Analysis of kyphosis, vertebral fracture and bone mineral density measurement in women living in nursing homes

Ayla C. Turk, MD, Fusun Sahın, MD, Ferıt K. Kucukler, MD, Hulya Devecı, MD.

ABSTRACT

الأهداف: تحليل العلاقة بين كسر العمود الفقري ، ودرجة حداب، و BMD في النساء اللواتي يعشن في دور رعاية المسنين.

الطريقة: أجريت هذه الدراسة المستعرضة في قسم الطب الطبيعي وإعادة التأهيل، مستشفى هيتت الجامعي، كوروم، تركيا ، خلال الفترة من يناير 2014م ويناير 2015م. من بين 126 مريضة شاركت في الدراسة، عاش 48 في دور رعاية المسنين (التمريض – مجموعة المنزل [NHG]) ، ولم يعيش 78 في دور رعاية المسنين (مجموعة التحكم [CG]). قيمنا كسور العمود الفقري من خلال طريقة Genant شبه الكمية. الحالات التي فيها زاوية كوب قياس 40 درجة أو أكثر شخصت بالحداب.

النتائج: كان متوسط عمر المشاركين في NHG 77.2 ± 7.6 سنة و 76.8±6.2 سنة في CG ($p<0.05$). تم العثور على معدل الحداب في NHG ليكون أعلى بنسبة 2.152.1% مقارنة مع 27.7% ل CG ($P>0.001$). في NHG ، بلغ المصابون بهشاشة العظام 68.7% ، كان 31.3 ٪ يعانون من نقص العظام. في CG ، كان 55.2% لديهم هشاشة العظام ، وكان 32% لديهم خمول ، 12.8% لديهم قيم طبيعية ($p>0.05$). كان معدل كسر العمود الفقري 37.5 ٪ في NHG و 24.3% في CG $p<0.05$. زاوية كوب لها ارتباط مع عدد الكسور في كلا المجموعتين ($p>0.05$).

الخاتمة: كانت معدلات ترقق العظام والحدب لدى النساء اللاتي يعشن في NHG أعلى من النساء اللواتي يعشن في CG. كما يرتبط حداب وعدد من الكسور، من المهم تحليل حداب في النساء المقيمات في NHG.

Objectives: To analyze the relationship between vertebral fracture, degree of kyphosis, and BMD in women living in nursing homes.

Methods: This cross-sectional study was carried out in the Department of Physical Medicine and Rehabilitation, Hitit University Hospital, Corum, Turkey, between January 2014 and January 2015. Of the 126 female patients who participated in the study, 48 lived in nursing homes (nursing-home-group [NHG]), 78 lived in non-nursing home settings (control-group [CG]). Vertebral fractures were evaluated via the semi-quantitative Genant method. Cases in which a Cobb angle measured 40 degrees or more resulted in a diagnosis of kyphosis.

Results: The mean age of participants in the NHG was 77.2±7.6 years and 76.8±6.2 years in the CG ($p>0.05$). The kyphosis rate in the NHG was found to be higher at 52.1% compared to 27.7% for the CG ($p<0.001$). In the NHG, 68.7% had osteoporosis, 31.3% had osteopenia; in the CG, 55.2% had osteoporosis, 32% had osteopenia, 12.8% had normal values ($p<0.05$).The vertebral fracture rate was 37.5% in the NHG and 24.3% in the CG ($p>0.05$). The Cobb angle had correlation with the number of fractures in both groups ($p<0.05$).

Conclusions: The osteoporosis and kyphosis rates of women living in NHG were higher than those of women living in CG. As kyphosis and the number of fractures are correlated, it is important to analyze kyphosis in women residing in NHG.

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From the Department of Physical Medicine and Rehabilitation (Turk), Faculty of Medicine, from the Department of Endocrinology (Kucukler), Hitit University, Corum; from the Department of Physical Medicine and Rehabilitation (Sahin), Faculty of Medicine, Pamukkale University, Denizli; from the Department of Physical Medicine and Rehabilitation (Deveci), Faculty of Medicine, Gaziosmanpasa University, Tokat, Turkey.

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Address correspondence and reprint request to: Dr. Ayla C. Turk, Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Hitit University, Corum, Turkey.
E-mail: drayla1976@hotmail.com
ORCID ID: orcid.org/0000-0002-0359-1710

Osteoporosis increases the susceptibility to fracture by causing a decrease in bone density and deterioration in bone microarchitecture.[1] Risk factors for osteoporotic fracture have been well-defined for women living in non-nursing home settings; however, studies analysing fractures sustained by nursing home residents have indicated that the fracture rates among these patients may be higher than those in women residing in the general community and that the risk factors for each group may differ.[2] Most nursing home residents have osteoporosis, a disease whose prevalence is, on average, 70% to 82%.[3] It has been reported that the osteoporotic fracture rate in the nursing home population is 3-11 times higher than that of age- and gender-matched residents in non-nursing home settings.[4] Nursing home residents are at a greater risk of suffering osteoporotic fractures if they are female; are elderly; have a low body weight; consume alcohol; have diabetes; suffer from vision loss, cognitive dysfunction or bowel and bladder incontinence; smoke; use psychotropic medication; have a maternal history of fractures; have low serum or vitamin D levels; or ambulate frequently.[2]

Bone mineral density (BMD) has been reported as a significant risk factor for fractures sustained by women residing in non-nursing home settings in all regions.[2,5] On the other hand, even though nursing home populations are associated with prevalence of low BMD, one recent study with a large sample found BMD to be a significant risk factor for osteoporotic fractures, especially in those who perform independent transfers.[6] Even though slight spinal curvature is a normal component of the spine structure, thoracic hyperkyphosis, which affects 20% to 40% of older adults,[7] can be observed among women as a result of aging or in certain health conditions, such as osteoporosis.[8,9] Recent evidence suggests that age-related hyperkyphosis is not equivalent to spinal osteoporosis.[10] However, postmenopausal women with kyphosis are found to have a lower bone mass and a higher fracture risk independent of bone mass.[8,11] One study that retrospectively screened 1,196 women for hyperkyphosis progression identified the following as risk factors for the condition: age, the existence of a vertebral fracture, a low BMD, degenerative intervertebral disc disease, family history, and a loss of body mass.[12] Therefore, hyperkyphosis, like dual-energy x-ray absorptiometry (DXA) and fracture-risk assessment tool (FRAX), is a potentially interesting parameter in the analysis of fracture risk.[11] However, no study to date has analyzed hyperkyphosis in the context of its relationship with BMD and vertebral facture in nursing home residents.

The aim of our study was to analyze the relationship between vertebral fracture, the degree of kyphosis, and BMD in women living in nursing homes.

Methods. This study was carried out in the Department of Physical Medicine and Rehabilitation of Hitit University Hospital, Corum, Turkey, between January 2014 and January 2015. An ethics committee approval for this study was obtained from the Ankara Numune Training and Research Hospital. The study was conducted in accordance with the principles of Helsinki Declaration, and all patients provided written informed consent prior to the study's initiation. One hundred twenty-six female patients over the age of 65 who were able to walk and carry out their daily activities and personal care were included in the study. Bedridden patients, patients with secondary osteoporosis, patients with congenital vertebral deformities (hemivertebra), patients with Scheuermann's disease or Schmorl's nodule, which may cause vertebral deformities, and patients who were using drugs that may cause secondary osteoporosis (namely, steroids and thiazides) were not included in the study. Flowchart was presented in **Figure 1**.

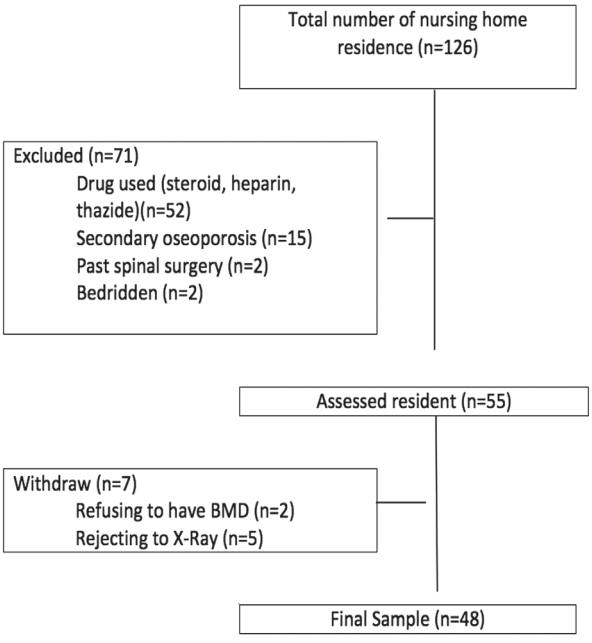

Figure 1 - Flowchart for the inclusion of the patients. BMD - bone mineral density

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The study protocol was approved by the local ethical committee. Informed consent forms were signed by all patients who volunteered to participate in the study.

The participating residents of 2 nursing homes in Çorum were visited by a single doctor, and data recorded from residents in nursing home were recorded on-site. The control group was selected from among the patients who had applied to the hospital for any reason and met the inclusion criteria. These patients lived in their homes or in the homes of relatives.

Examinations of all participants included the following: age (years), height (cm), weight (kg), smoking status (yes/no), daily tea consumption (0, 1, 2, or >2 glasses) and daily coffee consumption (0, 1, or ≥ 2 cups), weekly alcohol consumption (number of glasses per week) chronic diseases (namely, dementia, diabetes mellitus, hypertension, chronic obstructive pulmonary disease [COPD] and ischemic heart disease [yes/no]), fall history and the presence of a fragility fracture (yes/no; the fragility fracture is a result of mechanical forces referred to as low-level, low-energy trauma that normally would not result a fracture. According to the World Health Organization, a mechanical force refers to a standing position or a force that causes a fall from a lower height.[13] Evaluations of vertebral fractures were performed via the semi-quantitative Genant method.[14] The lateral thoracolumbar vertebral x-rays were analyzed by a radiologist that had no prior knowledge of the clinical conditions of the patients. In lateral spinal radiographies, the T4-L4 vertebrae were graded according to the reduction rate in their front, middle and/or back heights and the reduction that occurred in vertebral bodies. Accordingly, the following grades were made: Grade 0-normal; Grade I- mild deformation (a 20%-25% reduction of vertebral body on the anterior, middle and/or posterior side); Grade II-moderate deformation (a 25%-40% reduction of vertebral body); and Grade III-severe deformation (a 40% or greater reduction of vertebral body). This scoring system indicates the severity of the deformity but not the type of the deformity. This scoring system indicates the severity of the deformity but not the type of the deformity. The spinal deformity index (SDI) is an evaluation tool similar to Genant's semi-quantitative approach, which investigates the number and severity of vertebral fractures. The SDI was obtained by collecting vertebral fracture grades along the spine. Stage 0 indicates no fractures, and Stages 1 indicate mild, 2 moderate or 3 severe fractures.[15] A modified Cobb method was used to analyze the kyphosis angle. The Cobb angle was measured with lateral thoracolumbar vertebra radiography with the patient in a supine position. As T1-T3 vertebrae are not clearly visible because the shoulders and scapulae block them in lateral x-rays, the T4 and T12 vertebrae were designated as cut-off points. Six points that correspond to the mid-points of the end plateau of each of the T4-T12 vertebrae and the 4 corners of the vertebra corpus were marked, and perpendicular lines were drawn from the superior surface of the T4 vertebra and the inferior surface of the T12 vertebra with a computerized program and were recorded as the angle between intersection points. If T4 or T12 were not visible for any reason, a visible adjacent vertebra was used as an alternative (namely, if the T4 was not visible, T5 was used; if the T12 was not visible, the T11 was used). Intraclass correlation coefficient 0.99 was reported as the measurement type of the Cobb angle.[16] Cases in which the Cobb angle measured 40 degrees or higher resulted in a diagnosis of severe kyphosis.[10] Bone mineral densities were determined via the use of the DXA method (Hologic Explorer W, Bedford, Massachusetts). All measurements were performed by the same experienced operator. Relevant areas were defined in accordance with standard Hologic protocols. Bone mineral density was measured at the lumbar spine and right femur. Lumbar spine L1-L4, the femur neck and femur total values were measured. The BMD values of all areas were measured in terms of both absolute value (g/cm^2) and T-score. If the standard deviation of the lumbar or hip BMD values was -2.5 or below when compared to the young adult population, patients were diagnosed with osteoporosis; if the standard deviation of the values was between -1 and -2.5, patients were diagnosed with osteopenia.[17] Fracture risk was analyzed with a FRAX, a method which analyses the 10-year fracture probability of patients. The 10-year osteoporotic fracture probability was calculated by taking age, gender, BMI and fracture-risk factors into account. The risk factors taken into consideration in FRAX are osteoporotic fracture history, hip fracture in parents, smoking, use of more than 5 mg of corticosteroid daily for more than 3 months, rheumatoid arthritis, secondary osteoporosis and the consumption of more than three glasses of alcohol daily. The fracture risk analysis of the individual was calculated as a 10-year hip fracture or the risk of osteoporotic fracture risk. Major osteoporotic fracture is defined as spine, hip, forearm, and humerus fracture. Fracture-risk assessment tool helps clinicians to determine whether or not a patient needs OP treatment.[18]

Statistical analyses. All statistical analyses were performed via the Statistical Package for the Social Sciences Version 18.0 Package (SPSS Inc., Chicago, IL, USA). Descriptive statistics were presented as

arithmetic mean ± standard deviation. Results which did not follow normal distribution are expressed as median (range) values. For the tests of normality, we used the Kolmogorov-Smirnov test. In intergroup comparisons, the Student-T test, which is a parametric test, and analysis of variance supplemented with Bonferroni post-hoc test when a statistically significant difference between the subgroups was noted. The other tests were not normally distributed thus Mann-Whitney U test and Kruskall-Wallis test with post-hoc Dunn's test were used for comparisons among subgroups. Depending on normality of variables, Pearson's or Spearman's test was used for bivariate correlations. Differences were assessed by the Chi-squared test for categorical variables. A *p*-values of less than 0.05 were regarded as significant.

Results. Forty-eight participants (38.1%) lived in nursing home settings (NHG) and 78 participants (61.9%) lived in non-nursing home settings (CG). Of the participants, 38.1% were living in NHG and 61.9% were living in CG. The participants in the NHG had a mean age of 77.2 ± 7.6 years, and the participants in the CG had a mean age of 76.8 ± 6.2 years (p=0.73). The demographic data of the participants are presented in **Table 1**. Among these data, dementia was the only factor with a significantly higher rate in the NHG (p<0.001).

The comparison of clinical data between groups is shown in **Table 2**. The Cobb angle average was 41.1 ± 8.90 degrees in the NHG and 34.4 ± 6.70 degrees in the CG; the difference between them was highly significant (p<0.001). While kyphosis occurred at a rate of 52.1% (n=25) in the NHG, the kyphosis rate was 27.7% (n=22) in the CG. Even though there was no difference between groups in terms of the number of fractures, SDI, lumbar BMD scores and FRAX, femoral BMD values were found to be significantly lower in the NHG.

Vertebral fractures occurred at the rate of 37.5% (n=18) in the NHG and at the rate of 24.3% (n=19) in the CG (p>0.05). The overall fracture rates were 56.2% (n=27) in the NHG and 30.7% (n=24) in the CG (p>0.05). The vertebral fracture places were presented in **Table 3**.

Vertebral fractures most frequently occurred in T12 (33.3% in the NHG and 37.5% in the CG). While wedge-type fractures occurred most frequently in the

Table 1 - Demographics characteristics of the nursing home group and control group.

Demographics characteristics	Nursing home group (n=48)	Control group (n=78)	*P*-value
Age (years)	77.2 ± 7.6	76.8 ± 6.2	0.73
Height (cm)	152.1 ± 10.0	157.1 ± 8.3	0.001
Weight (kg)	62.2 ± 14.2	67.9 ± 12.5	0.019
BMI (kg/m2)	26.7 ± 4.7	27.1 ± 4.5	0.632
Smoking (yes/no)	1/47	2/76	0.875
Cups of tea per a day			0.019
0	4 (8.3)	0 (0)	
1	13 (27.1)	19 (24.4)	
2	18 (37.5)	23 (29.5)	
>2	13 (27.1)	36 (46.2)	
Cups of coffee per a day			0.112
0	44 (91.7)	66 (84.6)	
1	3 (6.3)	12 (15.4)	
Alcohol (per a week)	0	0	1.0
Dementia (yes/no)	15/33 (31.3)	5/73 (6.4)	<0.00
Diabetes mellitus (yes/no)	11/37 (22.9)	12/56 (28.2)	0.512
Hypertension (yes/no)	22/26 (45.8)	48/30 (61.5)	0.085
COPD (yes/no)	2/46 (4.2)	4/74 (5.1)	0.806
IHD (yes/no)	5/43 (10.4)	9/69 (11.5)	0.845
Fragile fracture history (yes/no)	3/45 (6.3)	14/64 (17.9)	0.062
Previous fall history (yes/no)	13/35 (27.1)	30/48 (38.5)	0.191

BMI - body mass index, COPD - Chronic obstructive pulmonary disease, IHD - Ischemic heart disease

Table 2 - Comparisons of clinical assessments between groups.

Clinical assessments	Nursing home group (n=48)	Control group (n=78)	*P*-value
Number of fracture (mean±SD)	0.56 ± 0.89	0.30 ± 0.60	0.091
Median (min.-max.)	0 (0-4)	0 (0-3)	
SDI (mean±SD)	0.89 ± 1.56	0.55 ± 1.23	0.142
Median (min.-max.)	0 (0-8)	0 (0-6)	
Cobb angle (mean±SD)	41.1 ± 8.90	34.4 ± 6.70	<0.001
L1-L4 Total T-score (mean±SD)	-2.7 ± 1.4	-2.3 ± 1.3	0.173
Femur neck T-score (mean±SD)	-2.3 ± 1.0	-1.6 ± 1.1	0.001
Femur total T-score (mean±SD)	-2.0 ± 1.1	-1.7 ± 1.4	0.242
FRAX major (mean±SD)	12.6 ± 8.7	12.4 ± 7.1	0.891
FRAX hip (mean±SD)	5.36 ± 5.75	5.25 ± 4.10	0.841

SDI - Spinal deformity index, FRAX - fracture-risk assessment tool

Table 3 - Locations of fractured vertebrae at NHG and CG.

NHG group	CG group
T 7: 2	T 8: 2
T 8: 4	T9: 2
T9: 1	T 10: 2
T 10: 2	T 11: 2
T 11: 4	T 12: 9
T 12: 8	L 1: 2
L 1: 1	L 2: 2
L 2: 1	L 3: 1
L 3: 2	

Table 4 - Correlation between number of fracture and clinical data at nursing home settings (NHG) and non-nursing home settings (CG) groups.

Variables	NHG group		CG group	
	r	*P* value	r	*P* value
Age	0.205	0.162	0.418	<0.001
Cobb angle	0.289	0.046	0.519	<0.001
SDI	0.939	<0.001	0.928	<0.001
Femur neck T-score	-0.299	0.043	0.454	<0.001
FRAX major	0.349	0.015	0.382	0.001
FRAX hip	0.398	0.005	0.337	0.003

SDI - Spinal deformity index, FRAX - fracture-risk assessment tool

Table 5 - Correlation between Cobb angle and clinical variable.

Variables	NHG (n=48) Cobb angle		Control group (n=78) Cobb angle	
	r	*P* value	r	*P* value
Age	0.191	0.194	0.315	0.005
BMI	-0.153	0.298	-0.045	0.697
Number of fracture	0.289	0.046	0.519	<0.001
SDI	0.300	0.038	0.458	<0.001
L1-4 total T-score	-0.168	0.255	-0.173	0.130
Femur neck T-score	-0.139	0.347	-0.100	0.384
Femur total T-score	-0.135	0.360	-0.221	0.051

NHG - nursing home settings, SDI - Spinal deformity index, BMI - body mass index

NHG (62.9%), 50% wedge- and 50% biconcave-type fractures were observed in the CG. The fracture type had no effect on kyphosis (p>0.05).

The vertebral fracture rate in patients with kyphosis was 44% (n=11) in the NHG and 30% in the CG (p>0.05). However, an examination of the relationship between the number of fractures and clinical evaluations revealed that age, BMI, SDI, femur neck T-score, FRAX major and FRAX hip in both groups were correlated with the number of fractures (**Table 4**). The interesting finding in this correlation was that while a moderate correlation (r=0.519) between the number of fractures and the Cobb angle was observed in the CG, the r value indicated a weak correlation (r=0.289) in the NHG.

When the 2 groups were compared according to BMD values, the femoral neck T-score was significantly lower in the NHG; 68.7% of the patients in this group were diagnosed with osteoporosis and 31.3% with osteopenia, while 55.2% of the CG participants were diagnosed with osteoporosis, 32% were diagnosed with osteopenia and 12.8% had normal values. The osteoporotic patient rate was significantly higher in the NHG (p<0.05).

When the correlation of the Cobb angle with clinical variables was examined, it was found that the angle in both groups had a significantly weak positive correlation with the number of fractures and SDI (**Table 5**). Moreover, the Cobb angle in the CG had a significant positive correlation with age, but no such link was found in the NHG. The interesting finding in this analysis was the fact that correlation coefficients exhibited a weak correlation in the NHG but a moderate correlation in the CG (r values for the number of fractures and SDI were, respectively, 0.289 and 0.300 in the NHG and 0.519 and 0.458 in the CG). Analyses of all patient results revealed no significant difference (p=0.143) between the average Cobb angle of 20 patients with dementia (39.4 ± 6.5) and the average Cobb angle of 106 patients without dementia (36.5 ± 8.5). A significant difference (p=0.003) was found between the average Cobb angle of 15 patients with dementia in the NHG (42.0 ± 5.2) and the average Cobb angle of 5 patients with dementia in the CG (31.9 ± 3.5). No significant difference (p=0.554) was found between the average Cobb angle of 5 patients with dementia (31.9 ± 3.5) and the average Cobb angle of 73 patients without dementia (34.5 ± 6.8) in the CG.

Discussion. This study indicated that the kyphosis and vertebral fracture rates, as well as the prevalence of osteoporosis, were higher among people living in nursing homes than among those residing in non-nursing home settings. Our findings also showed that dementia was a risk factor for vertebral facture and that the kyphosis angle was significantly wider in patients with dementia who lived in nursing homes.

The osteoporosis rate among women aged 76-86 years who live in non-nursing home settings has been reported as 18.4%.[19] While previous studies have identified the osteopenia rate as 43-50% and osteoporosis as 30% among older white women residing in non-nursing home settings.[20] A study conducted by Zimmerman et al[21] found that 79% of those living in nursing homes had osteoporosis. Moreover, the BMD values of women over 65 and who were living in nursing homes were found to be 15% lower than those who resided in non-nursing home settings. The osteoporosis rate among nursing home residents varies by country: the rate was reported as 47.3% in a study conducted in Taiwan,[22] and studies conducted in Western societies have reported rates as high as 55-85.8%.[4,21] In our study, osteoporosis was observed in 68.7% of the NHG

participants and in 55.2% of the CG participants. While all participants in the NHG were diagnosed with osteopenia/osteoporosis, 12% of those in the CG had normal BMD values. Lumbar and femoral bone densities were found to be significantly lower among women in the NHGs than women in the CGs.

In a study conducted with 151 nursing home residents, Rodondi et al[4] found rates of 52% osteoporosis and 36% vertebral fracture; most fractures were reported to have occurred on the L1 and T12 vertebrae. In a controlled study by Küçükler et al,[23] conducted with men living in a nursing home, the vertebral fracture rate was found to be 42% in the nursing home group and 17% in the control group. In our study, the vertebral fracture rate was 37.5% in the NHG and 24.3% in the CG. In both our groups, the number of fractures was correlated with femoral and lumbar BMD.

In our study, the number of vertebral fractures was found to be correlated with lumbar and femoral BMD in both the NHG and the CG. In an analysis carried out by Aspray et al[24] on nursing home residents with calcaneal BMD, a high fracture incidence was found to be correlated with low bone density; however, Küçükler et al[23] reported that BMD values in 75% of the patients with vertebral fracture were not osteoporotic. In predicting fracture, BMD, previous or family fracture history and many other parameters, as well as FRAX, which combines all these factors, are frequently used.[2] However, it is reported that the use of BMD or FRAX alone in predicting fracture risk in elderly populations has some limitations and that fracture-risk evaluations dependent only on BMD may give exaggerated or deficient results in terms of real fracture risk, based on the existence or absence of fractures.[26,27] According to the results of our study, the femoral neck BMD values were significantly lower in the NHG, and no differences were found between the 2 groups in terms of FRAX major and FRAX hip fracture scores.

The fact that the fracture incidence rate increases with age is well known; however, the effect of age on the fracture rate among nursing home residents is not clear.[27] In addition to studies that have established the effects of age on fracture risk,[2,27,28] there are studies that claim it has no effect.[29,30] In our study, the number of vertebral fractures was demonstrated to be positively correlated with age in both groups. Comorbid conditions, such as hemiplegia and dementia in individuals of an advanced age, and the degree of independence in daily life activities, as well as height, weight, and BMI, are reported to be factors associated with falls and fractures.[2,27,28] In our study, examinations of the systemic diseases frequently seen among the elderly population revealed that dementia was more frequent and that the kyphosis angle was wider in nursing home patients with dementia than in individuals with dementia who reside in non-nursing home settings.

There is a positive correlation between the degree of kyphosis and age among older individuals living in the general community.[8] Our study also showed that in the CG, the kyphosis angle increased to an extent that was commensurate with an increase in age; this relationship was not observed in the NHG. The fact that functional abilities among the elderly population deteriorate as kyphosis increases and even leads to early mortality has been demonstrated.[10,11,31] The kyphosis angle is also related to the fall risk[10,31] and increases the fracture risk by 1.7-fold.[32] A 22% increase in the annual vertebral fracture rate was reported for every 10° increase in the kyphosis angle.[33] In a study conducted by Kado et al[11] on older women residing in the general community, both short-term and long-term fracture risks were found to be associated with 2 parameters: hyperkyphosis and BMD.[11] Accordingly, numerous studies have been conducted on the relationships between kyphotic posture, vertebral fracture and osteoporosis in the elderly population, and contradictory results have been found.[7,8,31,33,34] The fact that the degree of kyphosis is negatively correlated with lumbar and femoral BMD has been demonstrated in numerous studies.[8,10,11] Pavlovic et al[8] determined that a negative correlation exists between thoracic and lumbar spinal curvature and both femoral and lumbar BMD. When the women in this study were evaluated based on their spinal curvatures, the participants with the highest curvatures had a significantly lower lumbar spine BMD than the other groups.[8] In a study which compared 51 osteoporotic patients with at least one vertebral fracture to 47 osteoporotic controls, the degree of thoracic kyphosis was found to be significantly higher in osteoporotic patients (an average 63 degrees) than in non-osteoporotic patients (an average 52 degrees).[35] In a study by Granito et al,[9] the thoracic kyphosis grade showed a negative correlation with bone mineral density, indicating that bone mass may contribute to increasing thoracic kyphosis.[9] Sinaki et al[36] reported that no significant relationship was found between lumbar BMD and spinal curvature among women aged 48-65 years. In our study, the kyphosis angle of the NHG was higher, and the femur neck T-score was significantly lower than those in the CG. However, the kyphosis angle was not correlated with BMD scores in either group.

Studies on the relationship between kyphosis and vertebral fractures have revealed that only 20-37% of the patients with hyperkyphosis are diagnosed with

vertebral fractures and that the degree of kyphosis is related to anterior wedge fractures on the thoracic spine.[37] Although hyperkyphosis increases the risk of spinal fracture by increasing the spinal load during daily bending activities, this can only be demonstrated through biomechanical analysis. Increased kyphosis has a stronger correlation with the number of thoracic vertebral fractures than with the number of lumbar vertebral fractures. The severity of vertebral wedging increases as BMD decreases, which can result in an increased number of vertebral compression fractures and excessive thoracic kyphosis.[10] However, some studies have reported that there is no significant relationship between the existence, place and number of vertebral fracture and kyphosis.[7,34] According to the results of our study, the number of vertebral fractures was related to the kyphosis degree, both among participants in the CG and in the NHG. This relationship, however, was stronger in the CG. Roux et al[38] found that the number of vertebral fractures increases with increased kyphosis. However, there is a group in which no vertebral fractures occur when there is higher kyphosis. The reason for this is the wedging of the vertebra due to pressure on the anterior of the vertebral body.

One of the limitations of our study was the fact that the daily life activities, as well as the functional and psychological status of our participants, were not evaluated. The addition of these evaluations may help us to understand how the significant data we identified among the older female population residing in nursing homes is reflected in their everyday lives. Moreover, in the detection of vertebral fractures, BMD and kyphosis progression as well as the establishment of a link with the women's functional statuses and activities of daily life will also provide important information for following up with the elderly women residing in nursing homes.

We believe that further prospective studies are required to identify features specific to both male and female populations in nursing homes, to establish their differences with those of similar age and gender who live in the general community and to determine risk factors in terms of spinal deformities, vertebral and other fractures, BMD and falls.

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