ORIGINAL RESEARCH

Comparative assessment of fracture risk among osteoporosis and osteopenia patients: a cross-sectional study

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Background: Both osteoporosis and osteopenia remain worldwide public health concerns. They both lead to bone fractures, which can lead to disability and burden on those who are afflicted.
Objectives: To assess and compare fracture risk between these two groups of patients.
Patients and methods: Our cross-sectional study included 82 patients (46 with osteoporosis and 36 with osteopenia) with an average age of 63±9.33 years, who received treatment at the Clinic for Medical Rehabilitation, Clinical Center of Vojvodina in Novi Sad, Serbia. The assessment of the fracture risk was executed by applying the Fracture Assessment Risk (FRAX) index (an algorithm developed by the World Health Organization) based on clinical fracture risks or combination of clinical fracture risks and bone mineral density.
Results: Patients with osteoporosis had significantly higher risk of major fracture compared to patients with osteopenia ($p<0.01$). Results from FRAX index in osteoporotic patients showed that more than half (58.70%) of patients had a low risk of fracture; less than one-third of patients (30.43%) had an intermediate risk of major osteoporotic fracture, while almost four out of every 10 (39.96%) had a high risk of hip fracture. The majority of patients with osteopenia (63.89%) had a low risk of major osteoporotic fracture, while 36.11% of them had an intermediate risk. The majority of patients with osteopenia (91.67%) had a low risk of hip fracture. Statistically significant differences in relation to specific fracture risks between patients with osteoporosis and osteopenia, in particular, weight ($t=-2.250$, $p=0.027*$) and previous fractures ($t=2.985$, $p=0.004**$), were established.
Conclusion: Osteoporosis patients had a high risk of major osteoporotic fracture, while there was no association between the intermediate level for major osteoporotic fracture and osteopenia. For patients suffering from an increased fracture risk, especially those who had already been diagnosed with osteoporosis, preventive measures such as designing individual therapeutic programs should be adopted.
Keywords: osteoporosis, osteopenia, fracture risk, fractures, FRAX index, bone fracture, body mass index, bone mineral density

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Introduction

Osteoporosis can be described as a skeletal disorder that is characterized by compromised bone strength, which predisposes individuals to an increased risk of fracture.[1] Fractures due to osteoporosis may be defined as those that occur as a result of a low-impact trauma, consequences of which range from chronic pain to institutionalization and death, due to complications.[2–7] These types of fractures may cause compression of nerve roots and loss of height of few centimeters, which is a visible sign of the disease. With larger deformities, it is possible to have gastrointestinal discomforts and pain after the meal because of increased chest pressure over abdominal organs. Excessive

muscle and ligament burden on the spine causes chronic, blunt, and persistent pain, especially in the lower back area. Back pain is one of the most significant factors that usurps the quality of life among patients suffering from osteoporotic vertebral fractures.[2,3]

According to the World Health Organization (WHO), osteoporosis occurs when the bone mineral density (BMD) of an individual is ≥2.5 SDs below the young adult mean value (T-score, −2.5 or lower) among postmenopausal women as well as among men aged over 50 years. Kanis et al stated that if the BMD has a T-score of between −1 and −2.5, the disorder is classified as osteopenia.[8] Although the most important determinant of fracture risk is low BMD, more than half of all low-trauma fractures occur among people with non-osteoporotic BMD (T-score > −2.5).[9–12]

The impact on decision about the treatment, beside the determination of BMD by dual-energy X-ray absorptiometry (DXA) method, has been through the assessment of probability of big osteoporotic fracture (spine, hip, forearm, upper arm) by using Fracture Assessment Risk (FRAX) index, which is a clinical instrument defined by Center for Metabolic Bone Disease of WHO (Sheffield, UK). By using FRAX index, it is possible to establish 10-year fracture risk, depending on the age, and life expectancy of clinical fracture risk.[13,14] The introduction of FRAX index has assisted with the identification of patients of low, intermediate, and high fracture risks. For patients with intermediate fracture risk, some additional prevention measures are advised, such as measuring of femur density and reassessment of the risk.[15]

Women who live in a developed country and aged over 50 years have about a 50% lifetime risk of sustaining a fracture, while men in that category have a 20% lifetime risk.[16] Globally, a bone breaks because of osteoporosis every 3 seconds; and in Europe, India, Japan, and the USA, there are an estimated 125 million people with the disease.[17] According to a recent global report, the number of people living with osteoporosis is said to increase dramatically in the future, as a result of aging populations and changes in lifestyles.[17]

A recent study by Serbia[18] found that out of 132 postmenopausal women, about 59% had normal BMD, whereas 41% had osteoporosis or osteopenia. The study revealed that about one-third of the patients had a fracture, and the average number of fractures was 1.47 in all the women in the study. There has been extensive research on osteoporosis and osteopenia in Serbia.[18–21] However, to the best of our knowledge, none of these studies has assessed the fracture risk factors associated with these two conditions, and a standardized FRAX questionnaire was not routinely applied in such assessments.

The purpose of this clinical research was to assess and compare the fracture risk among patients with osteoporosis and those suffering from osteopenia.

Patients and methods

A cross-sectional analysis was conducted on a group of patients with osteoporosis and others with osteopenia between April and August 2015. Patients who were already enrolled at the Clinic for Medical Rehabilitation (Clinical Centre of Vojvodina) in Novi Sad were invited to participate in this cross-sectional and comparative analysis. Measurements were executed by DXA examination of lumbar spine and proximal femur using the Lunar Prodigy Primo device.

BMD for all patients was measured through DXA examination. *T*-value was used for diagnosing osteoporosis and osteopenia. Osteoporosis is defined as a value for BMD 2.5 SD or more below the young female adult mean (T-score ≤ −2.5 SD). Severe osteoporosis (established osteoporosis) describes osteoporosis in the presence of one or more fragility fractures.[22]

In this study, we utilized a questionnaire to the participants face-to-face to obtain sociodemographic characteristics, medical history, and fracture history, and 11 questions from FRAX survey to obtain BMD of femoral neck. FRAX is an algorithm developed by the WHO for predicting hip fracture or any other osteoporotic fracture (spine, forearm, shoulder) based on clinical risk factors or a combination of clinical risk factors and BMD. Data obtained from the questionnaire were inserted in a FRAX calculator, which yielded a 10-year-long risk for hip fracture and major osteoporotic fractures (MOFs; hip, vertebral, distal radius, and proximal humerus). By using this clinical instrument, and following the guidelines given by National Osteoporosis Guideline Group (NOGG), patients were divided into three different risk levels (low, intermediate, and high) for occurrence of MOFs and hip fractures as well.[22] Ten-year risk for hip fracture was found to be higher by 3%, whereas for major fractures, it was higher by 20%, suggesting a treatment for such people.

Statistical analysis

We used the statistical program International Business Machines, SPSS version 22.0 (IBM Corporation, Armonk, NY, USA). Results were presented using standard statistical measures of central tendency and range of results. For establishing differences in results obtained on scales and subscales from which they were made of, Independent Sample *t*-test was used for testing the difference between the independent samples. Furthermore, only the variables with *p*-values ≤0.05 were considered to be statistically significant.

Ethical statement

Ethics approval from the Ethics Committee of the Clinical Center of Vojvodina in Novi Sad, Serbia, was obtained and all participants were enrolled in the study after signing the consent forms provided before entering the study.

Results

A total of 82 patients, 46 (7 men, 39 women) with osteoporosis and 36 (4 men and 32 women) with osteopenia, participated in this cross-sectional study. The average age of patients with osteoporosis was 66.34±10.23 years (range 43–88 years), while the average age of patients with osteopenia was 62.44±7.63 years (range 48–81 years). Table 1 presents the characteristics of all participants.

Table 1 General characteristics of the study participants

General characteristics	Osteoporosis	Osteopenia
Number	46	36
Age (years)	66.34±10.23	62.44±7.63
DXA, L1–4		
T score	−2.61±1.29[a]	−1.03±1.050[a]
BMD	1.034±0.84	1.043±0.116[a]
DXA femur total		
T score	−2.38±0.91[a]	−0.90±0.73[a]
BMD	0.718±0.106	0.892±0.094[a]

Notes: [a]Statistically significant difference between the groups (p<0.001). Data presented as mean ± SD.
Abbreviations: BMD, bone mineral density; DXA, dual-energy X-ray absorptiometry.

Statistically significant differences were established in representation of specific fracture risks between the patients with osteoporosis and osteopenia, in particular, weight (t=−2.250, p=0.05*) and previous fractures (t=2.985, p=0.01**; Table 2). Patients suffering from osteopenia had a significantly higher fracture risk compared to patients with osteoporosis, because of their weight, whereas patients suffering from osteoporosis had higher fracture risk in comparison to patients suffering from osteopenia, because of previous fractures (Table 2).

Through FRAX calculator, a 10-year fracture risk of hip fracture was confirmed among the patients with osteoporosis and osteopenia. Based on NOGG guidelines, patients were divided in to three risk levels (low, intermediate, and high) for MOF and hip fracture occurrence (Table 3).

The majority of patients (58.70%) had a low risk of MOF, less than one-third of patients had an intermediate risk, while 10.87% had a high risk (Table 3).

With regard to hip fracture, the majority of patients with osteoporosis (56.52%) had low fracture risk, almost four out of every 10 (39.96%) had high risk, while 6.52% had intermediate risk (Table 3).

The highest number of patients with osteopenia had low risk level for MOF (23 [63.89%]), then intermediate (13 [36.11%]), while the patients with high risk were not accounted for (Table 4).

The majority of patients with osteopenia (91.67%) had a low risk level for hip fracture; 5.56% of patients with osteo-

Table 2 Difference in representation of fracture risks between patients with osteoporosis and patients with osteopenia (Independent Sample t-test)

Fracture risks	Disease type	N	Mean	SD	t	df	p-value
Height	Osteoporosis	46	161.69	8.39	−0.348	80	0.729
	Osteopenia	36	162.28	6.22			
Weight	Osteoporosis	46	**74.33**	11.58	**−2.250**	80	**0.027[a]**
	Osteopenia	36	68.30	12.39			
BMI	Osteoporosis	46	27.77	4.57	−1.034	80	0.304
	Osteopenia	36	26.43	4.34			
Menopause	Osteoporosis	46	0.81	0.40	−1.362	80	0.177
	Osteopenia	36	0.89	0.32			
Previous fractures	Osteoporosis	46	**0.65**	0.48	**2.985**	80	**0.004[a]**
	Osteopenia	36	0.33	0.48			
Smoking	Osteoporosis	46	0.28	0.45	1.231	80	0.222
	Osteopenia	36	0.17	0.39			
Alcohol	Osteoporosis	46	0.065	0.250	−0.731	80	0.467
	Osteopenia	36	0.11	0.32			
Glucocorticoids	Osteoporosis	46	0.065	0.25	0.148	80	0.883
	Osteopenia	36	0.057	0.24			
Parental history of fracture line	Osteoporosis	46	0.239	0.43	−0.393	80	0.695
	Osteopenia	36	0.278	0.45			

Note: [a]Difference is statistically significant at 0.05 level. N=sample size; t=t-test scores. Values with significant p-value (<0.05) are bolded.
Abbreviations: BMI, body mass index; df=degrees of freedom.

Table 3 Degree of fracture risk for major osteoporotic fracture and hip fracture for patients with osteoporosis

Fracture type	Risk level							
	Low		Intermediate		High		All	
	N	%	N	%	N	%	N	%
Major osteoporosis	27	58.70	14	30.43	5	10.87	46	100
Hip	26	52.56	3	6.52	17	39.96	46	100

Table 4 Degree of fracture risk for major osteoporotic fracture and hip fracture for patients with osteopenia

Fracture type	Risk level							
	Low		Intermediate		High		All	
	N	%	N	%	N	%	N	%
Major osteoporosis	23	63.89	13	36.11	–	–	36	100
Hip	33	91.67	1	2.78	2	5.56	36	100

penia had a high risk level of hip fracture. Only one patient (2.78%) had an intermediate risk level of hip fracture (Table 4).

Discussion

Our study showed that patients suffering from osteopenia had a significantly higher fracture risk compared to those with osteoporosis, with weight being the contributing risk factor. Our results also indicated that patients suffering from osteoporosis and who had history of fractures had higher fracture risk in comparison to those suffering from osteopenia without history of fractures.

It is evident from the extended literature that reduced body weight and previous fractures are risk factors for lower BMD.[23,24] This is consistent with the findings from our study, which showed that the average value of body mass index (BMI) was 27.77±4.57 kg/m^2 among the patients with osteoporosis and 26.43±4.34 kg/m^2 among the patients with osteopenia. Results of previous studies showed that statistically significant differences in representation of particular fracture risks, such as body weight and previous fracture, were determined between patients with osteoporosis and those with osteopenia.[24] Our study revealed that patients suffering from osteopenia had a higher fracture risk compared to those suffering from osteoporosis, because of the lower body weight, whereas patients suffering from osteoporosis had a higher fracture risk because of previous fractures when compared to patients suffering from osteopenia. These findings are consistent with those from a previous research, which has shown that reduced BMI significantly affects the occurrence of osteoporotic fractures,[23] and from another study,[25] which suggested that patients with existing fracture due to osteoporosis have five times the risk of fracture compared to those with no history of fracture.

Our results showed significant difference in average means of fracture risk of the hip between patients with osteoporosis and those with osteopenia. Patients suffering from osteoporosis were found to have a significantly higher risk of hip fracture. This is consistent with reports by Cummings et al[25] that BMD of the hip is a stronger predictor of hip fracture than measurements of BMD of other areas of the skeleton.[26]

Data relevant for FRAX index were given for 46 patients with osteoporosis. The low risk of MOF was reported in more number of patients (27 [58.70%]) than intermediate (14 [30.43%]) and high of MOF (5 [10.87%]). With regard to hip fracture, the low fracture risk is reported in more number of patients with osteoporosis (26 [56.52%]), than high (17 [39.96%]) and intermediate fracture risks (3 [10.00%]).

In our study, we found that the majority of patients with osteopenia had low risk level for MOF (23 [63.89%]), with only 13 (36.11%) with intermediate risk, while the patients (33 [91.67%]) with high risk were not accounted for. In addition, the majority of patients with osteopenia had low risk level for hip fracture, with only one patient (2.78%) at an intermediate risk level and two (5.56%) at a high risk. This is contrary to findings from a previous study,[27] where hip fracture was found to be the most common among the patients with high level of risk (74.2%), which clearly indicates insufficient recognition of clinical risk factors pertinent to fracture occurrence. Findings from this study would be useful to public health researchers, policy makers, and program managers, in an effort to monitor and design programs and community-based interventional strategies aimed at reducing the risk of osteoporosis and osteopenia in Serbia and surrounding regions and to contribute to the global fight against osteoporotic bone fracture.

Our study was a cross-sectional study and, therefore, it was impossible to determine the causality. However, these findings provide basis to clinical determination of treatment options and allow some perspectives into the risk of fractures between patients with osteoporosis and those with osteopenia. Moreover, our sample size was relatively small, and while we have had some statistically significant results, a larger sample size could further confirm these findings. Finally, while this study showed that reduced weight can contribute to fracture risk, this is by no means a suggestion that overweight and obesity are protective of osteoporotic fractures. There is a fine line between healthy weight to maintain healthy strong bones and obesity, which can also contribute to fracture risk particularly during falls.

Conclusion

Reduced body weight and previous fractures have been found to be statistically significant factors in determining fracture risk among patients with osteoporosis and those with osteopenia. Patients suffering from osteoporosis have a higher percentage of major bone fracture, as well as hip fracture. These findings may be useful in the future design of interventional strategies to prevent and reduce fracture risk. Longitudinal studies and larger sample size are needed to further confirm these findings in this population.

Disclosure

The authors report no conflicts of interest in this work.

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