DOI: 10.5455/msm.2021.33.41-44
Received: FEB 15 2021; Accepted: MAR 18, 2021

ORIGINAL PAPER Mater Sociomed. 2021 Mar; 33(1): 41-44

Bone Density and Body Fat Distribution in Postmenopausal Women

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ABSTRACT

Background: In postmenopause there are changes in metabolism of bone tissue and consequent decrease of bone density. With ageing redistribution of fat occurs and an increase in body weight. Because of hormone changes in postmenopause fat is redistributed from gluteofemoral area to the abdominal region. **Objective:** The objective of this study was to examine the relationship between bone density and a body mass index (BMI), and distribution of the fat tissue in women in postmenopause (WHR). **Methods:** This research was prospective, and it included total of 83 women, 53 women were in the natural postmenopause and 30 women with the regular menstruation. **Results:** BMI in women in postmenopause was statistically significantly higher than BMI in women with the regular menstruations (p= 0,005). There was no statistically significant difference between waist hip ratio in women in the postmenopause in relation to the women with the regular menstruations. In women in the postmenopause significant positive correlation between BMI and density of the neck of femur was found (Z and T-score) (p=0,019; p=0,005). There was also significant negative correlation between the WHR and density of the lumbal spine (backbone) in women in the postmenopause (Z-score) (p=0,043). The identical analysis in women with regular menstruations, negative correlation between the density of the lumbal spine was found again (Z-score) and WHR , but the same was highly expressed (p=0,041). The observed correlation between BMI and bone density in this group of women was not statistically significant. **Conclusion**: Based on the presented results we conclude that the higher the BMI (p=0,019; p=0,005) the higher density of the femoral neck postmenopausal women have, and lower bone density of the lumbar spine the higher ratio waist / hip (p = 0.043). In the women with regular menstruation bone density of the lumbar spine is the lower the higher the ratio of waist and hip (p=0,041), while there was no correlation between BMI and bone density in this group of women.

Keywords: postmenopause, bone density, body mass index, waist/hip ratio.

1. INTRODUCTION

In the postmenopause the decrese of the estrogen concentration occurs (1), and changes in the metabolism of the bone tissue. The menopause is an importanat factor for changes occuring in bones´ density and for occurence of osteoporosis (2).

Bone mineral density (bone mineral density-BMD) is the best indicatoe of osteoporosis and the risk of bone fracture which increases in the postmenopause (3). The decrease of bone density leads to weakening of the sceleton which increases sensitivity of bones to fractures (4). In the developed countries osteoporosis becomes important public health problem because of cost of treatment and disability (5). With ageing redistribution of fat occurs and an increase in body weight. These changes begin well before menopause but in postmenopauzi they are accelerated. Approximately 60% women in postmenopause are overweight. Reasons for weight gain are also reduced energy consumption, reduced fat oxidation and increased insulin resistance (6). Ovarian stroma produces androstenedione and testosterone. By circulating androstenedione comes to fat tissue in which converges in the E1-estrone and testosterone. Adipocytes catalyze processes of aromatization of androgens to estrogens. In the stroma of fat tissue by conversion of androstenedione estrone E1 is created which is the main postmenopausal estrogen, and this is why in obese women there is slighter consequence of estrogen deficiency (7). Increased body mass index (Body

Mass Index- BMI) and fat tissue positively influence bone density because of extraglandular production of estrogen and increased support to the sceleton (8).

Due to hormonal changes in postmenopause fat is redistributed from the gluteofemoral area to the abdominal region. The androgenic fat distribution is typical for women with hyperinsulinemia, hyperandrogenism and in postmenopause. These are women with body mass index (BMI) higher than 28 kg/m^2, and with correlation of waist hip ratio (Waist Hip Ratio-WHR) higher than 0,85. Several studies talk about the protective role of increase of BMI on bone density (9, 10), as well as the impact of total body fat on bone density (11).

2. OBJECTIVE

The objective of this study was to examine the relationship between bone density and a body mass index (BMI), and distribution of the fat tissue in women in postmenopause (WHR).

3. EXAMINEES AND METHODS

3.1. Examinees

This study was carried out as a prospective, in Gynecological department of Public Health Institution Health Centre Kalesija and included a total of 83 examinees who were divided into two groups. The study group consisted of 53 examinees aged over 45 years who are in natural postmenopause.

The control group consisted of 30 women with regular menstruation, age over 45 years.

3.2. Methods

The study was carried out in three phases: nterview; bone mineral density (BMD); determining BMI and W/H ratio.

Form for interview of examinees is attached with the following information: full name, date of birth, telephone number, date of interviewing, menarche, menopause, postmenopause duration, character of perimenopause (irregular bleeding and menopausal symptoms), the use of hormonal contraception, the number of births and abortions, family history to fracture of the bones in old age, data on the use of hormone replacement therapy or other medications, and personal history of heart disease, thyroid gland diseases, diabetes and the kidney diseases.

Body mineral density (BMD) was measured by densitometry (dual energy X-ray absoptimetry–DEXA) of the lumbar spine from L1-L4 and femoral neck in the Department of Radiology, University Clinical Center Tuzla using LUNAR DPX-L. The values were compared according to the standards incorporated in the apparatus for age, race and gender. Results are expressed in deviation from the normal values as the standard deviation ("Z"-score) or "T" value, which is the bone density and is expressed in percentages or standard deviations.

Assessment of nutritional status was carried out by determining body mass index (BMI) where:

BMI = body weight (kg) / height (m^2)

Based on the measurement of waist circumference at its narrowest point and the thighs circumference at its widest point the ratio of waist and hip (WHR) was calculated according to the formula:

WHR = waist circumference (cm) / tigh circumference (cm).

Statistical analysis was done by SPSS 15.0 (Chicago, IL, USA). Made basic tests of descriptive statisticswere done, showing the measures of central tendencies, and dispersions. The Kolmogorov-Smirnoff test, t-test, Mann-Whitney U test, X2-test or the Fisher an exact test, and nonparametric Spearman's rank correlationwere used. The univariate linear regression analysis was used to determine the strength of the effect of certain variables on the parameters of bone density. All statistical tests were carried out with a level of statistical probability of 95% ($p < 0.05$).

4. RESULTS

A difference in body mass index (BMI) was found between postmenopausal women and women with regular menstruation (Figure 1). Postmenopausal women had a significantly higher BMI, p=0,005 (Table 1). There was no

Parameter		BMI	WHR
T spine score	Correlation coefficient	0,148	-0,261
	p-value	0,290	0,149
Z spine score	Correlation coefficient	0,003	-0,360
	p-value	0,985	0,043
Z waist score	Correlation coefficient	0,321	-0,255
	p-value	0,019	0,160
T waist score	Correlation coefficient	0,384	-0,150
	p-value	0,005	0,414

Table 2. Relationship between bone density, BMI and WHR in postmenopausal subject Abbreviation: BMI- body mass index; WHR-waist to hip ratio.

Parameter	Group	AM	SD	p-value
BMI	Postmenopause	27,79	4,73	0,005
	Regular menstruation	25,46	2,71	
WHR	Postmenopause	0,83	0,05	0,08
	Regular menstruation	0,87	0,08	

Table 1. BMI and waist-to-hip ratio in postmenopausal women and women with regular menstruation Abbreviation: BMI- body mass index; WHR-waist to hip ratio; AM- arithmetic mean; SD-standard deviation; significant p-values are imprinted in bold

Parameter		BMI	WHR
T spine score	Correlation coefficient	0,129	-0,542
	p-value	0,497	0,085
Z spine score	Correlation coefficient	0,020	-0,621
	p-value	0,918	0,041
Z waist score	Correlation coefficient	-0,154	-0,100
	p-value	0,418	0,769
T waist score	Correlation coefficient	-0,151	-0,169
	p-value	0,424	0,620

Table 3. Relationship between bone density, BMI and WHR in subjects with regular menstruation Abbreviation: BMI- body mass index; WHR-waist to hip ratio.

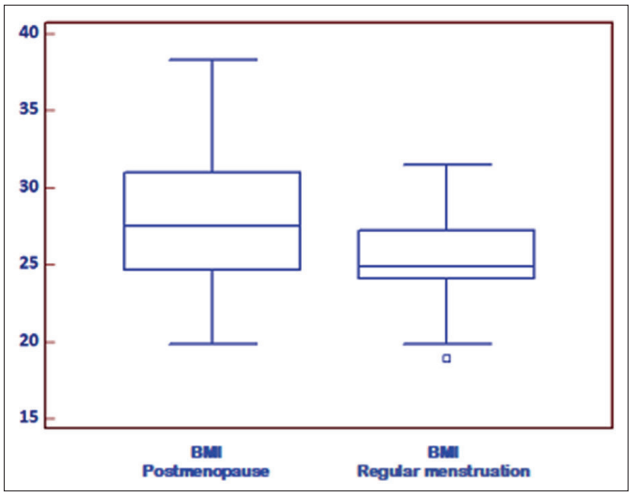

Figure 1. Average BMI in postmenopausal women and women with regular menstruation

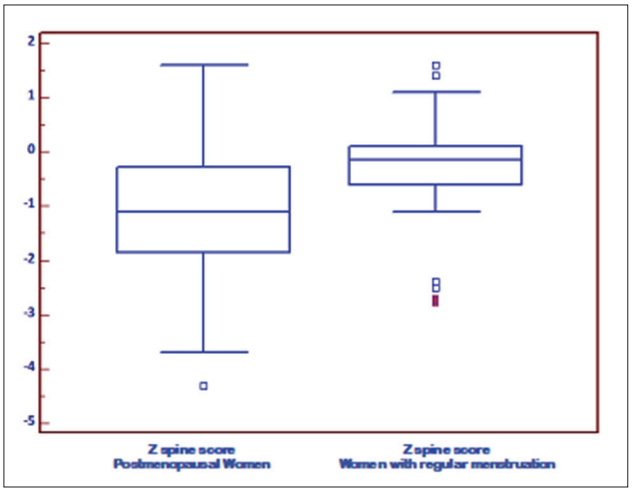

Figure 2. Z-score a of lumbar spine in postmenopausal women and women with regular menstruation

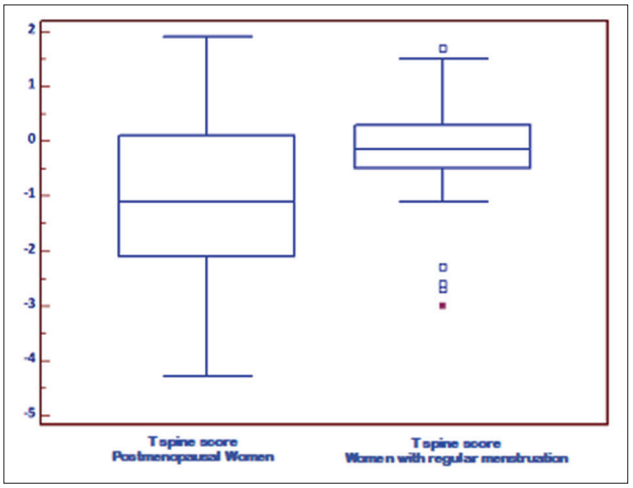

Figure 3. T-score of lumbar spine in postmenopausal women and women with regular menstruation

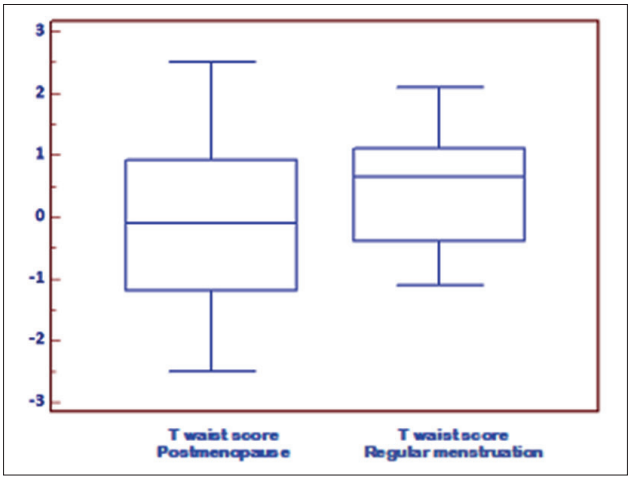

Figure 4. T-score of femoral neck in postmenopausal women and women with regular menstruation

statistically significant difference between the waist-to-hip ratio (WHR) in postmenopausal subjects compared with subjects with regular menstruation (Table 1).

Postmenopausal subjects had significantly lower bone density of the lumbar spine (Z-spines and T-spines) ($p = 0.01$), and lower density of the femoral neck (T-waist) ($p = 0.02$) compared to subjects with regular menstruation (Figure 2, Figure 3 and Figure 4).

A significant positive correlation was found in postmenopausal subjects between BMI and femoral neck density (Z and T-score) ($p = 0.019$; $p = 0.005$) (Table 2). There was also a significant negative correlation between WHR and bone density of the lumbar spine (Z-score) ($p = 0.043$) (Table 2).

In an identical analysis done only in subjects with regular periods, a negative correlation was found between bone density of the lumbar spine (Z-score) and WHR, but this time it was highly expressed ($p = 0.041$) (Table 3). There was no statistical significance in the observed correlation between BMI and bone density in this group of subjects (Table 3).

5. DISCUSSION

By monitoring the relationship between bone density parameters and BMI and W / H ratios in postmenopausal women, we found significant correlations. Postmenopausal subjects had significantly lower bone density in the lumbar spine as well as in the hip area compared to subjects with regular menstruation, which confirmes the claim of bone density reduction in postmenopausal women, especially in the lumbar spine which is first area affected by osteoporotic changes (12).

Years spent in menopause, that is, the length of postmenopause have had significant effects on postmenopausal bone density reduction (13).

Androgenic fat distribution is typical of women with hyperinsulinemia, hyperandrogenemia and postmenopausal women. These are women with a BMI greater than 28 kg / m^2 and a W / H ratio greater than 0.85.

The results of this study show the difference in BMI values between postmenopausal women and women with regular menstruation. Significantly higher BMI values were found in postmenopausal women, meaning that they were more obese than women with regular menstruation.

Significant correlations were found while monitoring the correlation and influence of BMI and W / H ratios on bone density in postmenopausal women, which was the goal of this study.

A significant correlation was found between BMI and WH

ratios in relation to bone density, which was examined in postmenopausal women. There was a significant negative correlation between W / H ratio and bone density of the lumbar spine. The higher the W / H ratio, the lower the bone density of the lumbar spine. This confirms that women with android-type obesity have lower bone density (14). Kim et al. (15) consider in their study that the WH relationship is a marker for visceral fat, which has a negative correlation with bone density in perimenopausal women.

In postmenopausal women, there was a significant correlation between BMI and femur density, that is, subjects with higher BMI had higher bone density in the hip area.

In a study conducted by Morin (16), women over 50 years of age had higher bone density in the lumbar spine and hip area if BMI was elevated. An elevated BMI influences an increase in BMD, and an elevated BMI reduces the risk of fracture and makes it one of the most significant factors affecting BMD (17). Young et al found a positive effect of BMI and weight on bone density in postmenopausal women (18).

Weight gain due to the amount of adipose tissue and changes in the distribution of adipose tissue from the gluteofemoral to the abdominal region are the result of postmenopausal metabolic changes. Extraglandular production of estrogen from adipose tissue explains the positive impact of BMI on bone density (19). Other studies have confirmed a significant positive correlation between BMI and BMD, showing that fat deposits represent an extraovarian source of estrogen (20).

In postmenopausal women, the W / H ratio had a significant positive association with the regulation of bone metabolism and arrest of osteoclast differentiation and activation (21).

Subjects with regular menstruation had a significant correlation between bone density of the lumbar spine and the W / H ratio. This time the correlation was highly expressed and also negative, which means that women with regular menstruation have lower bone density if their adipose tissue is arranged in the abdominal region.

In subjects with regular menstruation, there was no correlation between bone density and BMI. Although some studies have shown a positive correlation between BMI and hair density in women with regular menstruation (22).

6. CONCLUSION

Based on the results presented, we conclude that postmenopausal women have a higher femoral neck density, the higher the BMI ($p = 0.019$; $p = 0.005$), and a lower bone density of the lumbar spine, the higher the waist/ hip ratio (W-HR) ($p = 0.043$).

In patients with regular menstruation, the density of the lumbar spine was lower, the higher the waist-to-hip ratio ($p = 0.041$), while there was no association between BMI and bone density in this group of subjects.

- **Author's contribution:** Both authors gave substantial contributions to the conception and design of the work, in acquisition, analysis, and interpretation of data for the work and gave substantial contributions to data analysis. Also, both authors gave the final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to accuracy or integrity of any part of the work are appropriately investigated and resolved.
- **Conflicts of interest:** There are no conflicts of interest.
- **Financial support and sponsorship:** Nil.

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