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## BONE MINERAL DENSITY AND TRABECULAR BONE SCORE IN POSTMENOPAUSAL WOMEN WITH KNEE OSTEOARTHRITIS AND OBESITY

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### ABSTRACT

**The aim** of the study was to investigate the relationship between bone mineral density (BMD) of lumbar spine, femoral neck, trabecular bone score (TBS) and body mass index (BMI), in postmenopausal women with knee osteoarthritis (OA).

**Materials and methods:** The study group comprised 359 postmenopausal women aged 50-89 years. They were divided into 2 groups: I group – 117 postmenopausal women with symptomatic knee OA and II group – 242 women with a normal functional activity of knee joints. Analysis of data was performed taking into account their BMD of lumbar spine (L1-L4) and femoral neck, measured by the Dual-energy X-ray absorptiometry (DXA) Hologic (Discovery WI, USA, 2016). TBS of L1-L4 was detected by TBS insight® software (Medmaps, Pessac, France), and BMI classified by World Health Organization (WHO).

**Results:** In postmenopausal women with obesity prevalence of symptomatic knee OA was detected in 41.1% of cases. However, in women with normal BMI knee OA was revealed in 29.0% of women. The highest level of knee OA in obese women aged 70-79 years – 45.8%. According to a chi-squared ( $\chi^2$ ) test, a significantly higher level of BMI was detected in postmenopausal women with OA ( $\chi^2=5.05$ ,  $p=0.02$ ).

**Conclusion:** Women with a symptomatic OA had a significantly higher BMD of lumbar spine compared with women who had a normal functional activity of knee. Significant negative correlation were detected between TBS and BMI, and significant positive correlations between lumbar spine BMD and BMI.

**KEYWORDS:** bone mineral density (BMD), osteoporosis (OP), obesity, postmenopausal women, knee osteoarthritis (OA)

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### INTRODUCTION

Musculoskeletal disorders (MSDs) are the leading chronic condition that results in deterioration the health level of workforces among European population. Data released by the Ministry of Health of Ukraine suggest that MSDs widely spread in our country among the working age group. The total amount of people suffers from MSDs in Ukraine are up to 4 000,000, and near 2 000,000 among them are aged 35 – 60 years old [1]. The most prevalent MSDs are osteoarthritis (OA) and osteoporosis (OP) the number of which increases with age.

However, in a case obesity adjunction, the course of any disease worsens. The amount of people with overweight and obesity has highly increased and has nearly tripled since the last decades of previous century [2,3]. Nowadays, all over the world, are being conducted an important discussion about OA and OP that is focused on whether being overweight and obese may have a detrimental or protective effect on skeletal health [4]. On the one hand, some studies indicates inverse relationship between OA and OP, as opposite to this the increased bone mineral density (BMD) in patients with OA does not resulting in reducing risk of osteoporotic fractures [5]. At the same time some studies concludes that obesity has protective role on bone health, while others shows its detrimental effects [6].

### THE AIM

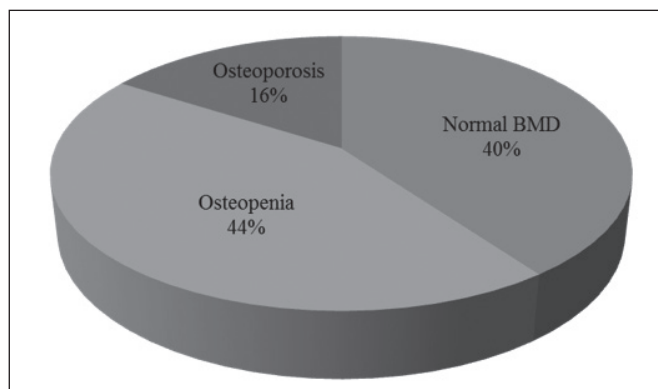
The aim of the study was to investigate the relationship between BMD of lumbar spine, femoral neck, TBS and body mass index (BMI), in postmenopausal women with knee OA and without.

### MATERIALS AND METHODS

The study was performed in D. F. Chebotarev Institute of gerontology, NAMS of Ukraine in accordance with the cooperation agreement between D. F. Chebotarev Institute of gerontology, NAMS of Ukraine and P. L. Shupyk National Medical Academy of Postgraduate Education (NMAPE) from 15 April 2019. The study was approved by the Ethical Committee of NMAPE (05.11.2018, Protocol № 10). All the participants had signed a voluntary informed consent form for participation in research, being the subjects to the respective diagnostic examination procedures.

The study included 359 postmenopausal females aged 50-89 years old, that were divided into four groups by age decades: 87 women aged 50-59 yrs, 162 women aged 60-69 yrs, 88 – aged 70-79 yrs, and 22 women over 80 years old.

The study groups consisted of 117 females with a symptomatic knee OA (I group) and 242 patients without osteoarthritis



**Fig. 1.** Distribution of patients according BMD

(II group). Diagnosis of a symptomatic OA was established according to the American College of Rheumatology (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 [7,8]. 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 [9].

The BMD of lumbar spine L<sub>1</sub>-L<sub>4</sub> and femoral neck was measured by the Dual-energy X-ray absorptiometry (DXA) Hologic (Discovery WI, USA, 2016). TBS of L<sub>1</sub>-L<sub>4</sub> was detected by TBS insight® software (MedImaps, Pessac, France), which is installed on DXA. Diagnosis osteoporosis was established according to the WHO group described criteria. OP is defined as spinal (L<sub>1</sub>-L<sub>4</sub>) or hip (femoral neck) BMD T-score is equal to or below 2.5 standard deviation (SD) of the young-adult reference mean BMD. Osteopenia is defined as a BMD T-score between -1.0 and -2.5 SD, and normal BMD – within 1.0 SD.

BMI was computed by the ratio of body weight (kilograms) and height<sup>2</sup> (meters), expressed in kg/m<sup>2</sup> (WHO,

1998). Diagnosis of obesity was established when BMI was over 30 kg/m<sup>2</sup>.

The results are presented in the following manner: Mean values (M) ± SD. For data calculation we used: regression, correlation analysis and chi-squared test. A result were considered significant if “p” values were lower than 0.05 (p<0.05). “Statistika 10.0” (StatSoft, Inc. ©) was used for data processing purposes.

**RESULTS**

In females with knee OA were detected significantly higher weight and BMI compared with females without OA (table I). However, there were observed no differences between age and height across all groups.

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 with OA had a significantly higher BMD of lumbar spine compared with woman who had a normal functional activity of knee (p=0.000068) (Table II).

With DXA-based BMD measurement of observed individuals, OP was detected in 54 women (16% of patients). In 158 females was osteopenia and in 144 was normal BMD (Fig.1).

In both groups there were observed no significant correlation between BMD of L1–L4, hip and age (Fig. 2) At the same time significant negative correlation were detected between TBS and BMI, therefore in a patients with higher BMI, TBS decreases (Fig.3). Correlation and regression analyses between BMI and BMD lumbar spine also shows significant positive relations, what means that at the same time with increasing of BMI increases BMD of lumbar spine (Fig.4).

In the obese subjects, OA was detected in 44 postmenopausal women (41.1%), while a normal functional activity of knee – 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 with obesity aged 50-59 years was detected knee OA comparing with 57.1% of women without OA. In the group of 60-69 years with obesity, there were

**Table I.** Anthropometric characteristic of examined women

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 <sup>2</sup>	28.8 ± 5.68	27.4 ± 4.87	6.45	0.01

Note. Group I – postmenopausal women with knee OA, Group II – postmenopausal women without OA.

**Table II.** Bone mineral density and trabecular bone score 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

Note. Group I – postmenopausal women with knee OA, Group II – postmenopausal women without OA.

detected 39.3% of patients with symptomatic OA comparing with 60.7% of females with a normal functional activity of knee. In the group of obese women of 70-79 years, knee OA was revealed in 45.8% and normal functional activity of knee 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 knee and obesity.

Among women with a normal BMI aged 50-59 years old knee OA was detected in 31.8% of cases comparing with 68.2% of those with a normal functional activity of knee joint. In group of 60-69 years, OA was detected in 27.2% of women comparing with 72.6% of those without OA. In the group of 70-79 years, there were 25.0% cases with symptomatic OA and normal functional activity of knee joint was revealed in 75.0% of women. In the oldest group of subjects over 80 years, the distribution was 43.8% of patients knee OA comparing with 56.2% of women with a normal functional activity of knee joints.

According to chi-squared ( $\chi^2$ ) test, a significantly higher level of BMI, or more precisely, obesity, was detected in postmenopausal women with knee 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  $\chi^2=20.20$ ,  $p=0.65$ .

## DISCUSSION

According to the data of the WHO, every one in 4 adults in the world has an overweight and every one in 11 – 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 [3].

Nowadays, all over the world, are being conducted an important discussion about obesity, OA and osteoporosis that is focused on whether being overweight and obese may have a detrimental or protective effect on skeletal health [4]. 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 postmenopausal women leads to a loss of total body BMD up to 2.5% as well as variable losses at regional bone sites 1%–13%. 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 weakening however a modest weight loss over a longer period of time (6 months) results in fewer or no bone loss [6].

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 [10]. 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 [11] and lower bioavailability of vitamin D accumulated and stored in the fat tissue [12].

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, 10].

All of these mechanisms could be further enhanced by aging that is another topical issue nowadays [10]. Together with an increasing rate of global aging, the number of people with OA is noticeably rising. OA characterized by the degradation of cartilage in joints and leads to bones rubbing together and results in stiffness, pain, and impaired movement (WHO) [13]. It usually results in decreased mobility and obesity is a major comorbidity in such patients [14]. Worldwide OA is estimated to affect 15% of people of different ages [13]. The relationship between OA and OP is complex and controversial [5].

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 [15].

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 [16]. In the Rotterdam study, patients with knee OA had a higher BMD, however the incident fracture risk was increased as compared with those without knee OA [5].

Undoubtedly, there is a certain correlation between BMD and severity of OA. There was 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 [17].

The Surveys of Osteoarthritis Research Society International (OARSI) consider obesity to be a strong risk factor for knee OA that 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 [18].

The Framingham study described an example of decreasing the risk of developing knee OA by 50% in losing weight females, on average 11 pounds (1 pound equals 453.59 g). The Clifford survey conclude the possibility of development knee OA increases in 1.36 times with every two units of putting on weight (approximately equal to 5 kg) [19].

Recent data from the Intensive Diet and Exercise for Arthritis study suggests that non-mechanical risk factors also play a part in OA development. Weight loss in obese subjects with concomitant knee OA may have anti-inflammatory, as well

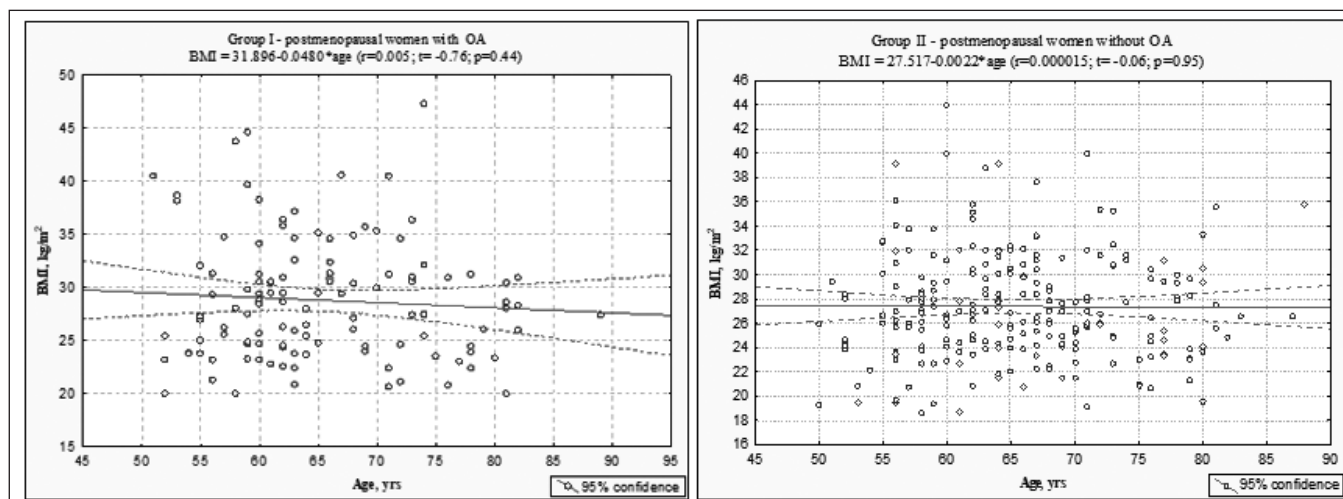


Fig.2. Correlation and regression analyses of relations between BMI and age in postmenopausal women with and without OA.

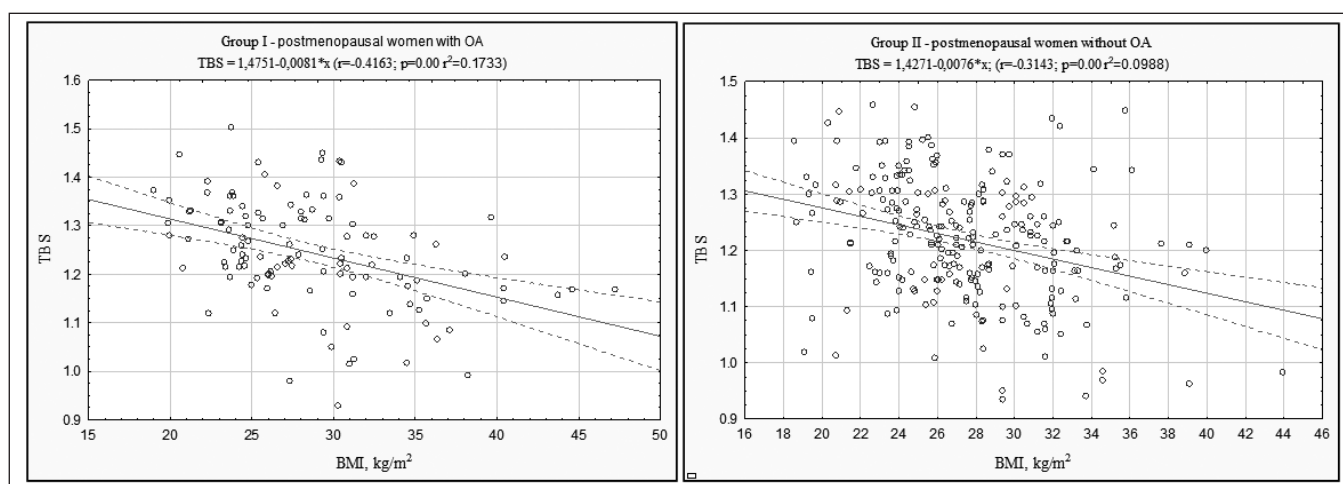


Fig.3. Correlation and regression analyses of relations between BMI and TBS in postmenopausal women with and without OA:

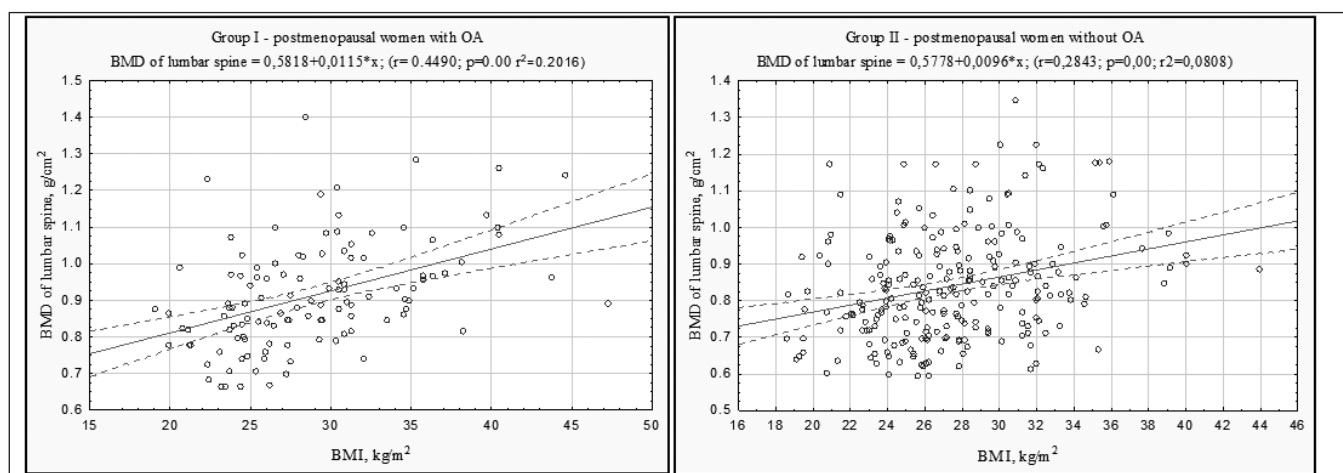


Fig.4. Correlation and regression analyses of relations between BMI and BMD lumbar spine in postmenopausal women with and without OA:

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].

This year, a group of Italian scientists was 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 [21, 22]. A higher BMD has also been reported in association with OA of the spine [9].

## CONCLUSION

The rates of obesity in patients with knee OA, is significantly higher compared to persons with a normal functional activity of knee. Postmenopausal women with knee OA had a significantly higher BMD of lumbar spine compared with women who had a normal functional activity of knee joints. Significant negative correlation were detected between TBS and BMI, and positive correlations between lumbar spine BMD and BMI.

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### Conflict of interest:

*The Authors declare no conflict of interest.*

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