ISSN 1669-9106 MEDICINA (Buenos Aires) 2023: 83: 1021-1023

RELATIONSHIP BETWEEN ADIPOSE TISSUE, ITS DISTRIBUTION AND BONE MINERAL DENSITY IN POSTMENOPAUSAL WOMEN

RUBÉN ABDALA[1], LUCIANA LEVI[1], ANTONIO MARMO[1], GISELLE MUMBACH[2]

[1]Instituto de Diagnóstico e Investigaciones Metabólicas (IDIM), Buenos Aires,
[2]Adeno-CEIMP, Posadas, Misiones, Argentina

E-mail: dr.rubenabdala@gmail.com

The relationship between adipose tissue and bone mineral density (BMD) is complex and depends on multiple factors. Body weight is considered a protective factor in bone health and, on the contrary, a low body mass index (BMI) is known as a risk factor in fragility fracture[1, 2]. Although osteoporosis diagnosis is done by determining the BMD by dual-energy X-ray absorptiometry (DXA), most fragility fractures are suffered by individuals without densitometric osteoporosis[3]. Research carried out on obese patients showed positive associations between weight and BMD (both; areal and volumetric), as well as higher cortical thickness and a greater number of trabeculae[4]. Despite these findings, the beneficial effect may vary in different skeletal sites, with an increase in fractures in peripheral sites such as the radius and lower extremities[5]. These results reveal the existence of multiple factors involved in the physio pathogenesis of fractures in obese patients.

The purpose of this research is to assess the relationship between adipose tissue, its location and spine and hip BMD in women over the age of 60 in a reference center in Argentina.

This is a cross-sectional, study. It was carried out consecutively on postmenopausal women over 60 years old with referrals for body composition assessment and muscle strength tests in a specialized medical center in Buenos Aires since 2018. To take part in the research, they needed a spine and hip bone density test from 24 months prior to the study. All measurements were obtained by the same specialized technician. The study was conducted according to the Declaration of Helsinki. Written informed consent was obtained from all participant.

Determinations

Information was obtained on previous BMD (g/cm^2) on spine and hip (femoral neck and total hip), and T-score. In order to define osteoporosis, the classification proposed by the World Health Organization in 2004 has been used, with T-score ≤ -2.5 in any of the assessed areas.

Anthropometric measurements were evaluated during the body composition assessment. Weight was measured with mechanical scales of 0.1 kg accuracy, and height was measured with a wall stadiometer of 0.5 cm accuracy. BMI was calculated with Quetelet's index (weight/height^2).

Body composition assessment was carried out with DXA equipment, Lunar Prodigy Advance (GE- Lunar, Madison, WI, USA), with enCORE software. For this purpose, the positioning of patients and regions of interest were determined according to the manufacturer's standards and the International Society for Clinical Densitometry (ISCD) guidelines. CoreScan was used to measure VAT (gr and cm^3).

Adipose tissue compartment

Total body fat mass was calculated in grams and %. Android and gynoid regional body fat were calculated in % and later the fat mass index (FMI) was assessed (total fat/height^2) as well as the A/G ratio. Visceral adipose tissue (VAT)

was measured in mass (g) and volume (cm^3). For this assessment, the region of interest provided by the manufacturer was used, in a 10 cm long area from the superior border of the iliac crest.

Skeletal muscle mass

Total skeletal muscle mass and upper and lower extremities muscle mass (appendicular muscle mass or AMM) were calculated by means of DXA.

Statistics

Quantitative variables were expressed as average and standard deviation (±SD). According to their distribution, the statistical analysis of women with and without osteoporosis in any assessed region was carried out by using Student's t-distribution and the Wilcoxon-Mann-Whitney test. Variable associations were obtained with the Pearson Correlation Coefficient. We considered a statistical significance of p-value ≤ 0.05. IBM SPSS Statistics (Version 27) was used for the analysis.

In total, 156 women took part in this study. The average age was 68.5±5.6 years old (60-89 years old age range). The average BMI was 24.87 ± 3.98. When classifying the samples into osteoporotic n= 74 (47%) vs. non-osteoporotic n = 84 (53%), it was clear that the second group shows higher values in: Total fat tissue (27513.99 ± 6862.83 vs. 24189.15 ± 7208.52 grams, p = 0.0037), VAT (599.23 ± 526.04 vs. 727.76 ± 545.25 g, p = 0.0426), BMI and FMI (Table 1). A simple correlation analysis showed a positive but small correlation between VAT and BMD Lumbar Spine r = 0.30; p < 0.05, VAT vs. BMD Total Hip r = 0.24; p < 0.05; VAT vs. BMD Femoral Neck r = 0.32; p < 0.05.

The high frequency of osteoporosis in our sample is a consequence of being a reference center for bone metabolism. Our study showed that women with osteoporosis had less visceral adipose tissue and fat mass than women without osteoporosis. Similar findings were recently published by Liu et al., who found a positive association between VAT and bone structural parameters at the distal tibia and radius using high-resolution peripheral quantitative computed tomography (HR-pQCT)[2]. Saarelainen et al. evaluated the participation of fatty tissue in BMD, finding a positive association

Tabla 1 | Osteoporosis vs. no osteoporosis women

	Osteoporosis (N = 74)	Without osteoporosis (N = 82)	p value
Age(y)	69 ± 6	68 ± 5	0.2949
Weight (k)	59.6 ± 9.5	65.0 ± 9.9	0.0006
Height (cm)	158.2 ± 5.6	158.8 ± 5.5	0.3040
BMI	23.8 ± 3.6	25.8 ± 4.0	0.0023
Fat (%)	41.2 ± 6.6	42.7 ± 4.8	0.2089
Fat (g)	24 189.1 ± 7208.5	27 514.0 ± 6862.8	0.0037
FMI (kg/h^2)	9.7 ± 2.8	10.9 ± 2.8	0.0062
Android (%)	39.3 ± 10.8	42.0 ± 8.3	0.1048
Gynoid (%)	44.6 ± 6.0	46.3 ± 4.7	0.0751
A/G	0.9 ± 0.2	0.9 ± 0.2	0.2201
VAT (g)	599.2 ± 526.0	727.8 ± 545.2	0.0416*
VAT (cm^3)	635.1 ± 557.6	771.3 ± 578.0	0.0415*
LS (g/cm^2)	0.90 ± 0.11	1.02 ± 0.1	<0.0001
FN (g/cm^2)	0.715 ± 0.07	0.810 ± 0.08	<0.0001
TH (g/cm^2)	0.74 ± 0.08	0.85 ± 0.09	<0.0001

BMI: body mass index; FMI: fat mass index; ASMM: appendicular skeletal muscle mass; VAT: visceral adipose tissue; LS: lumbar spine; TH: total hip; FN: femoral neck
**nonparametric: Mann–Whitney U test*

between BMD at the lumbar spine and trunk fat mass in postmenopausal women[6]. However, despite this supposed beneficial effect, Hind et al. reported that VAT increased the odds of any grade VF in women (VAT: OR = 2.50, p = 0.002)[7]. These findings highlight the inconsistency in the link between bone tissue and adipose tissue.

Different authors tried to identify the role of adipose tissue in the physiopathogenesis of osteoporosis. Among the beneficial effects, there is a greater production of 17β-estradiol levels and higher mechanical loads, which may have a positive effect on bones[8]. In addition, adiponectin and leptin, secreted by adipose tissue, would show a beneficial effect on bone mineral due to their ability to stimulate osteoblasts[9].

On the other hand, it is known that obese people have lower levels of vitamin D and that, depending on the obesity phenotype; they induce the release of cytokines that can affect bone health[10]. Although our study has limitations, among them we can mention that we did not obtain biochemical and therapeutic data and we do not know the level of physical activity, to the best of our knowledge, there is no local information on the relationship between adipose tissue and its distribution with bone mass. Therefore, it is important for us to be able to disseminate these results and encourage future research in this field.

References

1. Zhu K, Hunter M, James A, Lim EM, Cooke BR, Walsh JP. Relationship between visceral adipose tissue and bone mineral density in Australian baby boomers. *Osteoporos Int* 2020; 31: 2439-48.
2. Liu CT, Broe KE, Zhou Y, et al. Visceral adipose tissue is associated with bone microarchitecture in the Framingham osteoporosis study. *J Bone Miner Res* 2017; 32: 143-50.
3. Pasco JA, Seeman E, Henry MJ, Merriman EN, Nicholson GC, Kotowicz MA. The population burden of fractures originates in women with osteopenia, not osteoporosis. *Osteoporos Int* 2006; 17: 1404-9.
4. Sornay-Rendu E, Boutroy S, Vilayphiou N, Claustrat B, Chapurlat RD. In obese postmenopausal women, bone microarchitecture and strength are not commensurate to greater body weight: the Os des Femmes de Lyon (OFELY) study. *J Bone Miner Res* 2013; 28: 1679-87.
5. Gnudi S, Sitta E, Lisi L. Relationship of body mass index with main limb fragility fractures in postmenopausal women. *J Bone Miner Metab* 2009; 27: 479-84.
6. Saarelainen J, Honkanen R, Kröger H, Tuppurainen M, Jurvelin JS, Niskanen L. Body fat distribution is associated with lumbar spine bone density independently of body weight in postmenopausal women. *Maturitas* 2011; 69: 86-90.
7. Hind K, Pearce M, Birrell F. Total and visceral adiposity are associated with prevalent vertebral fracture in women but not men at age 62 years: the newcastle thousand families study. *J Bone Miner Res* 2017; 32: 1109-5.
8. Nelson LR, Bulun SE. Estrogen production and action. *J Am Acad Dermatol* 2001; 45: S116-S24.
9. Gilsanz V, Chalfant J, Mo AO, Lee DC, Dorey FJ, Mittelman SD. Reciprocal relations of subcutaneous and visceral fat to bone structure and strength. *J Clin Endocrinol Metab* 2009; 94: 3387-93.
10. Karampela I, Sakelliou A, Vallianou N, Christodoulatos GS, Magkos F, Dalamaga M. Vitamin D and obesity: current evidence and controversies. *Curr Obes Rep* 2021; 10: 162-80.