes submetidos a CB por bypass em Y de Roux, entre os anos de 2003 a 2013, de ambos os sexos. Foram realizadas avaliações antropométricas, composição corporal, DMO de coluna e fêmur por Absormetria por dupla emissão de raio-x (DXA) e variáveis bioquímicas, por meio de coletas séricas para a dosagem de cálcio, osteocalcina, PTH e coletas urinárias (urina-24 horas) para dosagem de deoxipiridinolina e cálcio. O nível de atividade física no lazer foi avaliado por questionário. A significância estatística foi estabelecida em 5%. A idade média dos grupos classificados como ativo e sedentário foi de [51,76(9,66)] e [47,06(12,16)] e o índice de massa corporal de [34,98(6,90)] e [29,26(5,92)], respectivamente. Houve diferenças nos níveis de osteocalcina (P=0,021), bem como tamanho de efeito pequeno observados nas variáveis: DMO do Fêmur total, osteocalcina, deoxipiridinolina e cálcio sérico (respectivamente d= 0.36; d=0.39; d=0.41; d=0.3). A adoção de um nível de atividade física considerada "alta" no lazer apresentou impacto positivo sobre os níveis circulantes de osteocalcina, além de outros parâmetros ósseos, indicando uma possível preservação da DMO no decorrer do processo de envelhecimento.*

Palavras-chave: *Cirurgia bariátrica; Densidade óssea; Estilo de vida sedentário.*

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INTRODUCTION

One of the most effective forms of treatment of severe obesity is bariatric surgery (BS)[1]. The literature describes that BS promotes an expressive loss of body mass and fat[2,3]. However, it is important to analyze the consequences of this weight loss in other body tissues and systems[4-6].

This loss of excess body mass by BS may reduce obesity-related comorbidities such as type 2 diabetes mellitus, systemic arterial hypertension, osteoarthritis, obstructive sleep apnea, gastroesophageal reflux, and others. However, some surgical techniques may result in malabsorption of nutrients in the digestive tract, such as gastrointestinal derivations, gastric bypass in Roux-Y[8], thus increasing the risk of nutritional deficiencies[9-11].

Among the possible consequences of this lower absorption of nutrients is the reduction of bone mass, which may lead to osteopenia or osteoporosis[12-15].

Studies have demonstrated a relationship between BS, calcium reabsorption difficulties and impaired bone metabolism[5,12,16-18].

On the other hand, these possible risks from BS can be minimized by increasing the level of physical activity. Bocalini et al.[19] found that a moderate-intensity exercise program is able to assist in the preservation of spine and femur BMD in postmenopausal women, even in the absence of hormone replacement. Complementarily, Muschitz et al.[20] demonstrated that a post-operative program of calcium supplementation and aerobic physical training, combined with strength training, minimizes the loss of bone mass when compared to patients submitted to BS who did not perform such a protocol.

Currently there are few studies addressing the impact of physical activity on bone mineral density and bone metabolism parameters in patients submitted to BS. In this sense, the aims of the present study were to compare bone markers and bone mineral density of patients submitted to BS with level of physical activity, as well as to verify the association between level of leisure-time physical activity and the BMD profile of patients.

METHODOLOGICAL PROCEDURES

Ethical procedures

The study was approved by the Permanent Ethics Committee in Research with Human Beings - State University of Maringá (COPEP-UEM) under protocol No. 412-2008.

Sample

The present study is characterized as transversal descriptive[21]. The study included 89 individuals submitted to BS (BS performed from 2003 to 2013) by the Unified Health System (SUS), living in Maringá-PR and Paranavaí-PR. All evaluations were conducted by a multidisciplinary team member of the Center for Multiprofessional Studies of Obesity - NEMO - State University of Maringá (UEM), composed of professionals and undergraduate and graduate students in physical education, nutrition and psychology. All evaluators were properly trained before the beginning of evaluations in order to standardize protocols.

Inclusion and exclusion criteria

The inclusion criteria were: to have been submitted to BS during a period of at least 12 months; having performed BS by SUS; aged over 18 years. The exclusion criteria were: to present clinical restrictions that impair the performance of physical exercises; pregnancy; metal orthopedic prostheses.

Anthropometric, Body Composition and Bone Mineral Density Evaluations

For anthropometric and body composition evaluations, patients were instructed to remain fasted (10 hours) and to wear light clothing. Body mass and height were measured to calculate the Body Mass Index (BMI). The body mass measurement was carried out using the scale of a Biospace octapolar multi-frequency bioimpedance device, model Inbody 520, with capacity for 250kg and accuracy of 0.1kg. Height was measured using Sanny aluminum stadiometer fixed to the wall with accuracy of 0.1cm and capacity of 2 meters.

Body composition and bone mineral density measurements were performed using Dual Energy X-Ray Absortometry (DEXA) - GE Lunar Prodigy Primo model by an evaluator duly trained by the Brazilian Society of Clinical Densitometry - SBDens / Brazilian Association of Bone Evaluation and Osteometabolism – ABRASSO[22]. For reconstruction of the underlying tissues image, allowing the quantification of bone mineral content, total fat mass and body mass free of fat and bone, Encore software version 10.0 was used.

In the evaluation of body composition and bone mineral density of the entire body, subjects were placed in the supine position, with palms facing downwards, in the center of the scan area. It was observed whether all parts of the subject's body were located in that area. Patients were instructed to remain immobile until the scan was finished, fixing tapes were placed at knee and ankle height. In the present study, the following variables were used: total fat mass, bone mineral content of the entire body and bone mineral density of the entire body.

In the measurement and evaluation of bone mineral density of the spine and femur, an accessory was used in order to standardize the position of feet and to minimize changes in the morphology of the skeleton of patients. Patients were instructed to rotate the foot of the assessed limb to the medial position of the body, in which it was fixed with fixing tapes to the accessory. The evaluation procedure was directed to the segment between L1 and L4 vertebrae. For evaluation of the femur, the femoral neck and the total femur region were considered as areas of evaluation. All procedures and measures were performed according to guidelines of the Brazilian Society of Clinical Densitometry[22].

The criteria used for diagnosis were determined by the International Society of Clinical Densitometry (ISCD-2008) for postmenopausal women and men aged less than 50 years: Z=score less than or equal to 2.0 standard deviations below value 0 (considered "below-expected for mean age"), Z-score greater than or equal to 2.0 standard deviations above the 0 value (considered "within the expected mean age").

Assessment of the level of Physical Activity

The level of physical activity was assessed through a questionnaire proposed by Larsson et al.[23], validated for men and women with BMI ranges from 17.6 to 59.2 kg/m^2. The instrument has two questions: one concerning the level of physical activity of the individual at work and another concerning the level of physical activity in leisure time. The questions are graded from 1 to 4, with "1" representing low level of physical activity, "2" representing moderate level of physical activity and "3" and "4" representing very high level of physical activity. Subjects were instructed to estimate the mean level of PA, if it changed much in the months of the year. For purposes of analysis, the answers to each of the questions in the questionnaire were divided into 2 categories (a) Sedentary and (b) active. In question 1, regarding leisure-time PA, subjects who indicated number 1 were considered sedentary and those who indicated numbers 2, 3 or 4 in the questionnaire were considered active. In this way, the classification of the level of physical activity was performed through categorization of affirmatives chosen by the subject.

Evaluation of the bone metabolism biochemical profile

After body composition evaluations, still in fasting, patients were referred to a clinical laboratory where blood and urine samples were collected. Serum levels of calcium, osteocalcin, PTH were measured through the blood samples and the deoxypyridinoline levels were measured with the urine sample. After these procedures, patients were properly equipped and oriented to perform a 24-hour urine collection in their residences, not to exceed one week from the date of collection at the laboratory. The orientation was to store all urine excreted within 24 hours from the second urine of the morning of the first day of collection and until the first urine of the second day of collection; and then return the collected material to the laboratory. With the 24-hour sample, calcium levels were measured.

Data analysis

The analysis of the descriptive statistics was made through measures of central tendency and dispersion (mean and standard deviation). Kolmogorov-Smirnov normality test was applied to analyze data distribution. Data that presented a non-parametric distribution were transformed into logarithms of 10 and then tested again for normality. After confirming data normality, ANCOVA was performed, comparing groups with different levels of physical activity, considering the subjects' age as a possible covariate. In addition, the Cohen's[24] D effect size was calculated. The SPSS 20.0 software was used to analyze data and the significance was set at 5%.

RESULTS

During the study period, 89 patients met the inclusion criteria and completed the collection procedures. Table 1 shows the means and standard deviations of variables: age, body mass, BMI and FM of groups: sedentary and active. When groups were compared, sedentary individuals had higher values for all variables analyzed.

Table 1. Sample characterization

	Sedentary (n=41)	Active (n=48)
Age (years)	51.76(9.66)	47.06(12.16)
Body mass (kg)	87.10(17.64)	75.41(17.89)
BMI (kg/m^2)	34.98(6.90)	29.26(5.92)
FM (kg)	39.99(13.12)	28.66 (12.51)

BMI: Body Mass Index; FM: Fat mass; * significant difference.

Table 2 presents the analysis of covariance for BMD variables and bone parameters included in the study, as well as the Effect Size of the Level of Physical Activity of subjects. The variable age was shown to have an effect on BMD of the Entire Body, Spine, Femur, Total Femur and Deoxipirodinoline. When Sedentary and Active groups were compared, only osteocalcin levels presented a significant difference, presenting small ES.

Table 2. Comparison of bone mineral density and bone parameters in sedentary and active individuals at leisure

	Sedentary (n=41)	Active (n=48)	P	ES	Classification
BMD Total Body [a]	1.109 (0.095)	1.121 (0.124)	0.479	0.11	Trivial
BMD Spine [a]	1.144 (0.182)	1.170 (0.199)	0.999	0.15	Trivial
BMD Femur [a]	0.914 (0.116)	0.969 (0.155)	0.380	0.13	Trivial
BMD Total Femur [a]	0.949 (0.128)	0.999 (0.150)	0.475	0.36	Small
Osteocalcin	26.81 (12.44)	32.04(14.41)	0.021*	0.39	Small
Deoxypyridinoline [a]	9.10 (3.41)	16.99(35.57)	0.207	0.41	Small
PTH	62.81 (26.10)	61.51 (34.30)	0.837	0.04	Trivial
Serum Calcium	9.49 (0.60)	9.67 (0.60)	0.225	0.3	Small
Urinary Calcium	91.21 (70.64)	88.16 (56.23)	0.648	0.05	Trivial

a effect of covariable age; BMD: Bone Mineral Density; PTH: Parathyroid hormone; * significant difference; ES: Effect size

For variables BMD Total Femur, Deoxypyridinoline and Urinary Calcium, there were no significant differences between groups. The ES of the level of physical activity was small.

Table 3 presents the results regarding the diagnosis of low bone mass and osteoporosis among active and sedentary participants. There were no associations between level of leisure physical activity and BMD classification.

Table 3. Diagnosis of bone mineral density among the different levels of physical activity

Variables	Active (n=48)		Sedentary (n=41)		P
	n	%	n	%	
BMD Total Body					NS
Normal	38	79.2	34	82.9	
Low Bone Mass	10	20.8	7	17.1	
Osteoporosis	0	0.0	0	0.0	
BMD Spine					NS
Normal	39	81.3	30	73.2	
Low Bone Mass	7	14.6	9	22.0	
Osteoporosis	2	4.2	2	4.9	
BMD Femur					NS
Normal	44	91.7	37	90.2	
Low Bone Mass	4	8.3	3	7.3	
Osteoporosis	0	0.0	1	2.4	
BMD Total Femur					NS
Normal	32	66.7	27	65.9	
Low Bone Mass	15	31.3	12	29.3	
Osteoporosis	1	2.1	2	4.9	

BMD: Bone Mineral Density; NS: Not significant for P <0.05

DISCUSSION

The hypothesis of the study that the level of leisure-time physical activity of sedentary and active postoperative individuals could influence BMD and/or bone metabolism markers was partially confirmed. The results show an increase of osteocalcin in active individuals and a relation of BMD (total, spine and femur) and deoxipyridinoline with age. However, this increase did not lead, during the time of study, to changes in the BMD of these patients.

In relation to osteocalcin levels, we showed that this marker was higher in active individuals. Osteocalcin is a marker used to check the osteoblastic action of bone metabolism, which may increase or maintain bone mass in operated individuals or in aging[24]. Thus, higher levels of physical activity and consequently osteocalcin may indicate greater preservation of the bone structures of operated patients in the long term.

The literature indicates that physical exercise and the consequent mechanical stress of muscular contraction interferes in a positive way on bone parameters, resulting in stimuli for bone formation[25]. In a complementary way, we know that performing a systematic physical training with control of the types of modalities, duration and intensity promotes a positive impact on femur BMD after six months of intervention with strength training[5,26,27].

The study by Bocalini et al.[19] found that a moderate exercise program is capable of preserving bone mineral density (BMD) of spine and femur in postmenopausal women, even in the absence of hormone replacement. In the same sense, Lewin et al.[28], in a study with 724 women, found that mechanical stress resulting from muscle contraction results in stimulus for bone formation.

Another study conducted in the United States (Nurses' Health Study)[29] of 11 American states beginning in 1986 followed, for 12 years, 61,200 postmenopausal women aged 40-77 years who had no cancer, cardiovascular disease or osteoporosis at the study baseline. In the evaluation period, 415 proximal femoral fractures were identified, and after adjustment for other variables such as age, BMI, use of estrogen replacement and smoking, the risk of fractures was 6% lower for each hour of weekly walking. Women who walked at least 8 hours per week had a 55% reduction in fracture risk (RR = 0.45; 95% CI = 0.32-0.63) compared to those considered sedentary (less than one hour weekly walking). Therefore, there was a linear reduction in risk with increased level of physical activity, and even in women who walked at least four hours per week, the reduction was 41% (RR = 0.59, 95% CI = 0.37- 0.94) (27).

Likewise, Bandeira and Carvalho[30] pointed out that postmenopausal women are at greater risk of presenting problems with osteoporosis in the femur and spine. In the same study, the prevalence of osteoporosis in the femur was statistically lower in women reporting walking or other physical exercise.

According to the results found, it is important to highlight the limitations of the present study, such as: absence of control of physical activity variables, such as modality, intensity, duration and time of adoption of most active habits.

CONCLUSION

Thus, for patients submitted to BS, the level of physical activity considered "active" in the leisure period did not present a direct relation with higher BMD levels when compared to sedentary ones. However, the adoption of a level of physical activity considered to be more active in leisure time may indicate greater preservation of BMD during the aging process as well as lower risk of fractures, since higher circulating osteocalcin levels are observed in the active group. The absence of statistically significant differences may be in part associated with the fact that the present study measured the level of leisure-time physical activity and not overall level of physical activity.

Finally, although the results presented modest values regarding the level of leisure-time physical activity and the bone parameters in postoperative patients, we emphasize the importance of the level of physical activity and, if possible, engagement in systematized physical training for maintenance or increase in bone matrix. Regardless of level of leisure-time physical activity, these variables have a significant impact reported in literature.

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REFERENCES

1. Brasil. Portaria No424, de 19 de março de 2013. Redefine as diretrizes para a organização da prevenção e do tratamento do sobrepeso e obesidade como linha de cuidado prioritária da Rede de Atenção à Saúde das Pessoas com Doenças Crônicas. Diário oficial da união. 20 de março 2013; Seção 1.
2. Sjöström L, Lindroos A-K, Peltonen M, Torgerson J, Bouchard C, Carlsson B, et al. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. N Engl J Med 2004;351(26):2683-93.
3. Buchwald H, Oien DM. Metabolic/Bariatric Surgery Worldwide 2011. Obes Surg 2013;23(4):427–36.
4. Benedetti G, Mingrone G, Marcoccia S, Benedetti M, Giancaterini A, Greco AV, et al. Body composition and energy expenditure after weight loss following bariatric surgery. J Am Coll Nutr 2000;19(2):270-4.
5. Byung JK, Myung SK, Cho KH, Park YG, Kim SG, Kim DH, et al. Relationship Between Bariatric Surgery and Bone Mineral Density: a Meta-analysis. Obes Surg 2015; 26(7):1414-21.
6. Stein EM, Silverberg SJ. Bone Loss After Bariatric Surgery: Causes, Consequences and Management. Lancet Diabetes Endocrinol 2014;2(2):165-74.
7. Geloneze B, Pareja JC. Cirurgia bariátrica cura a síndrome metabólica? Arq Bras Endocrinol Metabol 2006;50(2):400-7.
8. Choban PS, Jackson B, Poplawski S, Bistolarides P. Bariatric surgery for morbid obesity: why, who, when, how, where, and then what? Cleve Clin J Med 2002;69(11):897-903.
9. Fujioka K. Follow-up of Nutritional and Metabolic. Diabetes Care 2005;28(2):481-4.
10. Bloomberg R, Fleishman A, Nalle J, Herron DM, Kini S. Nutritional deficiencies following bariatric surgery: what have we learned? Obes Surg 2005;15(2):145–54.
11. Weng TC, Chang C-H, Dong Y-H, Chang Y-C, Chuang L-M. Anaemia and related nutrient deficiencies after Roux-en-Y gastric bypass surgery: a systematic review and meta-analysis. BMJ Open 2015;5(7):e006964.
12. Von Mach M, Stoeckli R, Bilz S, Kraenzlin M, Langer I, Keller U. Changes in bone mineral content after surgical treatment of morbid obesity. Metabolism 2004;53(7):918-21.
13. Gene Carey D, Pliego G, Raymond R, Brooke Skau K. Body Composition and Metabolic Changes Following Bariatric Surgery: Effects on Fat Mass, Lean Mass and Basal Metabolic Rate. Obes Surg 2006;16(4):469-77.
14. Santos MT, Souza FI, Fonseca FL, Lazaretti-Castro M, Sarni RO. Alterações de parâmetros relacionados ao metabolismo ósseo em mulheres submetidas à derivação gástrica em Y de Roux. Arq Bras Endocrinol Metab 2012;56(6):376-82.
15. Fleischer J, Stein EM, Bessler M, Della Badia M, Restuccia N, Olivero-Rivera L, et al. The decline in hip bone density after gastric bypass surgery is associated with extent of weight loss. J Clin Endocrinol Metab 2008;93(10):3735-40.
16. Fish E, Beverstein G, Olson D, Reinhardt S, Garren M, Gould J. Vitamin D status of morbidly obese bariatric surgery patients. J Surg Res 2010;164(2):198–202.
17. Sinha N, Shieh A, Stein EM, Strain G, Schulman A, Pomp A, et al. Increased PTH and 1.25 (OH) 2D levels associated with increased markers of bone turnover following bariatric surgery. Obesity 2011;19(12):2388–93.

18. Ducloux R, Nobécourt E, Chevallier JM, Ducloux H, Elian N, Altman JJ. Vitamin D deficiency before bariatric surgery: Should supplement intake be routinely prescribed? Obes Surg 2011;21(5):556-60.
19. Bocalini DS, Serra AJ, dos Santos L. Moderate resistive training maintains bone mineral density and improves functional fitness in postmenopausal women. J Aging Res 2010;2010:760818.
20. Muschitz C, Kocijan R, Haschka J, Zendeli A, Pirker T, Geiger C, et al. The Impact of Vitamin D, Calcium, Protein Supplementation, and Physical Exercise on Bone Metabolism After Bariatric Surgery: The BABS Study. J Bone Miner Res 2015;31(3):672–82.
21. Thomas JR, Nelson JK, Silverman SJ. Métodos de pesquisa em atividade física. Artmed; 2012.
22. Brandão CMA, Camargos BM, Zerbini CA, Plaper PG, Mendoça LMC, Albergaria B. Posições oficiais 2008 da Sociedade Brasileira de Densitometria Clínica (SBDens). Arq Bras Endocrinol Metabol 2009;53(1):107-12.
23. Larsson I, Lissner L, Naslund I, Lindroos AK. Leisure and occupational physical activity in relation to body mass index in men and women. Scand J Nutr 2004; 48(4):165–72.
24. Delmas PD. Biochemical markers of bone turnover for the clinical investigation of osteoporosis. Osteoporos Int 1993;3(1):81-6.
25. Flanagan EP. The Effect Size Statistic - Applications for the Strength and Conditioning Coach. Strength Cond J 2013;25(5):37–40.
26. Huck CJ. Effects of Supervised Resistance Training on Fitness and Functional Strength in Patients Succeeding Bariatric Surgery. J Strength Cond Res 2015;29(3):589–95.
27. Kato T, Terashima T, Yamashita T, Hatanaka Y, Honda A, Umemura Y. Effect of low-repetition jump training on bone mineral density in young women. J Appl Physiol 2006;100(3):839–43.
28. Lewin S, Gouveia CHD A, Marone MMS, Wehba S, Malvestiti LF, Bianco AC. Densidade mineral óssea vertebral e femoral de 724 mulheres brancas brasileiras: influência da idade e do peso corporal. Rev Assoc Med Bras 1997;43(2):127–36.
29. Feskanich D, Willett W, Colditz G. Walking and leisure-time activity and risk of hip fracture in postmenopausal women. JAMA 2002;288(18):2300–6.
30. Bandeira F, Carvalho EF De. Prevalence of osteoporosis and vertebral fractures in postmenopausal women attending reference centers. Rev Bras Epidemiol 2007;10(1):86–98.

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