Original Research Article

Comparison of body composition, nutritional status, functional status, and quality of life between osteoporotic and osteopenic postmenopausal women

Beril Dogu [a,*], Hulya Sirzai [b], Ahmet Usen [a], Figen Yilmaz [a], Banu Kuran [a]

[a] Department of Physical Medicine and Rehabilitation, Sisli Etfal Education and Research Hospital, Istanbul, Turkey
[b] Ankara Physical Medicine and Rehabilitation Education and Research Hospital, Ankara, Turkey

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ABSTRACT

Background and objective: Osteoporosis is a condition that affects body composition, physical activity, and psychological state. We aimed to examine the differences between osteoporotic and osteopenic postmenopausal women with respect to body composition, nutrition, functional status, and quality of life.

Materials and methods: A total of 102 osteopenic (Group 1) and 100 osteoporotic (Group 2) patients were enrolled in the study. Bone mineral density (BMD), fat tissue mass (FTM), lean tissue mass (LTM), and bone mineral content (BMC) were evaluated using dual-energy X-ray absorbtiometry. Nutritional status of the patients was assessed with the Mini Nutritional Assessment (MNA), functional status with the Nottingham Extended Activities of Daily Living (NEADL) scale, and quality of life with the assessment of health-related quality of life in osteoporosis (ECOS-16).

Results: Group 2 had significantly lower FTM, LTM, and MNA scores than Group 1 ($P < 0.05$). NEADL and ECOS-16 scores did not differ between the groups ($P > 0.05$). A significant correlation was found between MNA and FTM, LTM, BMC, and BMD ($P < 0.05$). Whereas the assessment of functional status showed a significant positive correlation with BMD and a significant negative correlation with age ($P < 0.05$), no significant correlation was found between functional status and body composition ($P > 0.05$).

Conclusions: We found lower FTM and LTM values and a poorer nutritional status in osteoporotic patients than in osteopenic ones. Nutritional status was correlated with body composition and BMD, and functional status was correlated with age and BMD.

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* Corresponding author at: Department of Physical and Rehabilitation Medicine, Sisli Etfal Education and Research Hospital, Halaskargazi caddesi, Şişli Etfal Eğitim ve Araştırma Hastanesi, 34377 Şişli-İstanbul, Turkey.
E-mail address: berildogu@hotmail.com (B. Dogu).

1. Introduction

Osteoporosis is a disease characterized by a decrease in bone mineral density (BMD), skeletal weakening, and increased fracture risk [1–3]. Due to an aging population worldwide, it constitutes a major public health problem, leading to increased mortality and morbidity rates [2,4].

As osteoporosis may lead to a limitation of daily activities by causing restricted mobility and pain, women who think they carry the risk of osteoporosis strive to reduce the risk of bone injury by limiting their physical activities [1,4]. This restriction leads to other conditions, such as loss of social roles, social isolation, loneliness, depression, anxiety, despair, loss of values, and psychological consequences [1].

Lean, fat, and bone mass are components of body weight. Lean tissue mass (LTM) and fat tissue mass (FTM) account for more than 95% of body weight [5]. Body composition is affected by many factors, the most important of which are aging and menopausal state [4,6,7]. FTM usually increases in healthy women; LTM and bone tissue mass are reduced after menopause. Information can be gathered about muscle strength by measuring LTM. This point is important because muscle strength affects bone mass and structure [7]. FTM is the metabolically active part that exerts a non-weight-bearing effect through the hormonal metabolism of adipocytes [5]. Studies examining how these factors affect bone structure reported controversial results. Some studies reported that LTM is a major determinant of BMD, whereas others found that FTM is the main determinant. Other studies suggested an equal effect of these two parameters [8,9]. These changes lead to the onset or progression of disability in advanced ages [10].

Nutrition is a significant factor related to health status in elderly people, and malnutrition is an important risk factor for the development of osteoporosis [11,12]. In addition, low body weight appears to be related to osteoporosis risk [11]. The assessment of nutritional status and the correction of personal nutritional errors may lead to reduction in bone fragility and an increase in quality of life [12].

In this study, we examined the differences between osteoporotic and osteopenic postmenopausal women with respect to body composition measured with dual-energy X-ray absorptiometry (DXA), nutritional status, functional status, and quality of life. Moreover, the relationship among these variables was investigated.

2. Materials and methods

2.1. Study participants

In our osteoporosis unit, patients in need of treatment due to osteoporosis or osteopenia were followed up on an outpatient basis twice a week by a team of physicians. In this unit, an assessment form containing detailed information about the demographic characteristics, health status, menopausal state, and medical disorders was initially filled out by patients, who were put under follow-up thereafter.

Our prospective cross-sectional study included those patients who were referred to our osteoporosis unit with the following characteristics: diagnosed with osteopenia or osteoporosis according to BMD scores within 3 months of L1–L4 and/or femur (femoral neck and/or total femur), aged 45–80 years, in a good health status and are physically active, and without metal prostheses. A total of 202 nonhospitalized postmenopausal Caucasian women volunteers were included. Patients who fulfilled these criteria were all investigated, respectively. Those with the following conditions were excluded: renal failure; rheumatologic, oncologic, and cardiac disease; cerebrovascular disease; chronic glucocorticoid usage; mild or severe cognitive impairment; metabolic bone disease; and patients who could not be mobilized alone. None of these patients had previously received any form of osteoporosis therapy. The assessment of the presence of fracture was not examined.

The patients were divided into the osteopenic (Group 1, $n = 102$) and osteoporotic (Group 2, $n = 100$) groups. Age, menopause duration, height, and weight of all of the patients were recorded.

This study was approved by our local ethics committee.

2.2. Bone mineral density and body composition measurements

BMD (g/cm^2), bone mineral content (BMC, g), LTM (kg), and FTM (kg) measurements were performed using the DXA technique (Lunar Prodigy Advance; GE, Madison, WI, USA).

BMD measurement was taken from three regions in the lumbar spine (L1–L4 anterioposterior) and femur (femoral neck and total femur). Diagnoses of osteoporosis and osteopenia were made according to the World Health Organization criteria (osteopenia, a T-score between -1 and -2.5 standard deviations [SD] below; osteoporosis, a T-score -2.5 SD or more below).

Body mass index (BMI, kg/m^2) was calculated as weight (kg) divided by the square of height (m).

2.3. Nutrition

The Mini Nutritional Assessment (MNA) was used to assess nutritional status. Scored between 0 and 30, this tool consists of four parts: anthropometric measurements, global evaluation, dietetic assessment, and subjective assessment. A score less than 17 indicates malnutrition; a score between 17 and 23.5 indicates malnutrition risk; and a score greater than 23.5 is indicative of adequate nutrition [11,12].

2.4. Functional status

The Nottingham Extended Activities of Daily Living (NEADL) scale was used to assess the patients' activity levels. This scale is composed of 22 questions and 4 subscales: mobility, kitchen, domestic, and leisure activities. The answers are scored between 1 and 4 (not at all = 0, with help = 1, on my own difficulty = 2, on my own = 3) [13].

2.5. Quality of life

Quality of life of the patients was evaluated by the assessment of health-related quality of life in osteoporosis (ECOS 16)

questionnaire. ECOS 16 consists of 16 questions developed to assess the quality of life of postmenopausal osteoporotic women. It has four dimensions: pain, physical functioning, fear of illness, and psychological functioning. Total score ranges between 1 and 5. Score 1 indicates good quality of life and 5 indicates low quality of life [14].

2.6. Statistical analysis

Statistical analysis in this study was conducted using the Number Cruncher Statistical System (NCSS) 2007 statistical software (Utah, USA). Aside from descriptive statistical methods, MANCOVA was used for intergroup comparisons, and the Pearson correlation test was employed to determine the relationships of variables with each other. The differences were considered statistically significant at a significance level of <0.05.

3. Results

Age and mean duration of menopause were significantly lower and mean BMI was significantly higher in Group 1 than Group 2 ($P < 0.05$) (Table 1).

The FTM, LTM, and BMC values of Group 1 were significantly higher than those of Group 2 ($P < 0.05$). As the

FTM, LTM, and BMC values were influenced by a significant difference between Group 1 and Group 2 with respect to age and duration of menopause, these parameters were reassessed using age and duration of menopause as the covariate factors. The FTM and LTM values were significantly higher in Group 1 than in Group 2 ($P < 0.05$) when age and duration of menopause were used as the covariates, and the BMC values were statistically similar in both groups ($P > 0.05$) (Table 2).

The MNA values and the NEADL subgroup and total scores were significantly higher in Group 1 than in Group 2 ($P < 0.05$), but no significant differences were found between the groups in ECOS 16 scores ($P > 0.05$). ECOS 16 and the NEADL subgroup and total scores did not differ between the groups when age and duration of menopause were taken as the covariates ($P > 0.05$). The intergroup differences for MNA values maintained a statistical significance ($P < 0.05$) (Table 3).

A significant positive correlation was found between the MNA values and the L1–L4, femoral neck, total femur BMD, FTM, LTM, BMC, and BMI values ($P < 0.05$) (Table 4).

The NEADL total score had a significant positive correlation with L1–L4, femoral neck, and total femur BMD, and a significant negative correlation with age ($P < 0.05$). This variable was not significantly correlated with FTM, LTM, BMC, and BMI ($P > 0.05$) (Table 4).

Although FTM and BMI had a significant positive correlation with ECOS 16 scores ($P < 0.05$), no significant correlation

Table 1 – Comparison of Groups 1 and 2 with respect to age, duration of menopause, height, weight, and body mass index.

	Group 1	Group 2	t	P
Age, years	58.67 ± 8.35	62 ± 8.4	−2.83	0.005
Duration of menopause, years	10.93 ± 8.12	15.34 ± 9.89	−3.45	0.001
Height, cm	155.71 ± 7	154.63 ± 15.19	0.65	0.516
Weight, kg	68.25 ± 10.76	63.85 ± 10.35	2.95	0.004
BMI, kg/m^2	27.75 ± 4.72	25.96 ± 4.29	2.80	0.006

BMI, body mass index.

Table 2 – Comparison of Groups 1 and 2 with respect to fat tissue mass, lean tissue mass, and bone mineral content values.

	Group 1	Group 2	P	*Age*Duration of menopause
FTM, kg	29.72 ± 7.55	26.11 ± 7.29	0.001	0.0001
LTM, kg	37.46 ± 4.58	36.21 ± 3.81	0.042	0.017
BMC, g	2080 ± 220	1830 ± 260	0.0001	0.248

FTM, fat tissue mass; LTM, lean tissue mass; BMC, bone mineral content.

Table 3 – Comparison of Groups 1 and 2 with respect to MNA, NEADL, and ECOS 16 values.

	Group 1	Group 2	P	Age*Duration of menopause
MNA	25.7 ± 2.92	24.18 ± 3.3	0.002	0.025
NEADL				
Mobility	15.92 ± 4.28	14.69 ± 4.02	0.036	0.344
Kitchen	14.65 ± 1.39	13.88 ± 2.6	0.009	0.726
Domestic	9.67 ± 2.79	8.46 ± 3.36	0.006	0.856
Leisure activities	12.46 ± 4.07	9.57 ± 5.05	0.0001	0.842
Total	52.7 ± 9.43	46.6 ± 12.78	0.0001	0.845
ECOS 16	2.44 ± 0.76	2.62 ± 0.75	0.098	0.286

MNA, Mini Nutritional Assessment; NEADL, Nottingham Extended Activities of Daily Living Scale; ECOS 16, assessment of health-related quality of life in osteoporosis.

Table 4 – Relationship between assessment parameters and bone mineral density, body composition, body mass index, and age.

		MNA	Mobility	Kitchen	Domestic	Leisure activities	Total NEADL	ECOS 16
L1-4 BMD, g/cm^2	r	0.234	0.115	0.124	0.22	0.279	0.239	−0.044
	P	0.001	0.103	0.079	0.002	0.0001	0.001	0.534
Femoral neck BMD, g/cm^2	r	0.156	0.108	0.179	0.148	0.212	0.199	−0.018
	P	0.026	0.125	0.011	0.035	0.002	0.004	0.794
Total femur BMD, g/cm^2	r	0.156	0.089	0.155	0.162	0.21	0.191	0.031
	P	0.026	0.207	0.028	0.022	0.003	0.007	0.666
FTM, kg	r	0.223	−0.073	0.028	−0.112	−0.04	−0.068	0.152
	P	0.002	0.315	0.698	0.12	0.583	0.346	0.034
LTM, kg	r	0.174	−0.039	0.034	−0.097	−0.12	−0.084	0.028
	P	0.016	0.587	0.642	0.18	0.097	0.248	0.697
BMC, g	r	0.206	0.117	0.093	0.045	0.134	0.126	0.044
	P	0.004	0.105	0.199	0.532	0.064	0.08	0.546
BMI, kg/m^2	r	0.197	−0.074	0.061	−0.141	−0.072	−0.084	0.156
	P	0.005	0.297	0.391	0.046	0.313	0.236	0.027
Age, years	r	0.109	−0.196	−0.054	−0.238	−0.215	−0.234	0.068
	P	0.124	0.005	0.443	0.001	0.002	0.001	0.338

BMD, bone mineral density; FTM, fat tissue mass; LTM, lean tissue mass; BMC, bone mineral content; BMI, body mass index; MNA, Mini Nutritional Assessment; NEADL, Nottingham Extended Activities of Daily Living Scale.

could be established between age and L1–L4, femoral neck, total femur BMD, LTM, or BMC (P > 0.05) (Table 4).

4. Discussion

4.1. Body composition

Our study indicated that osteoporotic women were older, had a longer duration of menopause, and had a lower BMI than osteopenic women. The osteopenic group had significantly higher FTM, LTM, BMC, MNA, and NEADL values than the osteoporotic group. The ECOS 16 results were not different. As the significant difference between the two groups with respect to age and duration of menopause might have influenced the results, the variables were reassessed using age and duration of menopause as the covariate factors. As a result, the FTM, LTM, and MNA values maintained statistical significance. The MNA values were correlated with femur BMD, LTM, FTM, BMC, and BMI; functional status assessed by the NEADL was positively correlated with BMD and negatively correlated with age. The NEADL score was not correlated with body composition. BMI and FTM were correlated with the ECOS 16 values.

Body weight peaks at around the 5th to 6th decade, and weight loss gradually begins in the 7th decade and continues for the rest of an individual's life [15]. Many methods have been developed to assess these changes in body composition, one of which is the DXA method. DXA is the most reliable noninvasive method in clinical practice. It is a widespread reproducible method associated with low radiation levels, and it enables rapid evaluation [16,17].

Using DXA, Andreoli et al. [17] found increased body fat and trunk fat but unchanged total body fat with aging. In a 5-year longitudinal study, Dey et al. [18] reported a significantly lower fat-free mass and body water and decreased muscle strength, especially in the trunk and lower extremity muscles, in both genders between ages 75 and 80.

Aside from bone loss, menopause also leads to muscle loss. Menopause is characterized by an increased rate of loss in lean

mass [19]. Similar to our results, Lasaite et al. [1] found decreased BMI, lean mass, and fat mass in 31 Lithuanian postmenopausal women compared with age- and sex-matched controls. Gnudi et al. [9], in a study enrolling 770 postmenopausal women, reported that osteoporotic women were older, shorter, and thinner than nonosteoporotic women. They also had lower BMC, BMI, and total lean and fat mass than nonosteoporotic women. However, the assessment of these changes as percentages revealed different results. In their study on osteoporotic and nonosteoporotic elderly postmenopausal women, Liu et al. [6] found that osteoporotic women were older, had a longer duration of menopause, and had lower ratios of total body, regional lean, and fat mass. By contrast, fat tissue percentages of osteoporotic women were lower than those of nonosteoporotic women, and lean mass percentages were not different between the groups. Rikkonen et al. [20] reported significantly lower proportions of BMI and lean mass and similar fat mass proportions in osteoporotic women than in osteopenic and healthy women.

4.2. Nutrition

Nutrition is an important factor in health status, and malnutrition is known to affect bone metabolism [21]. Inadequate food intake, especially the inadequate consumption of protein, is related to the reduction of skeletal muscle and bone mass in elderly people [22]. Optimal BMD and BMC were associated with nutrition [17]. MNA was developed to detect nutritional deficiencies even in a normal population [11]. Weight loss, psychological stress, and reduction in food consumption were strongly correlated with total MNA scores. These factors are followed by decreased mobility, decreased BMI, and reduction in the daily number of meals [21].

Salminen et al. [11] found a twofold increased risk of osteoporosis in the femoral neck and/or total hip regions when MNA scores were below the median score (27 for this study). Another study found that nutritional status, as assessed by MNA, affected BMD, and that osteoporotic women had a higher risk of malnutrition than higher MNA scores [12]. We also

detected lower MNA scores in osteoporotic women than in osteopenic ones, and this difference was consistently significant when age and duration of menopause were used as covariates.

Consistent with the literature, we showed a positive correlation between BMI and MNA [12,21]. However, our literature search did not retrieve any studies examining the relationship between body composition and MNA in osteopenic and/or osteoporotic patients. We found a significant relationship between the components of total body composition and MNA. A study on patients with chronic obstructive lung disease similarly demonstrated a positive correlation between MNA scores and fat content and lean body mass [23]. Moreover, a study on 41 men aged 62–91 years demonstrated significantly lower BMI, fat-free mass, and fat mass values in the undernourished group than in the eutrophic group [24].

It is worth noting that aside from nutritional habits, socioeconomic and psychological factors, acute and chronic disorders, tooth quality, use of multiple drugs, food consumption, digestion, and absorption, leading to malnutrition, may also have an impact [12,21].

4.3. Functional status

All humans lose muscle mass and muscle function with aging. This loss is apparent even in elite athletes who have a higher level of physical activity and performance than sedentary adults [19]. Age-related changes in muscle quality, aside from changes in the skeletal muscle quantity, may also contribute to loss in muscle function at an advanced age [18]. Reduced muscle strength is the major cause of increased disability [15]. If modifiable predictors leading to functional limitations are detected, successful aging may be promoted with increased life expectancy [25].

Our study showed better physical activity levels in the osteopenic group than in the osteoporotic group. However, this significant difference was not apparent when age and duration of menopause were used as the covariate factors. Furthermore, functional status assessed by the NEADL was correlated with BMD and age, and the NEADL score was not correlated with body composition.

The literature contains controversial results on low muscle mass and physical function [8]. Lebrun et al. [26] reported that higher lean mass values in postmenopausal women under the age of 75 years were correlated with higher muscle strength, muscle strength was correlated with better functional ability, and higher fat mass was associated with lower functional capacity. In a 3-year follow-up study on a patient population consisting of 4089 men and women aged between 45 and 100 years, Visser et al. [10] found a positive correlation between fat mass and disability but no correlation between low fat-free mass and high disability prevalence.

The decrease in fat-free mass with aging may be lower than that expected in total muscle mass because the weight of visceral organs may be maintained at the expense of skeletal muscle mass. Therefore, the authors stated that appendicular lean tissue could be more beneficial in assessing physical function [18].

Reduction in muscle strength and mass is expected to result in a progressive decrease in physical activity and a sedentary lifestyle [18]. On the basis of this result, Blain et al. [27] indicated that muscle strength could be more important for lower extremity performance than lean tissue and muscle mass; they also stressed that it could contribute to the maintenance of femoral neck BMD. Assessing muscle strength rather than muscle mass to detect the relationship among physical activities, and even doing so for lower and upper extremities separately, may be more useful to ascertain the effect on physical activity.

The ability to engage in physical activities is also dependent on various factors, such as general status, BMI, smoking, and socioeconomic status [3]. Functional limitations may also be present because of chronic diseases. These disease states may lead to weight gain, which in turn causes limited mobility, and increased strain in muscles and joints [25]. All these events may culminate into a vicious cycle that severely limits activities, leading to further increase in weight and functional restriction.

Increased BMI results in reduced osteoporosis risk but not in reduced osteopenia risk [4]. A higher BMI is considered to be associated with a higher degree of disability than a mid-level BMI. Studies reported an association between a below-normal BMI and decreased mobility. Similarly, Davidson et al. [25] reported an association between a higher BMI and a higher functional limitation in men and women. However, we did not observe a relationship between BMI and functional status, perhaps because all the participants in our study were mobile.

Falls are common in elderly people and can cause fractures, particularly in osteoporotic patients. Injuries secondary to falls may lead to the progressive fear of walking and other physical activities [15]. Osteoporosis may cause a limited physical activity level, changes in body composition, and an increased risk of health deterioration [1]. This phenomenon suggests that elderly patients, owing to their advanced age and increased risk of falls, might have avoided activities that led to the emergence of a relationship between physical activity level and BMD in our study population.

4.4. Quality of life

Changes in body composition with aging negatively affect quality of life [17]. Quality of life encompasses all aspects of health status, environment, financial status, and human truths. Health-related quality of life or health status is a subgroup of quality of life; it is related to physical, emotional, and social well-being [28]. Osteoporotic women usually have many handicaps with respect to the physical, psychological, and social aspects of quality of life. These handicaps lead to inadequacies in social and leisure activities, culminating in fluctuations in the emotional state [1]. Assessing these disorders and using them as outcome measures in studies carry increasing importance [2].

Osteoporosis is not always clinically evident because a low BMD remains asymptomatic, and patients with low-grade fracture and/or without fracture may not be aware of this condition. By contrast, a reduced BMD may sometimes cause a decrease in quality of life owing to the fear of potential new fractures [29]. The clinical effect of osteoporosis is determined by a fracture and its associated morbidity [2]. The main morbidity associated with osteoporosis stems from pelvic, vertebral, and

distal radius fractures [28]. Romagnoli et al. [29] reported no significant differences in pain, physical function, social function, and total European Foundation for Osteoporosis (QUA-LEFFO) scores among three groups designated as osteoporotic, osteopenic, and normal according to DXA results. However, the classification of osteoporotic and osteopenic patients with and without fracture revealed significant differences between osteoporotic patients with and without fractures with respect to physical condition, social function, overall health perception, and total QUALEFFO scores, although osteopenic patients with and without fractures did not differ among themselves. Similarly, another study found that osteoporotic patients with fractures had higher QUALEFFO scores than osteoporotic patients without fractures, and an increase in the number of fractures paralleled the QUALEFFO scores [30].

One study found that quality of life assessed by QUALEFFO-41 was better in osteopenic patients than in osteoporotic patients without fractures, but it was not different in the assessment by Short Form-36. The authors attributed these findings to the advanced age of the osteoporotic patients. Both questionnaires found a markedly affected quality of life of osteoporotic patients with fractures. However, the same study reported that in the pain assessment by visual analog scale, the pain of osteoporotic patients with fractures was not more intense than that of patients without fractures [21].

In our study population, we did not find any difference in the quality of life between osteopenic and osteoporotic patients. However, we found a positive correlation between quality of life and FTM and BMI, most likely because we did not evaluate the presence of fractures, which is a limitation of our study. Quality of life is affected by fractures, especially by the latest one. Another limitation of our study is that we did not measure the vitamin D levels. Osteomalacia is another cause of reduced muscle strength and body pain, which lead to altered quality of life and physical condition.

5. Conclusions

In conclusion, osteoporotic patients had lower FTM and LTM and a poorer nutritional status than osteopenic patients. Nutritional status correlated with lumbar and femur bone mineral density, lean tissue mass, fat tissue mass, bone mineral content, and body mass index. Functional status was associated with bone mineral density and age but not with body composition. No difference was found between the two groups in quality of life.

Conflict of interest

The authors state no conflict of interest.

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