DOI: 10.4274/tod.galenos.2022.59913
Turk J Osteoporos 2023;29:39-45

Assessment of the Relationship Between Osteoporosis, Metabolic Syndrome and Physical Activity Level in Postmenopausal Women

Postmenopozal Kadınlarda Osteoporoz, Metabolik Sendrom ve Fiziksel Aktivite Düzeyleri Arasındaki İlişkinin Değerlendirilmesi

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Abstract

Objective: This study aimed to investigate the relationship between osteoporosis, metabolic syndrome (MetS), and physical activity (PA) levels in postmenopausal women. The secondary aim was to evaluate the quality of life in postmenopausal women who were diagnosed with and without MetS.

Materials and Methods: One hundred fifteen postmenopausal women participated in this study. Biochemical parametersand bone mineral density (BMD) at the femoral neck and lumbar spine were measured. The MetS was diagnosed using the definitions of the Adult Treatment Panel III and the National Cholesterol Education Program. The PA level was determined using the International Physical Activity Questionnaire-Short Form (IPAQ-SF). The Questionnaire of the European Osteoporosis Foundation for the Quality of Life (QUALEFFO-41) was used to assess health-related quality of life (HRQoL).

Results: With respect to the classification of the World Health Organization, 66 (57.3%) women had osteoporosis and 49 (43.7%) women had osteopenia. MetS was present in 32 women (27.8%). According to IPAQ-SF, 27 (23.5%) women were inactive, 74 (64.3%) women were minimally active, and 14 (12.2%) women were highly active. There was no statistically significant relationship between MetS and PA levels in postmenopausal women ($p>0.05$). A statistically significant difference in BMD measurements was found between groups with and without MetS ($p<0.05$). Additionally, QUALEFFO-41 scores were similar between the two groups ($p>0.05$).

Conclusion: MetS was associated with greater BMD at the spine and hip in postmenopausal women, indicating that MetS has a bone-protective impact. Notwithstanding, PA level and HRQoL were similar between postmenopausal women with and without MetS.

Keywords: Postmenopausal osteoporosis, physical activity, metabolic syndrome

Öz

Amaç: Bu çalışmanın amacı, postmenopozal kadınlarda osteoporoz, metabolik sendrom (MetS) ve fiziksel aktivite (PA) düzeyi arasındaki ilişkiyi araştırmaktır. Sekonder amacı ise MetS tanısı olan ve olmayan postmenopozal kadınların yaşam kalitesini değerlendirmektir.

Gereç ve Yöntem: Bu çalışmaya 115 postmenopozal kadın katılmıştır. Femur boynu ve lomber omurga kemik mineral yoğunluğu (KMY) ve biyokimyasal parametreler ölçülmüştür. MetS, Yetişkin Tedavi Paneli III ve Ulusal Kolesterol Eğitim Programı tarafından belirlenen kriterler kullanılarak teşhis edilmiştir. PA seviyesi, Uluslararası Fiziksel Aktivite Anketi Kısa Formu (IPAQ-SF) kullanılarak belirlenmiştir. Avrupa Osteoporoz Vakfı Yaşam Kalitesi Anketi (QUALEFFO-41) sağlıkla ilgili yaşam kalitesini (HRQoL) değerlendirmek için kullanılmıştır.

Bulgular: Dünya Sağlık Örgütü sınıflamasına göre 66 (%57,3) kadında osteoporoz, 49 (%43,7) kadında osteopeni vardır. Otuz iki kadında (%27,8) MetS mevcuttur. IPAQ-SF'ye göre 27 (%23,5) kadın inaktif, 74 (%64,3) kadın minimal aktif, 14 (%12,2) kadın oldukça aktiftir. Postmenopozal kadınlarda MetS ile PA düzeyi arasında istatistiksel olarak anlamlı bir ilişki saptanmamıştır ($p>0,05$). MetS grubu ile non-MetS grubu arasında kemik mineral yoğunluğu (KMY) ölçümlerinde istatistiksel olarak anlamlı fark bulunmuştur ($p<0,05$). Ayrıca QUALEFFO-41 skorları iki grup arasında benzerdir ($p>0,05$).

Sonuç: Postmenopozal kadınlarda MetS'nin omurga ve kalçada daha fazla KMY ile ilişkili olması MetS'nin kemik üzerine koruyucu etkisi olduğunu göstermektedir. Bununla birlikte, MetS olan ve olmayan postmenopozal kadınlar arasında PA düzeyi ve HRQoL benzerdir.

Anahtar kelimeler: Postmenopozal osteoporoz, fiziksel aktivite, metabolik sendrom

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Received/Geliş Tarihi: 31.05.2022 **Accepted/Kabul Tarihi:** 11.08.2022

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Introduction

Osteoporosis is a systemic skeletal disease characterized by tissue degeneration and loss of bone mass, resulting in increased fracture risk and bone fragility (1). More than 200 million people worldwide are thought to be affected by this disease (2). Osteoporosis is becoming more common as people get older all over the world, including Turkey. The prevalence of osteoporosis in Turkish women over the age of 50 is 12.9 percent (3). Fragility fractures with low-energy trauma are the most important clinical outcome of osteoporosis (4). More than 40% of postmenopausal women are expected to experience a fracture at some time in their lives (5).

A healthy and balanced diet and regular physical activity (PA) are important contributors to bone health (6). External factors such as exercise help increase bone mass during adolescence and childhood, peaking in the third decade of life. After menopause, women's bone mass normally reduces by 2.5 percent and 0.5 percent respectively, each year. In elderly people, bone mass cannot be acquired with PA, however, bone loss can be avoided (7,8). On the other hand, continuous PA is beneficial to bone tissue and helps prevent bone loss (9). Falls may increase due to decreased mobility and physical ability as people get older, especially if they have osteoporosis. Exercise is a good way to reduce osteoporosis and fractures caused by aging (10).

Metabolic syndrome (MetS) is a serious health problem that affects 41.5 percent of postmenopausal women, according to studies from different nations (11). High insulin levels in the blood, excessive blood pressure, increased triglyceride levels, excessive fat levels around the waist, and poor high density lipoprotein (HDL) cholesterol are all symptoms of MetS (12). Observational data from systematic reviews and meta-analysis demonstrated a close relation between prolonged inactivity, lower PA levels, and an increased risk of developing MetS (13,14). The relationship between MetS and PA level in adults has been evaluated in many studies. However, the number of studies investigating this relationship in postmenopausal women is limited. Thus, the aim of this research is to assess the relationship between osteoporosis, PA level and MetS in postmenopausal women.

Materials and Methods

Subjects and Study Design

This cross-sectional study was carried out in the physical medicine and rehabilitation department of a state hospital between March 2019 and March 2020. A total of 115 postmenopausal women who were applied to the outpatient clinic for initial osteoporosis evaluation or annual check-ups were involved in the study. All participants gave their informed consent. Inclusion criteria accepted as all postmenopausal women with at least one year of menopausal experience who were referred to outpatient clinic for bone mineral density (BMD) test and agreed to participate in this study. Subjects were ruled out of the study if they (1) were significantly cognitively disabled and unable to follow instructions, (2) were terminally sick, or (3) refused to take part. MetS criteria were used to separate the participants into two groups. The MetS group (n=32) comprised individuals who had been diagnosed with MetS, whereas the non-MetS group (n=83) included those who had not been diagnosed with MetS. We followed the Declaration of Helsinki for the protocols of the researh, and the Local Ethics Committee of Malatya Clinical Research (decision no: 2019/124, date: 03.07.2019) confirmed the study.

Descriptive Data and Demographic Variables

The following variables were recorded: age, educational and marital status, parity, time since menopause (years), menopause (natural/surgical) type, body mass index (BMI), height, weight, smoking habits (yes/no), alcohol intake 3 or more units/day (yes/no), osteoporosis treatment (yes/no), systemic glucocorticoid use >3 months and ≥5 mg/day (yes/no), previous peripheral fracture (yes/no),previous spinal fracture (yes/no), history of hip fracture in parents (yes/no), rheumatoid arthritis (yes/no), secondary osteoporosis (yes/no), pain level last week by score between 0 and 10 on visual analog scale and comorbidities. Fragility fracture risks of the subjects were assessed using the Fracture Risk Assessment Tool (FRAX) which is a software that computes a ten-year risk of major osteoporotic fracture (wrist, humerus, spine, or hip fracture) and a ten-year risk of hip fracture.

Anthropometric Assessments and Laboratory Testing

Blood biochemical tests including fasting blood glucose, HDL cholesterol, triglycerides, 25-hydroxyvitamin D (3), serum electrolytes, parathormone, thyroid-stimulating hormone were requested from all subjects. The waist circumference of the participants was measured with a flexible tape measure while the subjects were standing in an upright stance with feet together, wearing minimal clothing. The blood pressure of the participants was measured by a nurse in the clinic while the patient was in a sitting position after resting. Body weights and heights of the participants were measured in light indoor attire without shoes. BMI was calculated by dividing weight in kilograms by the square of the height in meters.

Assessment of Osteoporosis

Osteoporosis was defined on the basis of BMD assessments. BMD was examined at the femoral neck and lumbar spine utilising X-ray absorptiometry with dual-energy (Discovery A series, Hologic QDR). The BMD results were categorized using World Health Organization (WHO) standards. Women with a T-score of -2.5 or less at the femoral neck or lumbar spine were classified as having osteoporosis according to WHO criteria. Women with a T-score between -1 and -2.5 were classified as having osteopenia and more than -1 were classified as healthy (15).

Assessment of MetS

Adult Treatment Panel III (ATP III) of the National Cholesterol Education Program (NCEP) was used to diagnose MetS.

Patients were diagnosed with MetS if they had three or more of abnormalities listed below: abdominal obesity (waist circumference >88 cm), high blood pressure: (systolic blood pressure ≥135 mmHg and/or diastolic blood pressure ≥85 mmHg, or if they were on anti-hypertensive medications), hypertriglyceridemia: (serum triglyceride level ≥150 mg/dL), low HDL-cholesterol <50 mg/dL, high fasting blood glucose (≥110 mg/dL, or if they were on anti-diabetic medications) (16).

Assessment of PA Level

PA level was measured using the International Physical Activity Questionnaire-Short Form (IPAQ-SF). This self-report questionnaire evaluates PA in the last seven days. This seven-question survey examines how much walking you did in the previous week, as well as how much moderate and severe PA you did at work, in transportation, at home, in the garden, and in leisure activities. On weekdays and weekends, sitting times are recorded individually. When PA is classified, it is divided into three categories: "inactive", "minimally active", and "highly active". The IPAQ-SF is mostly used as a measure of PA and is reported to have excellent reliability, its validity against objective measures of PA is questioned by Lee et al. (17,18). Saglam et al. (19) conducted validity and reliability studies on the Turkish version of the questionnaire.

Assessment of Health Related Quality of Life (HRQoL)

The Questionnaire of the European Foundation for Osteoporosis Quality of Life (QUALEFFO-41) was used to assess HRQoL. It is a self-reported, disease-specific, quality of life questionnaire with 41 items/questions separated into 5 parts: mental function, perception of general health, social function, physical function, and pain. Those five parts can be evaluated either individually or as part of a total result that includes all of the 41 questions (20).

Statistical Analysis

Using the G* Power (V3.1.7) tool, a total of 32 patients were identified as the minimum size for each group, with d=0.72, 80 percent power, and α =0.05. The sample size was also in line with past research (12). SPSS 20.0 was used to conduct the statistical analysis which is developed by IBM Corporation (Chicago, IL). Categorical variables, as well as, other discrete and continuous variables were represented in percentage and number, and median (min-max) respectively, while variables with normal distribution were represented in mean ± standard deviation. Kolmogorov-Smirnov test was used for data distribution analysis. Continuous and non-parametric variables were compared using the Mann-Whitney U test. Fisher's exact test and chi-square tests were used for comparison of categorical variables. With a type-I and type-II error of 5% and 20%, respectively, a p-value of less than 0.05 was found to be significant statistically.

Results

A total of 115 postmenopausal women included in this study. There were 66 (57.3%) women with osteoporosis and 49 (42.7%) women with osteopenia among them. Thirty-two (27.8%) women had MetS determined by the NCEP-ATP III. The mean age of the participants was 68±8.59, with a range of 46 to 90 years. On average, the participants were overweight, with a mean BMI of 31.2±6.09. According to IPAQ-SF, 27 (23.5%) women were inactive, 74 (64.3%) women were minimally active, and 14 (12.2%) women were highly active. Table 1 and Table 2 compare results from anthropometric data and cardiometabolic variables between women with and without MetS, respectively. Variables including BMD lumbar spine (L1-L4) T-scores, diastolic blood pressure, systolic blood pressure, waist circumference, BMI, mean body weight, and femoral neck T-scores were significantly lower in the non-MetS group than the MetS group ($p<0.05$) as shown in Table 1 and 2. When the FRAX values of the two groups were analyzed, the non-MetS group had a greater 10-year risk of major osteoporotic fracture ($p<0.05$). The 10-year risk of hip fracture was similar between the two groups ($p>0.05$). The non-MetS group also had a greater ratio of previous peripheral fractures ($p<0.05$). With regard to blood biochemical values, as summarized in Table 2, uric acid, fasting blood glucose, triglyceride levels were significantly higher and HDL cholesterol was significantly lower in the MetS group compared to the non-MetS group ($p<0.05$). For both disease-specific and general HRQoL instruments, there was no statistically significant difference between the groups across all subscales ($p>0.05$), as shown in Table 3. Furthermore, according to IPAQ-SF, there was no difference in PA levels between the MetS and non-MetS groups, as shown in Table 4 ($p>0.05$).

Discussion

The aim of this study was to determine the link between osteoporosis, MetS, and PA levels in postmenopausal women, as well as their impact on quality of life. Postmenopausal women with MetS had increased BMD at the spine and hip, according to the findings of this study. However, postmenopausal women with and without MetS had similar PA levels and HRQoL scores. In this research, the prevalence of MetS was determined to be 27.8%, which was lower than the prevalence of MetS reported in a Turkish survey in 2004 (percentage 41.1), but closer to the MetS prevalence in the overall population (percentage 33.8) (21). Obesity, determined as a BMI of 25 to 39.9 kg/m², is frequent in postmenopausal women. According to Silva et al. (22), roughly half of postmenopausal women are overweight or obese. BMI and body fat tissue mass are higher in postmenopausal women than in perimenopausal women, according to previous research (23). In this study, the mean BMI was over 30 kg/m² in both groups (34.3±6.63 vs. 30.05±5.47). Obesity is on the rise for a variety of reasons, including unhealthy nutrition habits and a sedentary lifestyle (24).

Studies have shown that the frequency of low PA levels in the people aged 15 and over ranges from 2.6 percent to 62.3 percent (25). According to IPAQ-SF, 23.5 percent of the individuals in this study had low PA levels, whereas 64.3 percent of the subjects

Table 1. Comparison of demographic and anthropometric characteristics between MetS and non-MetS group

Variables	MetS group (n=32)	Non-MetS group (n=83)	p-value
Age (years), mean ± SD	67.61±8.39	68.06±8.92	0.243
Weight (kg), mean ± SD	82.97±14.98	70.53±13.89	**<0.001***
Height (cm), mean ± SD	156.66±6.8	154.34±6.2	0.083
BMI (kg/cm²), mean ± SD	34.3±6.63	30.05±5.47	**0.001***
Marital status, N (%)			
Single	1 (33.3)	2 (66.7)	
Married	31 (27.7)	81 (72.3)	0.999#
Education level, N (%)	21 (34.4)	40 (65.6)	
Unschooled	11 (23.9)	35 (76.1)	0.190
Primary school			
High school	-	6 (100)	
University	-	2 (100)	
Number of pregnancies, median (min-max)	5 (1-11)	5 (0-10)	0.770
Type of menopause, N (%)			
Natural	28 (29.2)	68 (70.8)	0.583#
Surgical	4 (21.1)	15 (78.9)	
Duration of menopause (years), median (min-max)	22 (10-49)	21 (1-42)	0.651
Chronic diseases**, N (%)			
Yes	26 (32.1)	55 (67.9)	
No	6 (17.6)	28 (82.4)	0.171#
Rheumatoid arthritis, N (%)			
Yes	-	3 (100)	
No	32 (28.6)	80 (71.4)	0.559#
Secondary osteoporosis, N (%)			
Yes	-	5 (100)	
No	32 (29.1)	78 (70.9)	0.320#
History of spinal fracture, N (%)			
Yes	4 (25)	12 (75)	
No	28 (28.3)	71 (71.7)	0.999#
History of peripheral fracture, N (%)			
Yes	4 (13.3)	26 (86.7)	
No	28 (32.9)	57 (67.1)	**0.039#***
History of hip fracture in parents, N (%)			
Yes	2 (28.6)	5 (71.4)	
No	30 (27.8)	78 (72.2)	0.999#
Previous or current osteoporosis medication, N (%)			
Yes	14 (23)	36 (66.7)	
No	18 (33.3)	36 (66.7)	0.302#
Smoking, N (%)			
Yes	-	5 (100)	
No	32 (29.1)	78 (70.9)	0.320#
Alcohol intake (3 or more units/day), N (%)			
Yes	-	-	
No	32 (100)	83 (100)	-
Steroid use >3 months and ≥5 mg/day, N (%)			
Yes	1 (33.3)	2 (66.7)	
No	31 (27.7)	81 (72.3)	0.999#
Visual analog scale, median (min-max)	30 (0-80)	40 (0-70)	0.070
Bone mineral density, median (min-max)			
Lumbar spine (L1-L4) T-score	-2.05 (-3.7-1.2)	-2.7 (-4.8-0.2)	**0.014***
Femoral neck T-score	-2.20 (-4.50-0.20)	-1.50 (-2.40-0.10)	**0.030***
FRAX, median (min-max)			
10-year risk of major osteoporotic fracture	9.75 (3.1-42)	13 (4.2-42)	**0.041***
10-year risk of hip fracture	1.6 (0.2-29)	2.2 (0.8-33)	0.206

BMI: Body mass index, FRAX: Fracture risk assessment tool, MetS: Metabolic syndrome, SD: Standard deviation
Values are mean ± SD, median (min-max) or percentage (n, %)
*p-values are statistically significant (p<0.05) are shown in bold
**Chronic diseases include hypertension, diabetes mellitus, hypotyroidism, coronary heart disease

Table 2. Comparison results from cardiometabolic variables and biochemical blood tests between MetS and non-MetS group

Variables	MetS group (n=32)	Non-MetS group (n=83)	p-value
Waist circumference (cm)	100 (70-135)	83 (60-151)	**<0.001***
SBP (mm/hg)	140 (110-160)	120 (110-150)	**<0.001***
DBP (mm/hg)	80 (70-95)	75 (60-90)	**<0.001***
Fasting blood glucose (mg/dL)	106 (87-435)	93 (61-329)	**<0.001***
HDL-C (mg/dL)	43 (29.32-71)	51 (33-77)	**<0.001***
Triglyceride (mg/dL)	172 (74-750)	110 (57-312)	**<0.001***
25(OH)D3 (ng/mL)	13.8 (3-38)	16.4 (3-42)	0.079
Calcium (mg/dL)	9.40 (8.50-10.48)	9.51 (8.00-11.32)	0.263
Phosphate (mg/dL)	3.425 (2.5-4.91)	3.4 (2.05-5.37)	0.446
TSH (mlU/L)	1.4 (0.015-6.29)	1.5 (0.02-34.66)	0.769
PTH (pg/mL)	55.5 (18-95)	52.3 (22.7-209)	0.753
Uric acid (mg/dL)	5.1 (2.2-10.6)	4.2 (0.6-10.1)	**<0.001***

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HDL-C: High-density lipoprotein cholesterol, TSH: Thyroid-stimulating hormone, PTH: Parathormone, 25(OH) D3: 25-hydroxyvitamin D3, MetS: Metabolic syndrome
Values are median (min-max) *p-values with statistical significance (p<0.05) are shown in bold

Table 3. Comparison of physical activity distribution between MetS and non-MetS group

IPAQ-SF	MetS group (n=32)	Non-MetS group (n=83)	p-value
Inactive	8 (29,6)	19 (70,4)	0.483
Minimally active	22 (29.7)	52 (70.3)	
Highly active	2 (14.3)	12 (85.7)	

IPAQ-SF: International physical activity questionnaire short form, MetS: Metabolic syndrome
Values are percentage (n, %)

had moderate PA levels. In terms of PA levels, subjects with and without MetS both had a similar phenotype. MetS and PA levels in postmenopausal women were not found to have a significant relationship in this study (p>0.05). These results also showed that postmenopausal women with and without MetS had low-to-moderate PA levels. The link between PA level and MetS in adults has been studied extensively in the literature. In a study by Kazaz I et al. (26), PA level was evaluated in adults, and it was found that almost 81 percent of people with MetS were inactive. Frugé et al. (27) found in their study that patients with MetS were less active than patients without MetS. In a different research by Petersen et al. (28), it was found that when compared to active persons, those who were inactive in their leisure time had a greater risk of MetS. In this study, most of the subjects lived in rural areas. They were mostly occupied with farming and agriculture. As a result, the percentage of physically inactive people was found to be less than in previous studies. MetS is more likely in people stressed, having insufficient PA, and with unhealthy nutrition habits (26). In this study, subjects with and without MetS were overweight, with a mean BMI of 31.2±6.09. Therefore, MetS is thought to develop in these people mainly due to unhealthy nutrition habits. It is thought that this is why the difference with the literature in this study. In addition, the difference from the literature may be a result of the limited number of patients.

MetS is a heterogeneous syndrome composed of multiple disorders, each of which has its own unique impact on the metabolism of bone. Greater leptin levels and lower adiponectin, for instance, may affect bone metabolism in people with central obesity, since high levels of leptin and adiponectin have been linked to bone loss in a recent meta-analysis (29). Some studies have showed that adipose tissue causes proinflammatory cytokines, including TNF-alfa, IL-6 and/or IL-1, which are associated with bone loss (30,31). von Muhlen et al. (32) observed the presence of the relationship between lower BMD and MetS. In a cross-sectional research, the mean vertebral BMD of 2475 Korean women was substantially lower in women with MetS, and in the mean vertebral BMD considerably decreased in the presence of other MetS-related factors (33). On the other hand, opposite results have also been reported. Numerous cross-sectional researches have shown a positive relation between BMD and MetS (34). MetS has a multifactorial influence on bone mass, as it is linked to hyperinsulinemia, peripheral aromatization, excess body weight, and mechanical loads (35). Xue et al. (36) found that unadjusted femoral neck and lumbar spine BMD values were greater in MetS participants in comparison to non-MetS participants in a meta-analysis (n=13.122, number of studies=11). The favorable benefits of MetS on bone mass might be attributed to the increased mechanical stress experienced by MetS patients, according to a three-year retrospective longitudinal research of 1,218 postmenopausal women examining annual BMD changes (37). Zhou et al. (35) found a possible gender difference in the

Table 4. Comparison results of QUALEFFO-41 scores between MetS and non-MetS group

QUALEFFO-41	MetS group (n=32)	Non-MetS group (n=83)	p-value
Pain (back pain, sleep disturbance)	29.58±21.23	35.07±19.61	0.191
Physical function and mobility (dressing, bathing, cleaning, cooking, washing, dishes, shopping, standing, bending, kneeling, stairs, walking, body image)	30.83±17.95	30.78±16.03	0.989
Social function (sports, gardening, hobby, friends)	47.03±20.99	52.63±20.12	0.189
General health perception	55.36±14.02	53.15±13.16	0.429
Mental function (fatigue, depression, energy, loneliness, cheerfulness, hope, fear)	42.49±12.05	40.85±13.48	0.549
Total score	53.11±34.14	59.86±52.84	0.505

QUALEFFO-41: The Quality of Life Questionnaire of the European Foundation for Osteoporosis, MetS: Metabolic syndrome
Values are mean ± SD. *p-values with statistical significance (p<0.05)

link between MetS and bone in a meta-analysis and showed that MetS is a risk factor for developing osteoporosis in males, but it might not be a reliable predictor of osteoporosis for women. Consistent with previous studies which found a positive association between MetS and BMD, significant differences in BMD were reported between subjects with and without MetS in this study, so it may be deduced that MetS doesn't have a detrimental effect on bone health in postmenopausal women. Furthermore, preventive mechanisms for bone density may play a larger role in this disease than the deleterious effects on BMD due to inflammation.

Obesity and metabolic disorders have a negative impact on HRQoL (38). HRQoL in postmenopausal women with osteoporotic fractures has been extensively reviewed in previous studies. Briefly, the individuals with multiple vertebral and hip fractures had lower HRQoL than those with a distal forearm or a single vertebral fracture. There are fewer researches that look at HRQoL in individuals with osteoporosis who don't have any fractures. Wilson et al. (39) observed that patients who does not have vertebral fracture had lower values in the QUALEFFO-41 and SF-36 areas than the control group in a systematic study. Several research have looked into the link between MetS and HRQoL, and the most of them have found a link between MetS and a decline in quality of life. However, several studies identified a relationship barely in women, or just when BMI or depression were factors (40). In the present study, the domains of QUALEFFO-41 (mental function, general health perception, social function, physical function, and pain) were similar in postmenopausal women with and without MetS. The difference from the literature may be due to the limited number of patients.

Study Limitations

The study has several limitations. Firstly, PA is a complicated health behavior that is difficult to evaluate. PA levels of the participants were measured using a questionnaire that included self-reported open-ended questions about their most recent 7-day recall of PA. An accelerometer, pedometer, or activity tracker was not used as a more objective assessment tool. As a result, the PA status reported by the participants, was not measurable. Secondly, because the study was conducted in a single center, the number of patients was limited.

Conclusion

Postmenopausal women with and without MetS are overweight and have low-to-moderate PA levels, according to the findings of this study. No significant correlation is observed between MetS and PA level in postmenopausal women. MetS and BMD have a positive relationship in postmenopausal women. More well-designed and comprehensive researches should be undertaken to confirm the link between osteoporosis, MetS, and PA level in postmenopausal women, given the inconsistent results in this field.

Ethics

Ethics Committee Approval: The study was carried out with the Malatya Clinical Research Ethics Committee (decision no: 2019/124, date: 03.07.2019).

Informed Consent: Informing all individuals participating in the research their consent was taken.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Z.T.B., Concept: A.S., Design: A.S., Data Collection or Processing: Z.T.B., Analysis or Interpretation: Z.T.B., Literature Search: A.S., Writing: Z.T.B.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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