International Journal of Medical, Medicine and Health Sciences
ISSN: 2517-9969
Vol:14, No:8, 2020

Obesity and Bone Mineral Density in Patients with Large Joint Osteoarthritis

Vladyslav Povoroznyuk, Anna Musiienko, Nataliia Zaverukha, Roksolana Povoroznyuk

***Abstract*—**Along with the global aging of population, the number of people with somatic diseases is increasing, including such interrelated pathologies as obesity, osteoarthritis (OA) and osteoporosis (OP). The objective of the study is to examine the connection between body mass index (BMI), OA and bone mineral density (BMD) of lumbar spine, femoral neck and trabecular bone score (TBS) in postmenopausal women with OA. We have observed 359 postmenopausal women (50-89 years old) and divided them into four groups by age: 50-59 yrs, 60-69 yrs, 70-79 yrs and over 80 years old. In addition, according to the American College of Rheumatology (ACR) Clinical classification criteria for knee and hip OA, we divided them into 2 groups: group I – 117 females with symptomatic OA (including 89 patients with knee OA, 28 patients with hip OA) and group II –242 women with a normal functional activity of large joints. Analysis of data was performed taking into account their BMI, classified by World Health Organization (WHO). Diagnosis of obesity was established when BMI was above 30 kg/m^2. In woman with obesity, a symptomatic OA was detected in 44 postmenopausal women (41.1%), a normal functional activity of large joints - in 63 women (58.9%). However, in women with normal BMI – 73 women, who account for 29.0% of cases, a symptomatic OA was detected. According to a chi-squared (χ2) test, a significantly higher level of BMI was detected in postmenopausal women with OA (χ2 = 5.05, p = 0.02). Women with a symptomatic OA had a significantly higher BMD of lumbar spine compared with women who had a normal functional activity of large joints. No significant differences of BMD of femoral necks or TBS were detected in either the group with OA or with a normal functional activity of large joints.

***Keywords*—**Bone mineral density, BMD, body mass index, BMI, obesity, overweight, postmenopausal women, osteoarthritis.

I. Introduction

WORLDWIDE obesity is complex and pressing problem. Its prevalence has nearly tripled since 1975 [1], and is reaching nowadays pandemic levels [2]. According to the data of the WHO, every one in 4 adults in the world is overweight and every one in 11 has obesity. Such a high rate of body weight-related problems is alarming due to the fact that an overweight or obesity itself is a risk factor for dozens of diseases. It can cause premature disability and death by increasing the risk of cardiometabolic diseases, OA, dementia, depression and some types of cancers [2].

The mechanism behind obesity starts with a similar origin of osteoblasts and adipocytes, both being precursors of a mesenchymal stem cell (MSC). Aging alone alters the MSC in the bone marrow by promoting adipogenesis and reducing osteoblastogenesis [6]. Visceral abdominal fat is the most metabolically active and may be associated with a poor quality of bone tissue and lower BMD. The latter one is also associated with a higher frequency of falls, reducing up to 40% fat free mass composed mostly of skeletal muscle in the elderly [4] and lower bioavailability of vitamin D accumulated and stored in the fat tissue [5]. Besides, obesity affects the bone metabolism through multiple pathways, including an alteration of bone-regulating hormones, androgens-to-estrogens conversion in adipose tissue, lower serum levels of Sex Hormone Binding Globulin (SHBG), increased serum leptin levels, increased insulin growth factor production and hyperinsulinemia, inflammation, oxidative stress, endocannabinoid system [6], [19]. All of these mechanisms could be further enhanced by aging which is another topical issue nowadays [6]. Together with an increasing rate of global aging, the number of people with OA is noticeably rising. OA is estimated to affect 15% of people worldwide [7]. This condition usually results in decreased mobility and obesity which is a major comorbidity in patients with OA [8].

The Framingham study [17] has shown an example of decreasing the risk of developing knee OA in female population by 50% in a case of losing weight on average 11 pounds (1 pound equals 453.59 g). The Clifford survey result has shown that the possibility of development knee OA increases 1.36 times with every two units of putting on weight (conversion to kilograms it approximately equal to 5 kg) [17].

Nowadays, all over the world are being conducted an important discussion about obesity, OA and OP that is focused on whether being overweight and obese may have a detrimental or protective effect on skeletal health [3]. Historically, obesity has been linked to bone health as a protective factor consequently some researchers suggest that obesity has protective role on bone health, while others have revealed its detrimental effects. Weight loss in miscellaneous populations including pre- and post-menopausal women leads to a loss of total body BMD up to 2.5% as well as variable losses at regional bone sites 1%–13%. In the other homogenous populations studies of postmenopausal women more a 4%–13% weight reduction led to 1%–4% bone loss and a rise in bone turnover compared with a weight-stable group. According to the literature data, in premenopausal women greater weight loss (average 14%) during a relatively short period of time (3–4 months) results in significant bone

V. Povoroznyuk, A. Musiienko, and N. Zaverukha are with D.F. Chebotarev Institute of gerontology NAMS Ukraine, Kyiv, Ukraine (e-mail: okfpodac@ukr.net, musienko_anya@ukr.net, nataliyahryb@gmail.com).

R. Povoroznyuk is with the Institute of Philology, Kyiv National Taras Shevchenko University, Kyiv, Ukraine (e-mail: rocksol24@yandex.ru).

weakening however a modest weight loss over a longer period of time (6 months) results in fewer or no bone loss [19].

Recent data from the Intensive Diet and Exercise for Arthritis study suggest that suggests that non-mechanical risk factors must also play a part in OA development. Weight loss in obese subjects with concomitant knee OA may have anti-inflammatory, as well as biomechanical, benefits, that evidenced by reduced IL-6 levels. Furthermore, beside an association between obesity and OA in weight-bearing joints such as the knee and hip, obesity is also associated with the development of OA in non–weight-bearing joints, such as those in the hand [20].

Epidemiological studies suggest that in the same patient OA and OP rarely occur together. In addition, cross-sectional studies have indicated that OA is associated with an increase in BMD leading to a common assumption that an increased BMD is protective against OA progression [16].

The Surveys of Osteoarthritis Research Society International (OARSI) consider obesity to be a strong risk factor for knee OA which may also increase the rates of hip, hand and spinal OA, and the number of these painful conditions, together with their associated disability and loss of function, will continue to increase [9].

In the Korean National Health and Nutrition Examination Surveys, there were observed 5793 persons with OA. Their lumbar spine BMD was significantly higher than the one of subjects with knee OA. The findings prompted the conclusion about an inverse relationship between OP and the presence of knee OA; however, there is a non-linear and site-specific association between OP and the severity of knee OA [11].

This year, a group of Italian scientists studied TBS in 352 postmenopausal women with obesity. As a result, BMI was found to be negatively related to TBS and positively to the lumbar spine BMD [12], [13]. A higher BMD has also been reported in association with OA of the spine [14].

Undoubtedly, there is a certain correlation between BMD and severity of OA. Nevitt et al. reported an increased BMD at all sites in subjects with a moderate–severe OA of either hip, increased BMD at femoral neck and lumbar spine in subjects with a milder hip OA [15].

The objective of the study is to examine BMD and TBS of postmenopausal women suffering from obesity and OA.

II. Materials and Methods

The study included 359 postmenopausal women (50-89 years old) examined at the State Institution "Institute of Gerontology NAMS Ukraine" and the Ukrainian Scientific-Practical Center for OP.

The participants were divided into two groups: I group – 117 females with a symptomatic OA, II group – 242 patients without OA. In I group - 89 patients were with knee OA, 28 patients – with hip OA. Diagnosis of a symptomatic OA was established according to the ACR Clinical classification criteria for knee and hip OA (1986). According to these criteria, the presence of knee pain along with at least three of the following six items may be used to diagnose the knee OA: age after 50 years old, morning stiffness of less than 30 minutes, crepitus of knee motion, bone tenderness, bone enlargement, no palpable warmth [10]. The clinical ACR criteria for hip OA are: pain and internal rotation less than 15° and flexion of the hip ≤115° or internal rotation ≥15°, pain at internal rotation, stiffness ≤60 min, and age over 50 years [18]. Lower prevalence estimates for a symptomatic rather than a radiographic OA in the general population reflect the fact that a radiographic OA is not always accompanied by a clinical disease [14].

The BMD of lumbar spine L_1-L_4 and femoral neck was measured by the Dual-energy X-ray absorptiometry (DXA) Hologic (Discovery WI, USA). TBS of L_1-L_4 was detected by TBS insight® software (MedImaps, Pessac, France), which is installed on DXA.

BMI was computed by the ratio of body weight (kilograms) and height^2 (meters), expressed in kg/m^2 (WHO, 1998). Diagnosis of obesity was established when BMI was above 30 kg/m^2.

All the women were divided into four groups by age decades: 50-59 yrs – 87 women, 60-69 yrs – 162 women, 70-79 yrs – 88 women, and over 80 years old – 22 women.

The results are presented in the following manner: Mean values (M) ± Standard Deviation (SD). For data calculation we used: regression, correlation analysis and chi-squared test. A result was considered significant if *p* values were lower than 0.05 ($p<0.05$). "Statistika 6.0" (StatSoft, Inc. ©) was used for data processing purposes.

III. Results

No differences were observed between age and height across all groups. However, women with OA had a significantly higher weight and BMI compared with II group (Table I).

TABLE I
ANTHROPOMETRIC CHARACTERISTICS OF THE EXAMINED PATIENTS

Parameters	Group I	Group II	F	p
Age, years	65.4 ± 8.41	65.8 ± 7.80	0.24	0.62
Weight, kg	75.3 ± 15.30	72.1 ± 12.68	4.39	0.04
Height, cm	161.9 ± 6.38	162.2 ± 6.90	0.20	0.65
BMI, kg/m^2	28.8 ± 5.68	27.4 ± 4.87	6.45	0.01

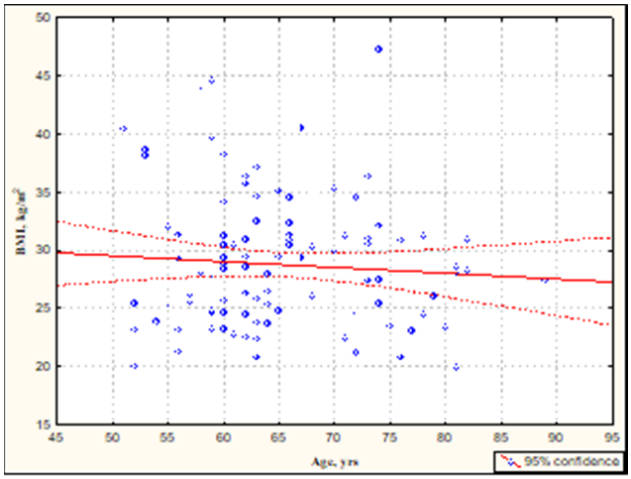
TABLE II
BMD AND TBS IN EXAMINED PATIENTS

Parameters	Group I	Group II	F	p
TBS	1.24 ± 0.11	1.22 ± 0.10	3.32	0.06
BMD of lumbar spine	0.90 ± 0.16	0.83 ± 0.01	16.3	0.00
BMD of right femoral neck	0.67 ± 0.12	0.65 ± 0.11	3.12	0.07
BMD of left femoral neck	0.66 ± 0.12	0.65 ± 0.10	0.91	0.33

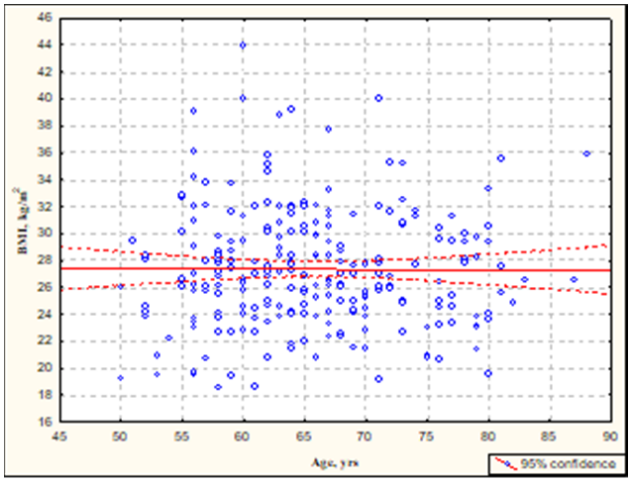
In this study, no significant differences were found either for group I or II while analyzing the BMD of femoral necks ($p = 0.07$ and $p = 0.33$, respectively) and TBS ($p = 0.06$). However, the women of group I had a significantly higher BMD of lumbar spine compared with woman who had a normal functional activity of large joints ($p = 0.000068$)

(Table II).

Correlation and regression analyses of relations between age and BMI are shown in Fig. 1 (A) – with OA, Fig. 1 (B) – with a normal functional activity of large joints.



(A) BMI = 31.896-0.0480*age (r = 0.005; t = -0.76; p = 0.44)



(B) BMI = 27.517-0.0022*age (r = 0.000015; t = -0.06; p = 0.95

Fig. 1 Correlation between BMI and age

In the obese subjects, OA was detected in 44 postmenopausal women (41.1%), while a normal functional activity of large joints - in 63 women (58.9%). However, out of 73 women with a normal BMI, 29.0% of cases had a symptomatic OA.

In 42.9% of women in the age group of 50-59 years with obesity was detected large joint OA comparing with 57.1% of women with a normal functional activity of large joints. In the group of 60-69 years with obesity, there were detected 39.3% of patients with symptomatic OA comparing with 60.7% of females with a normal functional activity of large joints. In the group of obese women of 70-79 years, large joints OA was revealed in 45.8% and normal functional activity of large joints in 54.2% of participants. In the oldest group of subjects over 80 years, the OA was in 33.3% comparing with 66.7% of woman with a normal functional activity of large joint and obesity.

Among women with a normal BMI aged 50-59 years old large joint OA was detected in 31.8% of cases comparing with 68.2% of those with a normal functional activity of large joint. In group of 60-69 years, OA was detected in 27.2% of women comparing with 72.6% of those with a normal functional activity of large joints. In the group of 70-79 years, there were 25.0% cases with symptomatic OA and normal functional activity of large joint was revealed in 75.0% of women. In the oldest group of subjects over 80 years, the distribution was 43.8% of patients large joint OA comparing with 56.2% of women with a normal functional activity of large joints.

According to chi-squared ($\chi 2$) test, a significantly higher level of BMI, or more precisely, obesity, was detected in postmenopausal women with large joint OA ($\chi 2 = 5.05$, $p = 0.02$). In the first group, there were 44 women with obesity and 73 with normal body weight. In the second group – 63 subjects had obesity and 179 - a normal BMI. In the group of 50-59 year-old women, the values were $\chi 2 = 0.86$, $p = 0.68$, in the group of 60-69 year-olds the values were: $\chi 2 = 2.42$, $p = 0.12$, in the group of 70-79 year-old the values were: $\chi 2 = 3.56$, $p = 0.05$, and in the group of women over 80 years the values were $\chi = 20.20$, $p = 0.65$.

IV. Conclusion

In the patients with large joint OA, the frequency of obesity is significantly higher compared to persons with a normal functional activity of large joints.

Women with large joint OA had a significantly higher BMD of lumbar spine. At the same time, there were no significant differences of BMD of femoral necks and TBS in the examined study participants.

As we are planning to continue our research, the presented results should be taken into account for a further study of a larger sample of postmenopausal women with OA at our department.

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