Comparison of the Characteristics of Back Pain in Women with Postmenopausal Osteoporosis with and without Vertebral Compression Fracture: A Retrospective Study at a Single Osteoporosis Center in Poland

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Background: The incidence of unspecific back pain and osteoporotic vertebral compression fractures increases significantly with age. Considering the difficulties in the diagnosis of spontaneous osteoporotic vertebral fractures, this retrospective study aimed to compare the characteristics of back pain in women with postmenopausal osteoporosis with and without vertebral compression fractures.

Material/Methods: This study enrolled 334 women with postmenopausal osteoporosis; 150 had vertebral fractures, and 184 had no vertebral fractures. Densitometric vertebral fracture assessment and bone mineral density measurements in the central skeleton were performed for each patient. The participants completed a survey about features of their back pain.

Results: Patients with vertebral fractures had more severe back pain based on the numeric rating scale: 6.14 vs 4.33 ($P<0.001$, odds ratio [OR]=1.43, 95% confidence interval [CI]: 1.29-1.59). Among these individuals, back pain caused reduction in normal activity during the day ($P<0.001$, OR=4.68, 95% CI: 2.86-7.68), and pain occurred more often ($P<0.001$, OR=1.77, 95% CI: 1.47-2.13), lasted longer ($P<0.001$, OR=2.01, 95% CI: 1.65-2.46), predominantly occurred in the lumbar spine ($P<0.001$, OR=4.70, 95% CI: 1.96-11.29), and intensified during normal everyday activities ($P<0.001$). Based on these results, a new survey was created. It demonstrated a sensitivity of 70.67% and a specificity of 67.37% in predicting a current compression fracture.

Conclusions: Patients with vertebral compression fractures experience higher pain intensity and exhibit specific features of back pain. The new survey can be considered a supportive tool in assessing the possibility of vertebral compression fractures.

Keywords: Back Pain • Spinal Fractures • Osteoporosis • Pain Measurement

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Background

Back pain is a common problem among elderly patients [1,2]. Pain is most frequently caused by degenerative changes in the vertebrae, spinal nerve compression, and radiculopathy [3,4]. It could be the result of injury caused by actions such as lifting a heavy object or making a sudden movement [5-7]. Unfortunately, these situations can also be the cause of a vertebral compression fracture, which is a complication of unrecognized and untreated osteoporosis [8-12]. A large number of compression fractures are spontaneous [13,14] and therefore difficult to diagnose. Another reason for difficulties in diagnosing this type of fracture is the variety of methods recommended for the diagnosis of osteoporosis and vertebral compression fractures. While the diagnosis of vertebral compression fractures is based on radiographic examination [15], the diagnosis of osteoporosis should be confirmed by central dual-energy X-ray absorptiometry [16]. The aim of this study was to look for specific features of back pain associated with vertebral compression fractures [17].

Material and Methods

Study design and subjects

This comparative study of 334 postmenopausal women was performed between June 2018 and August 2019 in Warsaw, Poland, and was approved by the Ethics Committee of the Center of Postgraduate Medical Education in Warsaw (no. 64/PB/2018). Participants with osteoporosis diagnosed according to World Health Organization definitions of osteoporosis and osteopenia [18] (inclusion criterion) were recruited from among patients hospitalized in the Bone Metabolic Department or remained under the care of the Osteoporotic Clinic. The exclusion criteria were (1) taking steroids, (2) suspected or diagnosed secondary osteoporosis, (3) high-energy, nonosteoporotic vertebral fractures, and (4) presence of severe scoliosis or overlapping calcifications or structures in the mediastinum and abdominal cavity that precluded identification of the borders of vertebral bodies. Informed written consent was obtained from all participants before measurements and data collection.

Diagnosis of Osteoporosis and Vertebral Fractures

The diagnosis of osteoporosis was confirmed by measuring the bone mineral density of the hip and spine, using dual-energy X-ray absorptiometry [18,19]. For identification of vertebral compression fractures, all patients underwent thoracic and lumbar spine morphometry by a densitometric vertebral fracture assessment tool. All densitometric measurements were provided through use of a Horizon W dual-energy bone densitometer (Hologic, Inc., Bedford, MA, USA). The vertebrae T6–L4 were assessed. A compression fracture was diagnosed when the anterior, middle, or posterior height of the vertebral body was reduced by at least 25% [20]. To ensure repeatability of measurements, all tests were performed by the same highly qualified technician using the same device. Based on the results of the morphometric examination, patients were divided into 2 groups: those with vertebral fractures (n=150), regardless of the number of fractures, and those without vertebral fractures (n=184).

Questionnaire

Participants were asked to complete a questionnaire about their symptoms (Table 1). Pain assessment was conducted using an 11-point numeric rating scale (NRS) that patients with chronic pain prefer over a visual analog scale [21]. The questionnaire was validated by the authors using Cronbach's alpha test (obtained coefficient for the entire questionnaire was 0.757); it was not a modification of questionnaires concerning the quality of life [22], disability [23], or the effectiveness of osteoporosis treatment [24]. A different number of responses was assigned to subsequent questions in the questionnaire because some patients did not answer all questions.

In the next stage, based on statistically significant results, a new 5-point survey was created, characterizing the back pain after a compression fracture.

Statistical Analysis

Continuous data in the text and Table 2 are presented as mean±standard deviation, and categorical data in Table 3 are shown as percentages. For the variable determining the intensity of back pain on the NRS, after excluding the normality of the distribution using the Shapiro-Wilk test, a nonparametric analysis was conducted, with the P value of the Kolmogorov-Smirnov test results shown as p(1), that of the Mann-Whitney U test results as p(2), and that of the Wald-Wolfowitz test results as p(3). For the densitometric measurement results, a Kolmogorov-Smirnov test was conducted. For categorical data, the significance was verified by the chi-square test, with p(4) indicating the P value, and for the individual answers in Table 3, the structure indicators test was used, with the P value indicated as p(5). In addition, the Kendall tau correlation coefficient was calculated along with the gamma coefficient as appropriate. For selected variables, univariate logistic regression analysis with the odds ratio (OR) and 95% confidence intervals (CIs) was conducted. The 5 most differentiating questions were selected from the survey presented in Table 1 for assessing the risk of undiagnosed vertebral fractures. After statistical analysis was performed, the questions were reformatted to allow only "yes" or "no" answers. The new questionnaire was created in such a way that only a positive answer to all questions

Table 1. Questions included in the questionnaire with possible answers.

Questions	Possible answers
On a Numeric Rating Scale from 0 to 10, how sever is your back pain?	A number from 0 to 10
Does your back pain limit your activity during the day, ie, make it necessary to stop (even for a moment) regular household activities?	2 possible answers: yes; no
If there is back pain, that limits your activity, how long does it last during the day?	4 possible interval answers: 1-2 hours; 3-4 hours; 5-8 hours; round the clock
How often does the severity of your back pain limit your daily activity?	4 possible answers: not at all; once a week; more often than once a week; every day
In which part of the spine the back pain is most severe?	3 possible answers: cervical, thoracic, lumbar
Does the back pain occur at night?	3 possible answers: no; yes, but does not wake up; yes and wake up
During which part of the day is back pain most severe?	4 possible answers: morning; during the day; in the evening; at night
Do you remember ever experiencing an episode of sudden and more severe than usual back pain that could have occurred spontaneously or was associated with an injury?	2 possible answers: yes; no

Table 2. Comparison of densitometric parameters of spine, femoral neck and hip in 334 osteoporotic women with (n=150) and without (n=184) vertebral fractures.

Parameter	Patients with vertebral fractures	Patients without vertebral fractures	p(1) value
BMD – vertebrae L1–L4 (g/cm^2)	0.741±0.079	0.745±0.068	>0.1
T-score – vertebrae L1–L4	-2.78±0.71	-2.75±0.61	>0.1
Z-score – vertebrae L1–L4	-0.58±0.92	-0.73±0.84	=0.1
BMD – femoral neck (g/cm^2)	0.595±0.078	0.612±0.069	<0.025
T-score – femoral neck	-2.28±0.72	-2.11±0.64	<0.025
Z-score – femoral neck	-0.41±0.80	-0.36±0.69	=0.1
BMD – hip (g/cm^2)	0.703±0.11	0.735±0.08	<0.005
T-score – hip	-1.89±0.78	-1.69±0.69	<0.025
Z-score – hip	-0.34±0.84	-0.20±0.77	=0.01

was considered diagnostic for a compression fracture. Then, the results of the vertebral fracture assessment were compared with the results of the questionnaire and the sensitivity and specificity of the new method were calculated. Statistical analysis was performed using Statistica TIBCO Software Inc. (data analysis software system, version 13.3, Palo Alto, CA, USA). A *P* value <0.05 was considered statistically significant.

Results

The results for bone mineral density, T-score, and Z-score in the lumbar spine, femoral neck, and hip are presented in

Table 2. A summary of the analyzed responses from the questionnaire is presented in **Table 3**. Increased severity of pain was found among patients with vertebral fracture (**Figure 1**) compared with patients without vertebral fracture (6.14±2.10 vs 4.33±0.03), [p(1)<0.001, p(2)<0.001, p(3)<0.001, respectively, OR=1.43, 95% CI: 1.29-1.59]. Patients with a compression fracture had limitations to daily activity more frequently than patients without a fracture [p(4) and p(5) < 0.001, Kendall tau b coefficient 0.35, gamma coefficient 0.65, OR=4.68, 95% CI: 2.86-7.68]. Frequency of back pain that limited activity during the day was higher for subjects with vertebral fracture [p(4)<0.001, Kendall tau c coefficient 0.38, gamma coefficient 0.51, OR=1.77, 95% CI: 1.47-2.13]. The difference between

Table 3. The summary analysis of categorical data of the responses provided in the questionnaire.

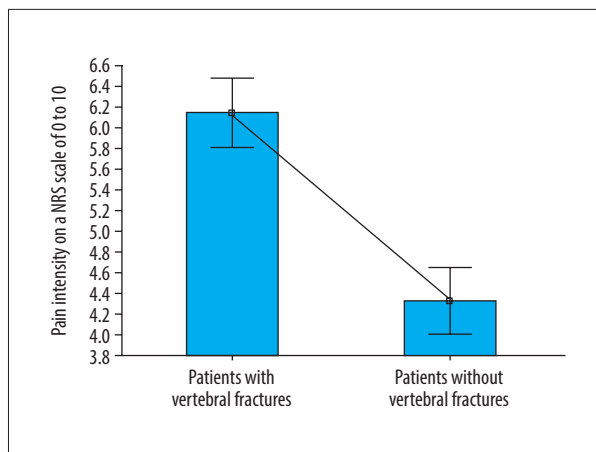| Questions	Answer	Patients with compression fractures	Patients without compression fractures	p(5) value
Does your back pain limit your activity during the day, ie, make it necessary to stop (even for a moment) regular household activities?	Yes	118 (79.19%)	82 (44.81%)	<0.001
	No	31 (20.81%)	101 (55.19%)	<0.001
		n=149	n=183	
If there is back pain, that limits your activity, how long does it last during the day?	Not at all	29 (19.73%)	101 (55.19%)	<0.001
	1-2 hours	37 (25.17%)	49 (26.78%)	0.866
	3-4 hours	37 (25.17%)	17 (9.29%)	0.177
	5-8 hours	16 (10.88%)	9 (4.92%)	0.612
	Round the clock	28 (19.05%)	7 (3.83%)	0.326
		n=143	n=183	
How often does the severity of your back pain limit your daily activity?	Not at all	32 (21.77%)	101 (55.19%)	0.001
	Once a week	14 (9.52%)	15 (8.20%)	0.900
	More often than once a week	37 (25.17%)	31 (16.94%)	0.410
	Every day	64 (43.54%)	36 (19.67%)	0.016
		n=147	n=183	
In which part of the spine the back pain is most severe?	Cervical spine	4 (3.36%)	30 (17.65%)	0.464
	Thoracic spine	13 (10.92%)	14 (8.24%)	0.813
	Lumbar spine	102 (85.72%)	126 (74.11%)	0.016
		n=119	n=170	
Does the back pain occur at night?	No	92 (63.45%)	131 (71.58%)	0.199
	Yes, but does not wake up	6 (4.14%)	9 (4.92%)	0.945
	Yes and wake up	47 (32.41%)	43 (23.50%)	0.348
		n=145	n=183	
During which part of the day is back pain most severe?	Morning	14 (9.33%)	36 (19.57%)	0.383
	During the day	107 (71.33%)	82 (44.57%)	<0.001
	In the evening	27 (18%)	57 (30.98%)	0.210
	In the night	2 (1.34%)	9 (4.89%)	0.822
		n=150	n=184	
Do you remember ever experiencing an episode of sudden and more severe than usual back pain that could have occurred spontaneously or was associated with an injury?	Yes	77 (54.23%)	43 (24.02%)	<0.001
	No	65 (45.77%)	136 (75.98%)	<0.001
		n=142	n=179	

Figure 1. Pain intensity among patients with and without vertebral fractures (mean values with 95% confidence intervals).

the groups was due to the "not at all" answer [p(5)=0.001] and the "every day" answer [p(5)=0.016]. A longer duration of pain limiting activity during the day was found in the group of patients with a fracture [p(4)<0.001, Kendall tau c coefficient 0.46, gamma coefficient 0.59, OR=2.01, 95% CI: 1.65-2.46]. The difference between the groups was due to the "not at all" answer [p(5)<0.001]. There was no significant difference between the groups in terms of occurrence of back pain at night and sleep interruption due to pain [p(4)=0.2]. A difference in the location of back pain was found between the patients with a compression fracture and those without a fracture [p(4)<0.001, OR=4.70, 95% CI: 1.96-11.29]. The difference between the groups was due to the "lumbar spine" answer [p(5)=0.016]. Patients with a compression fracture in contrast to patients without a fracture experienced the strongest back pain "during the day" [p(4)<0.001, p(5)<0.001, Kendall tau c coefficient -0.71, gamma coefficient -0.12]. Patients with a compression fracture more often remembered ever experiencing an episode of sudden and severe back pain [p(4) and p(5)<0.001, Kendall tau b coefficient 0.31, gamma coefficient 0.58, OR=3.75, 95% CI: 2.32-6.04].

Using a combination of the above variables, we created a questionnaire that had a sensitivity of 70.67% and a specificity of 67.37% in predicting current compression fractures of the spine, if all 5 questions were answered in the affirmative. The risk assessment questionnaire for a current undiagnosed compression fracture in the thoracic or lumbar spine included the following questions:

1. Does your back pain limit your activity during the day, that is, make it necessary to stop (even for a moment) regular household activities?
2. Does this type of pain occur at least once a week?
3. If back pain that limits your daily activity occurs, does it last at least an hour a day?
4. Is back pain strongest in either thoracic or lumbar spine?
5. In case of back pain, which limits your daily activity, does pain have the average severity or exceed 5 (0 to 10 scale)?

Discussion

Researchers have reported many features that distinguish the character of back pain of patients with compression fracture from that of patients without this type of injury. A seemingly simple assessment of the intensity of pain on NRS performed among women with vertebral fractures due to osteoporosis [25,26] demonstrated that patients with vertebral fractures experience much more severe pain compared with patients without fractures. This finding leads to the conclusion that osteoporotic fractures of the spine are in fact not asymptomatic [27,28]. Instead, the severity of back pain is underreported owing to the spontaneous character of fractures [13,14,29,30], the lack of awareness of patients about the existence and high frequency of spontaneous vertebral fractures, and the widespread occurrence of back pain in the elderly [31-35]. If a patient seeks medical advice due to back pain, the severity of the symptoms may be interpreted as the progression of degenerative changes or radiculopathy. As a result, the patient will receive only symptomatic treatment instead of further diagnostics [36,37].

Moreover, given that patients with a present compression fracture more often report an episode of sudden, severe back pain in the past [38], the view that osteoporotic fractures of the spine are mostly asymptomatic is incorrect [39]. This misperception is mainly due to their spontaneous character [30] and the fact that most individuals experienced nontraumatic vertebral fractures [40].

In addition to revealing the greater intensity of pain among patients with a compression fracture, our study demonstrated that these patients had more frequent occurrence of back pain, as well as a longer duration of pain, which significantly increased during daily activities and made rest necessary. Pain was most often localized in the lumbar spine. Therefore, the obtained results confirmed that back pain in patients with a compression fracture is significantly different from back pain caused by other pathologies such as degenerative changes [39]. The features of back pain in patients with a compression fracture, such as intensity or activity limitation, have been confirmed in another study [41], but our survey is one of the first tools that may be applicable in clinical practice for the early diagnosis of vertebral compression fractures and improved management of patients experiencing such fractures [42,43].

The questionnaire can be used in women with diagnosed postmenopausal osteoporosis and without any previously diagnosed

vertebral fracture. The last exclusion criterion must be imposed in each case, because the high sensitivity and specificity of the created questionnaire resulted from a comparison of participants from 2 groups, those with a current compression fracture and without such a fracture.

Limitations of the Study

This study has several limitations. The study did not determine whether back pain varies depending on the number of fractures. This requires further investigations. Other study limitation is the method used to detection of vertebral fractures (ie, densitometric vertebral fracture assessment). Although conventional radiography still remains the standard in diagnostics of vertebral fractures [44], the agreement between radiography and densitometric vertebral fracture assessment can reach 98.76% [45]. The research included only hospitalized patients and patients under the care of one osteoporosis clinic, so the results cannot be extended to the whole population. The study was based on one of the first such surveys conducted in Poland, and the sample size was relatively small. Therefore, future research is needed to verify our findings.

Conclusions

Patients with vertebral compression fracture are characterized by higher pain intensity and specific features of back pain. The new 5-point survey that we presented can be considered as a supportive tool in assessing the possibility of vertebral compression fractures.

Conflict of Interest

None.

References:

1. Makris UE, Fraenkel L, Han L, et al. Restricting back pain and subsequent mobility disability in community-living older persons. J Am Geriatr Soc, 2014;62(11):2142-47

2. Scheele J, Enthoven WT, Bierma-Zeinstra SM, et al. Characteristics of older patients with back pain in general practice: BACE cohort study. Eur J Pain, 2014;18(2):279-87

3. Kubaszewski Ł, Nowakowski A, Gasik R, Łabędź W. Intraobserver and interobserver reproducibility of the novel transcription method for selection of potential nerve root compression in MRI study in degenerative disease of the lumbar spine. Med Sci Monit, 2013;19:216-21

4. Karaman H, Tüfek A, Ölmez Kavak G, et al. Effectiveness of nucleoplasty applied for chronic radicular pain. Med Sci Monit, 2011;17(8):CR461-46

5. Vlaeyen JWS, Maher CG, Wiech K, et al. Low back pain. Nat Rev Dis Primers, 2018;4(1):52

6. Balagué F, Mannion AF, Pellisé F, Cedraschi C. Non-specific low back pain. Lancet, 2012;379(9814):482-91

7. Taylor JB, Goode AP, George SZ, Cook CE. Incidence and risk factors for first-time incident low back pain: A systematic review and meta-analysis. Spine J, 2014;14(10):2299-319

8. Bottai V, Giannotti S, Raffaetà G, et al. Underdiagnosis of osteoporotic vertebral fractures in patients with fragility fractures: Retrospective analysis of over 300 patients. Clin Cases Miner Bone Metab, 2016;13(2):119-22

9. Guglielmi G, di Chio F, Vergini MR, et al. Early diagnosis of vertebral fractures. Clin Cases Miner Bone Metab, 2013;10(1):15-18

10. Majumdar SR, Kim N, Colman I, et al. Incidental vertebral fractures discovered with chest radiography in the emergency department: Prevalence, recognition, and osteoporosis management in a cohort of elderly patients. Arch Intern Med, 2005;165(8):905-9

11. Choi YJ, Yang SO, Shin CS, Chung YS. The importance of morphometric radiographic vertebral assessment for the detection of patients who need pharmacological treatment of osteoporosis among postmenopausal diabetic Korean women. Osteoporos Int, 2012;23(8):2099-105

12. Chang HT, Chen CK, Chen CW, et al. Unrecognized vertebral body fractures (VBFs) in chest radiographic reports in Taiwan: A hospital-based study. Arch Gerontol Geriatr, 2012;55(2):301-4

13. Vande Berg B, Malghem J, Maldague B, et al. Spontaneous vertebral fracture: Benign or pathological? JBR-BTR, 2007;90(5):458-60

14. Parfitt M, Qiu S, Palnitkar S, Rao DS. Abnormal bone remodeling in patients with spontaneous painful vertebral fracture. J Bone Miner Res, 2011;26(3):475-85

15. McCarthy J, Davis A. Diagnosis and management of vertebral compression fractures. Am Fam Physician, 2016;94(1):44-50

16. Blake GM, Fogelman I. The role of DXA bone density scans in the diagnosis and treatment of osteoporosis. Postgrad Med J, 2007;83(982):509-17

17. Clark EM, Hutchinson AP, McCloskey EV, et al. Lateral back pain identifies prevalent vertebral fractures in post-menopausal women: Cross-sectional analysis of a primary care-based cohort. Rheumatology (Oxford), 2010;49(3):505-12

18. Kanis JA, Glüer CC. An update on the diagnosis and assessment of osteoporosis with densitometry. Committee of Scientific Advisors, International Osteoporosis Foundation. Osteoporos Int, 2000;11(3):192-202

19. Johnson J, Dawson-Hughes B. Precision and stability of dual-energy X-ray absorptiometry measurements. Calcif Tissue Int, 1991;49(3):174-78

20. Puisto V, Heliövaara M, Impivaara O, et al. Severity of vertebral fracture and risk of hip fracture: A nested case-control study. Osteoporos Int, 2011;22(1):63-68

21. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis Care Res (Hoboken), 2011;63(Suppl. 11):S240-52

22. Cook DJ, Guyatt GH, Adachi JD, et al. Quality of life issues in women with vertebral fractures due to osteoporosis. Arthritis Rheum, 1993;36:750-56

23. Helmes E, Hodsman A, Lazowski D, et al. A questionnaire to evaluate disability in osteoporotic patients with vertebral compression fractures. J Gerontol A Biol Sci Med Sci, 1995;50:M91-98

24. Lips P, Cooper C, Agnusdei D, et al. Quality of life as outcome in the treatment of osteoporosis: The development of a questionnaire for quality of life by the European Foundation for Osteoporosis. Osteoporos Int, 1997;7:36-38

25. Terakado A, Orita S, Inage K, et al. A clinical prospective observational cohort study on the prevalence and primary diagnostic accuracy of occult vertebral fractures in aged women with acute lower back pain using magnetic resonance imaging. Pain Res Manag, 2017;2017:9265259

26. Toyoda H, Takahashi S, Hoshino M, et al. Characterizing the course of back pain after osteoporotic vertebral fracture: A hierarchical cluster analysis of a prospective cohort study. Arch Osteoporos, 2017;12(1):82

27. Yang W, Song J, Liang M, et al. Functional outcomes and new vertebral fractures in percutaneous vertebroplasty and conservative treatment of acute symptomatic osteoporotic vertebral compression fractures. World Neurosurg, 2019;131:346-52

28. Jacobs E, McCrum C, Senden R, et al. Gait in patients with symptomatic osteoporotic vertebral compression fractures over 6 months of recovery. Aging Clin Exp Res, 2020;32(2):239-46

29. Aubry-Rozier B, Gonzalez-Rodriguez E, Stoll D, Lamy O. Severe spontaneous vertebral fractures after denosumab discontinuation: Three case reports. Osteoporos Int, 2016;27(5):1923-35

30. Vande Berg B, Malghem J, Lecouvet F, Maldague B. Spontaneous vertebral fracture: Benign or malignant? JBR-BTR, 2003;86(1):11-14

31. Makris UE, Higashi RT, Marks EG, et al. Physical, emotional, and social impacts of restricting back pain in older adults: A qualitative study. Pain Med, 2017;18(7):1225-35

32. Makris UE, Fraenkel L, Han L, et al. Risk factors for restricting back pain in older persons. J Am Med Dir Assoc, 2014;15(1):62-67

33. Grasland A, Pouchot J, Mathieu A, et al. Sacral insufficiency fractures: An easily overlooked cause of back pain in elderly women. Arch Intern Med, 1996;156(6):668-74

34. Marshall LM, Litwack-Harrison S, Cawthon PM, et al. A prospective study of back pain and risk of falls among older community-dwelling women. J Gerontol A Biol Sci Med Sci, 2016;71(9):1177-83

35. Hartvigsen J, Hancock MJ, Kongsted A, et al. What low back pain is and why we need to pay attention. Lancet, 2018;391(10137):2356-67

36. Alrwaily M, Timko M, Schneider M, et al. Treatment-based classification system for low back pain: Revision and update. Phys Ther, 2016;96(7):1057-66

37. Alexandre A, Corò L, Paradiso R, et al. Treatment of symptomatic lumbar spinal degenerative pathologies by means of combined conservative biochemical treatments. Acta Neurochir Suppl, 2011;108:127-35

38. Wong AY, Karppinen J, Samartzis D. Low back pain in older adults: Risk factors, management options and future directions. Scoliosis Spinal Disord, 2017;12:14

39. Clark EM, Gooberman-Hill R, Peters TJ. Using self-reports of pain and other variables to distinguish between older women with back pain due to vertebral fractures and those with back pain due to degenerative changes. Osteoporos Int, 2016;27(4):1459-67

40. Minonzio JG, Bochud N, Vallet Q, et al. Ultrasound-based estimates of cortical bone thickness and porosity are associated with nontraumatic fractures in postmenopausal women: A pilot study. J Bone Miner Res, 2019;34(9):1585-96

41. Nevitt MC, Ettinger B, Black DM. The association of radiographically detected vertebral fractures with back pain and function: A prospective study. Ann Intern Med, 1998;128(10):793-800

42. Kessenich CR. Management of osteoporotic vertebral fracture pain. Pain Manag Nurs, 2000;1(1):22-26

43. Francis RM, Aspray TJ, Hide G, et al. Back pain in osteoporotic vertebral fractures. Osteoporos Int, 2008;19(7):895-903

44. Kendler DL, Bauer DC, Davison KS, et al. Vertebral fractures: Clinical importance and management. Am J Med, 2016;129(2):221.e1-10

45. Diacinti D, Guglielmi G, Pisani D, et al. Vertebral morphometry by dual-energy X-ray absorptiometry (DXA) for osteoporotic vertebral fractures assessment (VFA). Radiol Med, 2012;117(8):1374-85