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Prevalence of osteoporosis increased in postmenopausal women with postural scoliosis

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ABSTRACT

BACKGROUND
Menopause is an aging process of the female reproductive system characterized by reduced estrogen levels. This results in increased osteoclastic activity, causing increased bone resorption and thus reduced bone mineral density (BMD). In addition to being influenced by osteoclastic activity, BMD of the lumbar vertebrae is also affected by the erector spinae muscle. The purpose of this study was to determine an association between postural scoliosis and erector spinae muscle endurance and its relation to BMD in postmenopausal women.

METHODS
This was a cross-sectional study conducted on postmenopausal women, who were selected by simple random sampling among residents of Mampang Prapatan subdistrict. The postural abnormality of scoliosis was determined by physical examnation, while erector spinae muscle endurance time was assessed using a modified Biering-Sorensen technique, and BMD was measured by bone mineral densitometry, to categorize into normal, osteopenia, and osteoporosis.

RESULTS
A total of 213 postmenopausal women with mean age of 53.52 ± 3.64 years participated in the study. The prevalence of scoliosis was 54.0%, and osteoporosis was 38.1%. The prevalence of osteoporosis was higher in women with scoliosis (48.7%) in comparison with those without scoliosis (31.6%) (p=0.411). In postmenopausal women with strong erector spinae muscle endurance the risk of of scoliosis was lower (0.76;95% Confidence Interval = 0.58 - 0.99)

CONCLUSIONS
In post menopausal women with postural scoliosis found a higher incidence of osteoporosis. High endurance of erector spinae muscle lowers the risk of scoliosis. Exercise to improve posture and increase endurance of erector spinae muscle need to be done to prevent decline of BMD.

Key words: Scoliosis, erector spinae muscle, endurance, postmenopausal women

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Prevalensi osteoporosis meningkat pada perempuan pascamenopause dengan skoliosis postural

ABSTRAK

LATAR BELAKANG

Menopause adalah proses penuaan sistem reproduksi perempuan, yang ditandai dengan terjadinya penurunan hormon esterogen. Penurunan hormon esterogen akan menstimulasi peningkatan aktivitas osteoklas, yang akan menyebabkan terjadinya peningkatan aktivitas resorbsi tulang, sehingga terjadi penurunan densitas masa tulang. Densitas masa tulang vertebra lumbal selain dipengaruhi oleh aktivitas osteoklas, juga dipengaruhi oleh tekanan tonus otot yang bekerja di sekitar vertebra. Kelemahan otot erektor spina juga diperkirakan menyebabkan skoliosis postural. Penelitian ini bertujuan untuk menentukan adanya hubungan antara skolisis dan ketahanan otot erektor spina serta kaitannya dengan densitas masa tulang pada perempuan pascamenopause.

METODE

Rancangan penelitian jenis potong lintang digunakan pada subjek perempuan pasca menopause, yang dipilih secara random sederhana pada Kecamatan Mampang Prapatan Jakarta Selatan. Abnormalitas postur berupa skoliosis ditentukan berdasarkan pemeriksaan fisik, ketahanan otot erektor spina ditentukan dengan modifikasi metode Biering-Sorensen. *Densitas masa tulang ditentukan dengan* bone mineral densitometry *(BMD), dengan menilai skor T kemudian dibuat kategori densitas tulang normal, osteopenia, dan osteoporosis.*

HASIL

Sebanyak 213 perempuan pasca menopause dengan rata-rata usia 53,52 ± 3,64 tahun ikut serta pada penelitian. Prevalensi osteoporosis (48.7%) lebih tinggi pada pada perempuan pascamenopause yang mengalami skoliosis postural dibandingkan yang tidak mengalami skoliosis (31,6%) (p=0,411). Pada perempuan pascamenopause yang memiliki ketahanan otot erektor spina yang kuat risiko terjadinya skolisis lebih kecil sebesar 0,76 (95% Interval keperayaan 0,58- 0,99).

KESIMPULAN

Pada perempuan pascamenopause yang mengalami skoliosis postural dijumpai kejadian osteoporosis yang lebih tinggi. Ketahanan erektor spina yang kuat menurunkan risiko terjadinya skoliosis pada perempuan pascamenopause. Perlu dilakukan pelatihan perbaikan postur dan peningkatan ketahanan otot erektor spina untuk mencegah terjadinya penurunan densitas masa tulang.

***Kata kunci**: Skoliosis, ketahanan, otot erektor spina, perempuan pasca menopause*

INTRODUCTION

Menopause is an irreversible aging process of the female reproductive system, leading to cessation of menstruation. Per definition menopause starts 12 months after the last menstruational period. At this point in time no Graaffian follicles are to be found in the ovaries, thus reducing the sinthesis of estrogens. The reduction in estrogen concentrations gives rise to numerous symptoms, including signs of vasomotor instability such as tachycardia and

facial hot flushes, urogenital abnormalities such as vaginal dryness and dyspareunia, and disturbances of bone metabolism.[1-3]

As a result of repeated microtraumas, bony tissues are constantly undergoing dynamic remodeling, in which bone formation is followed by resorption. The cells playing a role in the process of bone remodeling are the osteoblasts, which give rise to the formation of osteoid cells, and the osteoclasts, which function in bone resorption. Bone consists of two types of tissue, i.e. trabecular or cancellous bone and compact or cortical bone. Trabecular bone undergoes an annual rate of bone formation and resorpstion of approximately 25%, wheras cortical has an annual turnover rate of only 3%.[4-6]

In menopause there is a decrease in gonadal functioning, leading to increased activity of osteoclastic progenitor cells. The reduction in estrogen synthesis initiates excessive bone resorption, followed by inadequate bone formation. All osteoblasts, osteocytes, and osteoclasts possess estrogen receptors. Estrogens influence bone cells indirectly through cytokines growth factors. High estrogen levels increase apoptosis of osteoclasts through production of transforming growth factor (TGF-â). In conditions of estrogen deficiency, T cells increase the recruitment, differensiation, and survival of osteoclasts through interleukin-1 (IL-1), IL-6, and tumor necrosis factor alpha (TNF-á). One study on ovariectomized mice found significantly higher levels of IL-6 and higher numbers of macrophages and granulocytes. These findings demonstrate that estrogens play a role in inhibiting the secreetion of IL-6, and that IL-6 plays a role in recruitment of osteoclasts via monocytes.[2,5,6] The excessive activity of osteoclasts leads to imbalance of the bone formation and resorption processes, with a higher resorption rate relative to the rate of bone formation, thus resulting in a reduction of bone mass. In a cross-sectional study on 203 postmenopausal women aged 47-60 years a prevalence of osteoporosis of 30% was found, while according to the National Osteopororosis Foundation 55% of postmenopausal women aged 50 years or older have osteoporosis.[7,8]

In the bone remodeling process, contraction of muscles is also believed to play a role, where stresses and strains on the bones stimulate bone remodeling. Decreased muscular activity or contraction may presumably decrease bone formation and is thought to play a role in reducing bone mass. The muscles responsible for maintaining vertebral alignment are the erector spinae. Adequate functioning of the erector spinae is thought to be capable of preventing postural abnormalities and reduction in vertebral bone mass. One of the most frequent postural abnormality occurring as a result of faulty alignment is postural scoliosis. Another postural abnormality frequently found in patients with osteoporosis is kyphosis. The postural abnormalities in postmenopausal women with osteoporosis are caused by thinning of the vertebral bodies and/or weakness of erector spinae muscles.[9,10]

Erector spinae muscles are type I muscles, which are adapted for long-term low-intensity activities and serve to support the spinal column in a given posture, to control spinal motion, and to particularly protect the spinal column in truncal flexion. These supporting, control, and protective functions may be disturbed when the erector spinae muscles are fatigued.[11,12]

The degenerative processes in postmenopausal women commonly lead to a decreased work capacity or endurance of the muscles, including the erector spinae. The decreased erector spinae endurance could be explained as a result of prolonged low back pain.[12] In women with osteoporosis, tasks that challenge balance may cause associated co-contraction of trunk muscles,[13] thus considerably increasing spinal loading. In this connection, vertebral fractures in individuals with fragile bone may lead to further fractures, as a result of aforementioned spinal loading.

In other studies, scoliosis was assessed by measuring Cobb's angle on X-ray radiographs

and endurance of truncal muscles by electromyopgraphy. [14,15] In view of these facts, this study was conducted with the purpose to determine an association between scoliosis and bone mineral density in postmenopausal women and its relation to erector spinae muscle endurance.

METHODS

Study design

This study used a cross-sectional design and was conducted from December 2009 to March 2010 at Mampang Prapatan subdistrict in South Jakarta.

Study subjects

A total of 213 postmenopausal women who had menopause for 5 years were recruited for participation in this study. The inclusion criterion was acutely or chronically ill postmenopausal women. The subjects were selected by simple random sampling from among residents of the catchment area of the Mampang Prapatan subdistrict Health Center in South Jakarta.

Data collection

Data collection was done by physiotherapists who had been trained previously by the investigators. The subjects were interviewed using a questionnaire containing items on age, education, occupation, number of past pregnancies, and duration of menopause.

Physical examination

Physical examination was performed to determine body weight, height, presence of postural scoliosis, and erector spinae endurance. The presence of scoliosis was determined by a simple physical examination, in which the minimally clothed subjects standing in a relaxed posture were inspected for symmetry of shoulders and hips. Vertebral alignment was determined by comparison with a plumb line made from a cord with a suspended weight. The subjects were initially palpated to find the spinal process of the seventh cervical vertebra. Subsequently the plumb line was suspended without touching the subjects, and the alignment of the vertebrae was compared against the plumb line, to find any lateral deviation of the spine.[16] The procedure for determination of postural scoliosis is shown in Figure 1.

Modified Biering-Sorensen test for erector spinae endurance

The strength of the erector spinae muscles was assessed by placing the subjects in a position of horizontal truncal extension on a special examination table and is illustrated in Figure 2. The Biering-Sorensen test has a demonstrated validity and reliability for determining erector spinae endurance.[17]

Figure 1. Postural scoliosis examination

Figure 2. Horizontal truncal extension test

Based on the results of a preliminary study using our modified Biering-Sorensen test, normal muscle endurance time for postmenopausal women was set at 30 seconds for the present study.[12]

Measurement of bone mineral density

Measurements of bone mineral density (BMD) were expressed as T scores of the lumbar spine. The BMD was determined at Budi Jaya Hospital, Jakarta, using the Lunar DPX Bravo Nomusa densitometer (GE Medical Systems), which is a dual-energy x-ray (DXA) absorptiometer. BMD was measured for the carpal bones, lumbar vertebrae, and femoral head. The T score criteria for determining bone mineral density used the follwing WHO standards: normal BMD if the T score is $\geq$ -1, osteopenia if the T score is < -1 and > -2.5, and osteoporosis if the T score is $\leq$ -2.5.[18]

Ethical clearance

This study was obtained approval and ethical clearance from the Research Ethical Committee, Faculty of Medicine, Trisakti University. All participating subjects agreed to a written and signed informed consent.

Statistical analysis

Chi-square test was used to compare the BMD between normal subjects and those with postural scoliosis. The relationship between postural scoliosis and erector spinae endurance was determined from calculation of the prevalence ratio. The alpha level was set at 0.05 for all statistics.

RESULTS

Mean age of the subjects was 53.51 ± 3.62 years, the majority (50.7%) of them had finished primary school, and most of them (66.6%) were unemployed. Mean body mass index (BMI) was 26.21 ± 5.53, indicating overweight nutritional status. (Table 1)

Table 1. Distribution of subject characterisitics, posture, erector spinae endurance, and vertebral bone mineral density (n=213)

Characteristic	n (%)
Age (years)*	53.51 ± 3.62
Educational level	21 (9.8)
No formal education	20 (9.3)
Primary school (not finished)	109 (50.7)
Primary school	40 (18.6)
Junior high school	19 (8.8)
Senior high school	4 (1.8)
University/college	21 (9.8)
Employment	
Entrepreneur	19 (8.9)
Government official	2 (0.01)
Trader	49 (23.0)
Unemployed	143 (66.6)
Postural abnormalities	
Normal	98 (46.0)
Postural scoliosis	115 (54.0)
Erector spinae endurance	
More than or equal to 30 seconds	90 (42.3)
Less than 30 seconds	123 (57.7)
Duration of menopause (years)*	4.00 ± 2.20
Body weight (kg)*	59.14 ± 11.33
Height (cm)*	148.86 ± 5.21
Body mass index(kg/m^2)*	26.21 ± 5.53
Bone mineral density	
T score*	-1.61 ± 1.05
Classification#	
Normal	26 (12.2)
Osteopenia	100 (46.9)
Osteoporosis	87 (40.9)

*Mean ± SD; #Classification: Normal: T score >-1; Osteopenia T score $\geq$-2.5 - $\leq$-1; Osteoporosis T score <-2.5

Table 2. Bone mineral density category by postural scoliosis postural (n=213)

Postural scoliosis	Bone mineral density category			p
	Normal (n,%)	Osteopenia (n,%)	Osteoporosis (n,%)	
Yes	12 (10.4)	47 (40.9)	56 (48.7)	0.0411
No	14 (14.3)	53 (54.1)	31 (31.6)	

Most of the subjects (54.0%) had postural scoliosis, while 57.7% was unable to perform horzontal contraction of the erector sipnae muscles for 30 seconds. The majority of BMD scores of the subjects (46.9% of all subjects) was in the osteopenia category.

In subjects with postural scoliosis, the proportion of osteoporosis (48.7%) was significantly higher than that of subjects without postural scoliosis (31.6%) (p=0.041) (Table 2). The data on the relationship between erector spinae endurance and postural scoliosis is shown in Table 3.

There was a significant association between erector spinae muscle endurance and postural scolisosis. In subjects with high erector spinae muscle endurance (≥ 30 seconds), the risk of postural scoliosis was 0.76 (95% Confidence Interval 0.58 – 0.99) (p=0.0351) which was lower than that in subjects with poor erector spinae muscle endurance (Table 3).

DISCUSSION

Our study shows that the majority of postmenopausal women have postural scoliosis, which is similar to the results of a previous study conducted by Birkes et al., who found an increased scoliosis prevalence in individuals older than 60 years. Our results are also similar to those of Schwab et al., showing a mean Cobb's angle of 17º at age 70.5 years.[14,19]

Differing results were found in a study involving 380 postmenopausal women aged 50 years and older, where the prevalence of lumbar scoliosis was 12.9%.[20] This difference between this study and ours was due to the differing methods used for the assessment of scoliosis. In the study by Urrutia,[20] the presence or absence of scoliosis was based on lumbar curvature magnitude in the coronal plane, as measured in DXA images with Cobb's method. A lumbar curvature of 10° or above was taken as indicating the presence of scoliosis.

In our study the prevalence of osteoporosis was higher in postmenopausal women with scoliosis, as compared to subjects without postural scoliosis. The results of a retrospective study of radiographs of 454 consecutive adult patients were consistent with our results, as they showed that scoliosis was common among the osteoporotic subjects and that lumbar scoliosis is a useful clinical marker for osteoporosis.[21] The study conducted by Cheng et al. showed a lower BMD in subjects with idiopathic scoliosis.[15]

The amount of bone in the vertebral bodies is directly related to their load-bearing strength. In osteoporosis, the reduction in bone mass of the vertebral bodies may result in their failure

Table 3. Relationship between between erector spinae endurance and postural scoliosis (n=231)

Erector spinae endurance	Postural scoliosis		PR* (95% C.I.)	p
	Yes	No		
≥ 30 seconds	41	49	0.76 (0.58- 0.99)	0,0351*
< 30 seconds	74	49		

*PR : prevalence ratio

under the load of the body, as they are essential for supporting the weight of the body.[22] Epidemiological studies indicate that adults with osteoporosis or osteomalacia have a six-fold higher risk of scoliosis, which is associated with significant morbidity, including low back pain and radicular symptoms.[23]

Our study shows that there is a lower risk of postural scoliosis in subjects with high erector spinae muscle endurance in comparison with subjects low erector spinae muscle endurance. These results support those of a previous study conducted by Kawahara et al. in patients with osteoid osteoma and scoliosis, indicating that the occurrence of scoliosis was associated with weakness of the erector spinae muscle endurance.[24] Another study on patients with progressive idiopathic scoliosis, who underwent electromyography (EMG) examination, also found a higher degree of paravertebral muscle imbalance in these patients.[25]

This study demonstrated that subjects with postural scoliosis have lower bone mineral densities and that the occurrence of postural scoliosis is influenced by weakness of the erector spinae muscles. Erector spinae muscles of adequate strength exert strains and stresses on the spinal column, thus stimulating balanced bone remodeling and playing a role in maintaining aligment of the spinal column and preventing postural scoliosis. A limitation of this study was the absence of an analysis of the relation between type of activity and sports habits of the subjcts and erector spinae endurance.

CONCLUSIONS

Postmenopausal women with postural scoliosis have a significantly increased prevalence of osteoporosis. High erector spinae muscle endurance reduces the risk of postural scoliosis postural. To reduce the risk of osteoporosis in postmenopausal women with scoliosis, it is recommended that postmenopausal women perform exercises for improving their posture and erector spinae muscle endurance.

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