Relationship between variables of body composition and mineral bone density in elder women*

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ABSTRACT

There are controversies in the literature as to the importance of the total body mass (TBM), lean mass (LM), and fat mass (FM) as determinant factors to the mineral bone density (MBD) in elder women. **Purpose:** To determine the relationship of the MBD to the TBM, LM and FM in elder women. **Methods:** It was studied ninety-seven 60-70 years old women (mean 66.41 ± 4.82 years). None of the participants was using hormones or any other medication that could affect the bone metabolism, as well as they were not smokers or alcohol consumers. The body composition and the MBD of the femoral cervix (FC) and lumbar spine (LS) were measured through DXA, a lunar DPX-IQ. The relationship between TBM, LM, and FM as well as the FC and LS' MBD were performed separately using linear regression analysis. The multiple regression analysis was used to determine the TBM, LM, and FM on the FC and CL MBD. **Results:** The TBM was strongly correlated to the FC and LS' MBD ($r = 0.54$, $p = 0.01$, and $r = 0.37$, $p = 0.01$, respectively) than the FT ($r = 0.30$, $p = 0.01$, and $r = 0.19$, $p = 0.06$, respectively) and the LM ($r = 0.44$, $p = 0.01$, and $r = 0.26$, $p = 0.05$, respectively). **Conclusion:** The TBM and LM were the body components that kept a significant relationship to the FC and LS' MBD. The FM showed a weak correlation to the FC and LS' MBD, and it was not significant in this last site. Thus, the TBM and the LM are the most significantly determinants among the body composition to the MBD in elder women.

Keywords: Bone mass. Postmenopausal. Body mass.

INTRODUCTION

The increase in the body mass (BM) along the aging years is a risk factor for the health among elder populations, and the effects of the ponderal changes on the elders' health is yet little known. The increase in the BM, especially in 40 to 60 years old individuals, that suffers a decrease after 70 years and the gradual loss in the body height would be in major part responsible by: the decreasing bone mass, the increasing body fat, the decreasing free-fat mass and its major components, and by alterations in the amount of minerals, water proteins, and potassium(1). There are several risk factors to the outcome of the osteoporosis, and among them it is: low body mass, white race, female gender, advanced age, smoking habit, low index of calcium ingestion, sedentarism, early menopause, and motherhood history of femoral cervix fracture and/or osteoporosis(2). The risk for hip fracture in elder women occurs due to the fact the ponderal loss is related to the decrease in the MBD(3). The direct relationship between the reduction in the MBD and the changes in the BM are mainly presented in white or Asian women with familiar history of osteoporosis, low height and thin(4). In a study performed by Coin *et al.*(5) with elder men and women with low body mass (< 22 kg/m^2) assessing the proximal femoral, total hip and total body MBD by means of double-energy X-Ray absorptiometry (DXA), it was verified that the low body mass is associated to the bad nutrition, protein deficiency and osteoporosis. Besides, the bone mineral status was closest to the lean mass (LM) in men than in women, and this is associated to the body composition.

Following these investigation lines, Gillette-Guyonnet *et al.*(6), studying elder osteoporotic women, observed a significant correlation between the MBD and the body composition: total body mass (TBM), fat bass (FM), and lean mass (LM). As to the protective effect on the femoral cervix's MBD, the FM showed the most significant correlation. On the other hand, Binder and Kohrt(7), in a study performed with elder men and women, verified that the LM had a major correlation to the MBD and FM. These authors have suggested that the strong significance between the LM and FM reflects not only the effects on the body volume, but also the functional relationship between muscles and bones. Upon the analysis of the BM in women in different decades of their lives, Lewin *et al.*(8) verified that the BM exerts an important influence both in the acquisition and in the loss of the bone mass. Women with large body mass reached their vertebral and femoral bone mass peak sooner than those with lower body mass, besides of attaining higher MBD values. On the other hand, a higher BM minimized the loss of the skeletal mass, and this represents a protective factor against the decrease in the bone mass that is consequence of the aging and the menopause. In order to clarify previously reported controversial results, this study had the purpose to set a correlation between the TBM, LM, and FM to the MBD in elder women.

MATERIALS AND METHODS

It was studied one-hundred female volunteers with mean age of 66.41 ± 4.82 living in the Brazilian Federal District, in the satellite-cities of Taguatinga, Ceilândia, Areal, Riacho Fundo and Núcleo Bandeirante, participants in the Golden Generation Project. All elder women participating in the study had a less active lifestyle, and they were practicing no regular physical exercise.

The exclusion criteria were: not to practice any regular physical exercise for more than four months; did not use medications that could change the bone metabolism such as glucocorticoids, biphosphonates, calcium, anticonvulsants, antineoplastics, hormones, and calcitonin; were not smokers; were not daily alcohol consumers; and did not present the following clinic changes: previous fractures in the columna vertebralis, and/or femur or hip, acute or chronic thoracolumbar pain, stature loss higher than 2.5 cm or thoracic hyperkyphosis, thoracic deformities, chronic hepatic diseases, past gastrectomy, renal and endocrine diseases.

According to the criteria established, from the total 100 individuals participating in the tests, three were excluded since they presented increased body volume, besides of body overweight that would difficult the total body scanning on the densitometer. So, the final sampling was composed by ninety-seven elder women.

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The study was approved by the Ethics Committee of the Brasilia Catholic University, and before signing the free and clarified consent term, all participants were informed on the purposes, procedures, possible discomforts, risks and benefits of the study.

Procedures

Anthropometric Assessment: To measure the BM, a 100 g resolution, 150.0 kg maximum, 2.5 kg minimum capacity, and 50/60 Hz frequency Personal Line 150 Filizola scale was used. The individual to be assessed was positioned stand up in front of the scale with a side spacing between the feet, straight and looking ahead. To measure the height, a Cardiomed model WCS 115/220 cm precision stadiometer was used.

The measurement was performed using a cursor at a 90º angle related to the scale, and the stature was assessed having the individual in the orthostatic position with her feet united, trying to touch the measurement device with the frontal surfaces of her heels, pelvic girdle, scapular girdle, and occipital region, remaining a few minutes in inspiratory apnea, with her head parallel to the ground.

Assessment of the Bone Mineral Density (MBD) and Body Composition (BC): To measure the MBD and the BC, a densitometer with an assessment protocol through a Lunar double-energy radiological absorptiometry (DXA) model DPX-IP in the medium mode (sampling velocity of five mm/s and RX (ampola) current = 750 mA) was used. It was analyzed the vertebra of the lumbar spine (L_2-L_4) and the femur cervix, and those regions were identified and analyzed through a 4.X software, version of the documentation 10/98 B, Part Number 6740. The quality control of the system was daily performed, giving a variation coefficient (*in vitro* accuracy error) always < 0.05%. During the measurement of the femoral cervix, the individual assessed was in dorsal decubitus, having her arms close to the chest and legs apart. To measure the lumbar columna vertebralis (LCV), the individual remained in dorsal decubitus with her legs supported on a specific support and bended at a 90º angle, having her arms supported on her chest. To measure the body composition, the individual remained in dorsal decubitus having her legs extended and united, and the arms extended along her body.

Procedures to the Statistical Analysis: The descriptive analysis and inferences were performed through the mean and standard deviation. The relationship between the independent (TBM, LM, and FM) and dependent (MBD of the femoral cervix and columna vertebralis between L_2-L_4) variables were performed separately through simple linear regression analysis. The multiple regression analysis was used to determine the independent variable contribution to each other and to the femoral cervix (FC) and the lumbar columna vertebralis' (LCV) MBD with a significance level of $p \leq 0.05$.

To the statistical analysis, it was used the Statistical Package for Social Sciences software (SPSS, 10.0).

RESULTS

Initially, it was performed an exploratory data analysis. It was found no missing cases in the sampling, and the variables assessed did not present any deviation to the normality.

The correlation of the TBM to the dependent variable (MBD of the FC) presented a positive correlation (figure 1) and statistically significant (r = 0.54; p = 0.01), thus explaining the 29% MBD at that site. The relationship between the TBM and the MBD of the LS presented a positive (figure 2) and statistically significant (r = 0.37; p = 0.01) correlation. Nevertheless, such correlation was a little lower with a 14% variation in the LS' MBD.

The relationship of the independent variable FM to the dependent variable MBD of the FC presented a positive (figure 3) and statistically significant (r = 0.30; p = 0.01) correlation with a 9% variation in the MBD at that site. Related to the LS' MBD, the correlation was positive, as shown in figure 4. Nevertheless, such correlation was not statistically significant (r = 0.19; p = 0.058), and the correlation was quite weak, explaining only a 4% variation at that site.

TABLE 1
Presents the descriptive features of the sampling as to the following variables: age, stature, TBM, FM, LM, MBD of the FC and LS

Variable	Mean ± SD	Magnitude
Age (years)	66.41 ± 4.82	60-79
Stature (cm)	151.19 ± 5.27	138-162
TBM (kg)	64.81 ± 11.21	43-97
FM (kg)	25.30 ± 8.19	10.09-61.55
LM (kg)	38.71 ± 4.77	29.22-52.96
MBD-FC (g/cm²)	0.86 ± 0.13	0.59-1.16
MBD-LS (g/cm²)	0.98 ± 0.17	0.64-1.69

SD: standard deviation; TBM: total body mass; FM: fat mass; LM: lean mass; MBD: mineral bone density; FC: femoral cervix; LS: lumbar spine.

TABLE 2
Presents the results of the simple linear regression analysis, related to the TBM, FM, and LM variables, and the FC and LS' MBD in ninety-seven elder women

Variable	TBM	FM (kg)	LM (kg)
MBD-FC (g/cm²)	0.536*	0.305*	0.437*
MBD-LS (g/cm²)	0.370*	0.193	0.255**

* $p \leq 0.01$; ** $p \leq 0.05$; TBM: total body mass; FM: fat mass; LM: lean mass; MBD: mineral bone density; FC: femoral cervix; LS: lumbar spine.

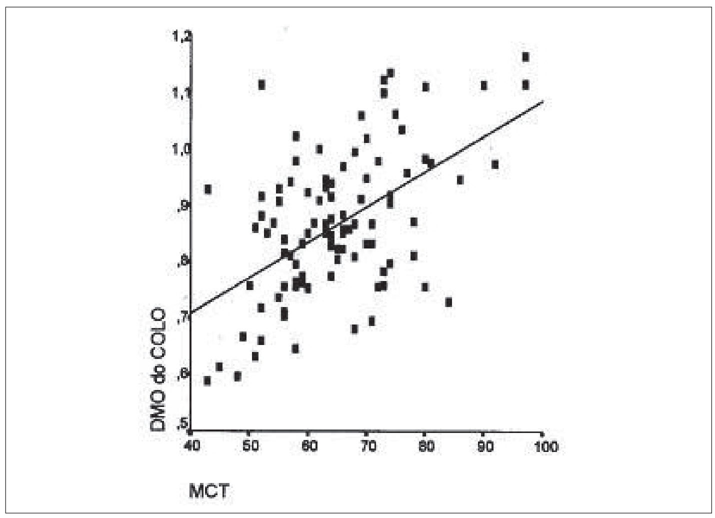

Fig. 1 *– Relação entre MCT e DMO do colo femoral (g/cm²)*

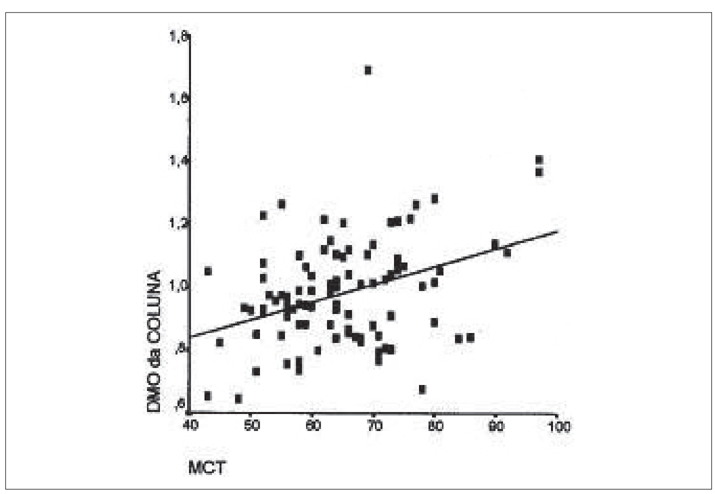

Fig. 2 *– Relação entre MCT e DMO da coluna lombar (g/cm²)*

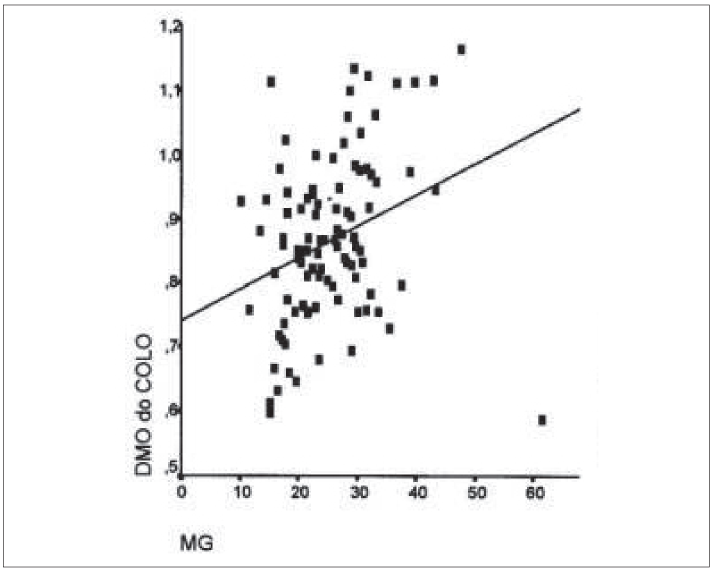

Fig. 3 *– Relação entre MG e DMO do colo femoral (g/cm²)*

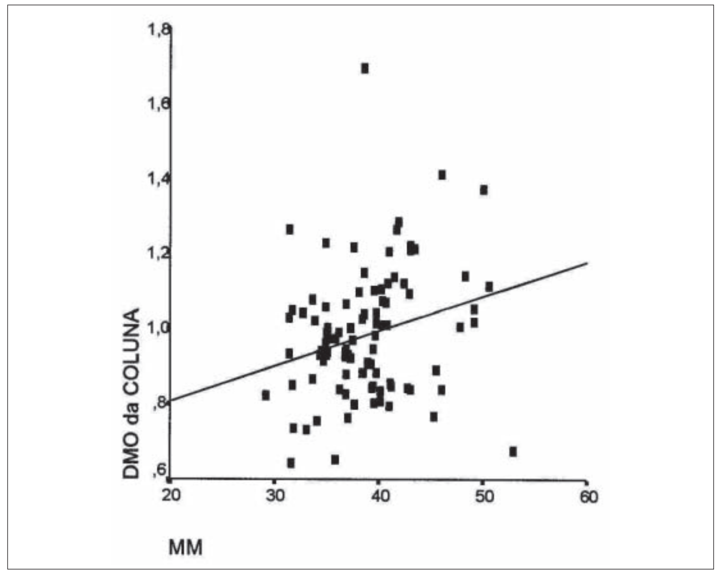

Fig. 6 *– Relação entre MM e DMO da coluna lombar (g/cm²)*

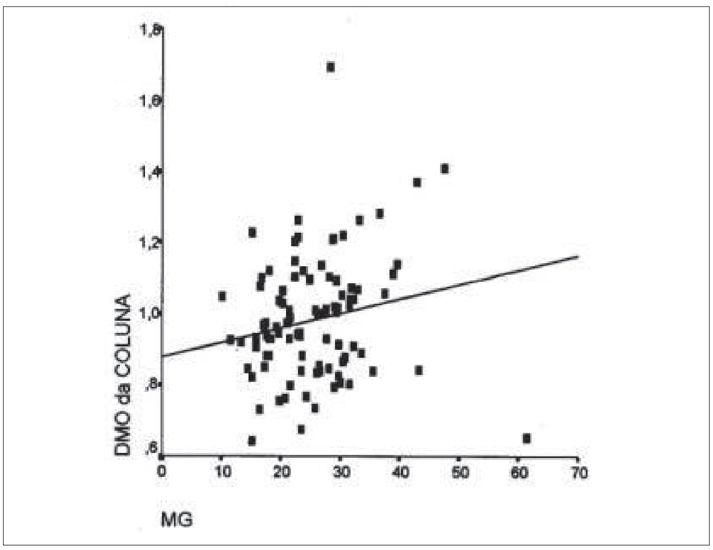

Fig. 4 *– Relação entre MG e DMO da coluna lombar (g/cm²)*

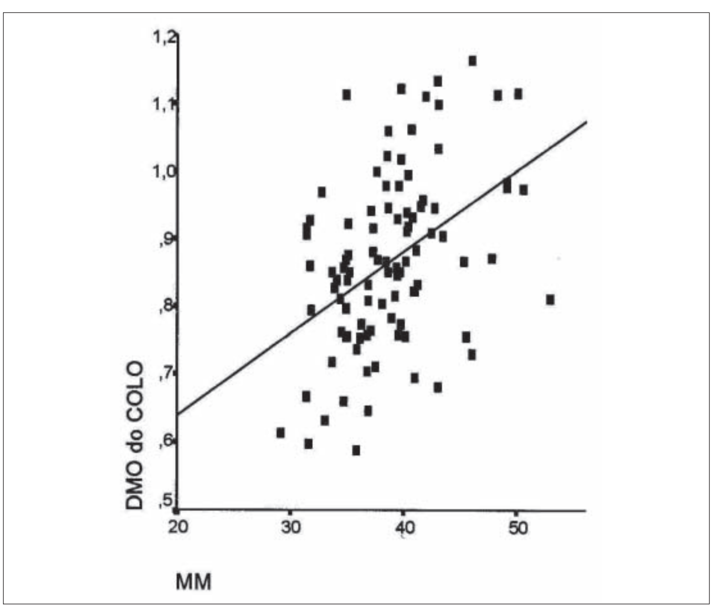

Fig. 5 *– Relação entre MM e DMO do colo femoral (g/cm²)*

TABLE 3
Results of the multiple regression between the femoral cervix and the lumbar spine's MBD related to the body composition components (TBM, FM, and LM) in ninety-seven elder women

Variable	Constant	TBM (kg)	FM (kg)	LM (kg)	R^2
MBD-FC (g/cm²)	0.864**	0.008*	–0.002	–0.001	0.33
MBD-LCV (g/cm²)	0.051	0.012**	–0.004	–0.011	0.18

* $p \leq 0.01$; ** $p \leq 0.05$; TBM: total body mass; FM: fat mass; LM: lean mass; MBD: mineral bone density; FC: femoral cervix; LCV: lumbar columna vertebralis.

It was verified a positive (figure 5) and statistically significant correlation between the LM and the FC's MBD (r = 0.44; p = 0.01), thus explaining a 19% variation at that site. The LM related to the CL's MBD presented a positive (figure 6) and statistically significant (r = 0.26; p = 0.05) correlation, but with a weak 6% variation at that site.

The combination of the body composition components (TBM, FM, and LM) explained the 33% variation in the MBD, as well as the 18% variation in the LS' MBD. The TBM was the most constant variable between the two assessed MBD sites, with a statistically significant correlation ($p \leq 0.01$ in the FC, and $p \leq 0.05$ in the LS). This variable presented a strong correlation to the FM and LM (r = 0.717, $p \leq 0.01$, and r = 0.820, $p \leq 0.01$, respectively) in the MBD at the both assessed sites. The relationship between the LM and the FM was moderate, with a statistically significant correlation (r = 0.470, $p \leq 0.01$) at the assessed sites.

DISCUSSION

The analysis of the data presented in table 2 shows that the bigger body mass, the bigger the femoral cervix and lumbar columna vertebralis' MBD will be. However, there was a positive and significant correlation between the MBD at both sites, and the femoral cervix MBD was 29% higher than the lumbar columna' MBD (L2-L4), that is, a high body mass is more benefic to the MBD of the femoral cervix than the MBD of the lumbar columna vertebralis.

Results found in this study are similar to the observations performed by Gillette-Guynnet *et al.*[6] in a study on the body composition in osteoporotic elder women, when they found significant correlations in the relationship between the TBM and the FC's MBD. Coin *et al.*[5] studying elder men and women with low body mass and individuals with normal body mass, verified that low body mass women presented high risk for fractures, besides of significant reductions in their MBD leading to the osteoporosis. Lewin *et al.*[8] observed in a study performed with 724 Brazilian women of several age levels that the higher TBM the higher MBD values. The relationship between the TBM and the FC's MBD, MBD had an approximate gain of 0.72%/kg. Furthermore, it was found reductions in the FC's MBD, but not in the LS' MBD. Such reductions occurred mainly at the predominant region of the cortical bone, since the decreasing in the cortical bone is basically result from the progressive osteoblasts incapacity to form the bone due to the aging factor. For Christopher *et al.*[9], the loss in the cortical bone is more associated to the aging than to the estrogenic deficiency, while the trabecular bone is much more sensitive to the lack of the sexual steroids. According to Nordin *et al.*[10], a higher decreasing in the femoral cervix's MBD can be explained by the bone loss related to the menopause, which is self-limiting, and lasts approximately ten years.

The data presented in the correlation between the fat mass and femoral cervix's MBD shows a significant correlation only in the femoral cervix's MBD, with a 9% variation at that site. The correlation to the lumbar columna vertebralis and the fat mass has explained only a 4% variation, showing that the fat mass is better to the femoral cervix's MBD than to the lumbar columna vertebralis'.

Reid *et al.*[11] and Gillette-Guyonnet *et al.*[6], studying osteoporotic elder women, observed a significant correlation between the FM and the MBD. The FM explained the variation in the body composition as well as in the FC's MBD more than in the LM, thus evidencing that the FM exerts a protective factor at that site of the body. Studies performed by Reid *et al.*[12] and Goulding and Taylor[13] indicated that the FM is the most important indicator of the femoral cervix's MBD in postmenopausal women. Salamone *et al.*[14], analyzing the body composition and the MBD in 334 American pre- and postmenopausal women with ages from 44 to 50 years old, observed that the FM was not significantly correlated to the LS' MBD and to the analysis of the total body. Similar results were also attained by Flicker *et al.*[15] studying the determining factor to the MBD in elder women, and they found a negative association between the FM and MBD in every assessed site. These studies indicate that in elder women, the FM is associated to a decrease in the bone mass mainly in the LS region, and this may cause the development of the osteoporosis. Such negative association between the FM and the LS' MBD can be attributed to different factors, such as: life-style, sedentarism, food habits, and even a combination of these factors.

According to the figures 5 and 6, the higher lean mass, the higher MBD at the femoral cervix and columna vertebralis L2-L4 sites. Nevertheless, there was a statistically significant correlation in the MBD at both assessed sites, and the femoral cervix' MBD presented a lower 19% variation, evidencing a 10% higher difference in relation to the fat mass.

In the Binder and Kohrt[7] study with four-hundred and two postmenopausal women and one-hundred and sixty men with ages ranging from 55 to 95 years old, the lean mass was strongly related to the femoral cervix's MBD, suggesting that the strong correlation between the lean and the bone mass reflects not only the effects of the body volume, but also the functional relationship between the muscle and the bone. Still, these authors added that with the increase in the lean mass, there is a decrease in the fat mass that contributes to the high MBD levels. Opposed to these results, Douchi *et al.*[16] studying the amount of adiposity in a group composed by ninety-three individuals with several age levels found a positive correlation between the LM and the MBD-LS (L2-L4), suggesting that the LM is a determinant factor to the MBD mainly in men, due to several factors, and among them: the biological interrelationship between the muscle and the bone, increment of biomechanical forces and levels of the physical activity (that is higher for men than for women). Also, these authors verified that the LM is the major determinant to the MBD in pre-menopausal women. Visser *et al.*[17] and Reid *et al.*[11], studying elder men and women, observed that after a two years period, there was a 0.6% decrease in the women's LM, and these changes were positively related to the FC's MBD.

According to the multiple regression analysis, it was possible to observe in the present a correlation between the following statistically significant variables: total body mass, fat and lean mass ($p \leq 0.01$), mainly in the femoral cervix's MBD. The multiple determination coefficient indicates that the components of the body composition further explain most the existing correlation (33%) between the femoral cervix's MBD than the coefficient found in the lumbar columna vertebralis' MBD (18%), and it can be said that the total body mass is a predictor of the MBD at both sites assessed, since it presented a statistically significant correlation ($p \leq 0.01$; $p \leq 0.05$) both to the femoral cervix and to the lumbar columna vertebralis MBD.

Similar observations were found by Coin *et al.*[5] studying elder women and men with low body mass and individuals with normal body mass. Obese individuals presented high MBD levels, and this decreased their risk for fractures, while in low body mass individuals, the MBD levels decreased, thus increasing their risk for fractures. In that same study, the authors confirm our findings when they presented a significant correlation between the FC's MBD, FM, and LM. Pluijm *et al.*[18], studying the determinant factors to the MBD in men and women through their body composition observed that the increment in the TBM in women is positively associated to the FC's MBD, while the loss in the FM substantially reduced the positive associated between the TBM and MBD at that last site.

CONCLUSION

Thus, we concluded that the TBM and LM were the most significant body components in the FC and LS' MBD relationship in 60 to 79 years old women. In such sense, the body mass and the musculature are the most probable determinant factors to the changes in the body composition and in the postmenopausal women's MBD.

These findings suggest that new strategies must be accomplished in order to propitiate the maintenance and/or increase in the LM levels with the aging, thus promoting an improvement to the quality of life among such age level.

All the authors declared there is not any potential conflict of interests regarding this article.

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