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High erector spinae endurance reduced low back pain in postmenopausal women

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ABSTRACT

Low back pain (LBP) is the most frequent health problem in all age groups, including postmenopausal women, who are at risk of disability, due to degenerative processes affecting all organ systems, including the erector spinae muscles. In addition, postmenopausal women also experience a decrease in esterogen levels, which stimulates osteoclastic activity and initiates a reduction in bone mineral density (BMD). The aims of the present study were to determine the relationship between LBP prevalence and erector spinae endurance, BMD reduction, and body mass index (BMI) respectively. This was a cross-sectional study, conducted on 213 postmenopausal women, selected by simple random sampling. Assessment of pain, expressed on a visual analog scale (VAS), was performed by interviews and measurement of erector spinae muscle endurance time using a modified Biering-Sorensen technique, while BMD was assessed by bone densitometry. The results of the study showed that the postmenopausal women had a mean age of 53.5 ± 3.6 years. The prevalence of LBP and osteoporosis in the postmenopausal women was 58.2% and 21.6%, respectively. A significant positive linear correlation was found between BMI and VAS (r=0.165; p=0.016). In addition, the t-test demonstrated a significant difference in mean VAS scores between good and poor erector spinae endurance (p=0.008). However, the chi-square test showed no significant relationship between reduced BMD and LBP (p>0.05). It is recommended that low back pain in postmenopausal women be managed by strengthening exercises of the erector spinae.

Key words: Low back pain, erector spinae, bone mineral density, postmenopause

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INTRODUCTION

Back pain, particularly low back pain (LBP), is the most common complaint in all age groups, including postmenopausal women. Inappropriately managed, LBP may become chronic and carries the risk of disability.[1] Failure of management of LBP may increase economic loss, both direct costs for treatment and indirect costs due to decreased work productivity and early retirement.[2] The lower back region is the area of the vertebral column

from below the twelfth ribs down to the inferior gluteal folds. Anatomically, the lower back region is composed of the lumbar vertebrae, which are held in their vertical position by the action of the enveloping muscles.[3,4] In general, the prevalence of LBP is 23.7% in postmenopausal women,[5] 42.1% in workers[6] and 62.3%[7] in young adults.

Muscular activity is required for stabilizing the vertebral column when supporting heavy loads, and is directed upwards, opposing gravity. According to electromyographic (EMG) studies conducted by Noorbaksh,[8] there is postural muscular activity in each body segment in the standing position, to maintain the erect posture. In the relaxed standing posture, muscular activity is minimal in the sacrospinal region or the abdomen, but varies according to the position of the vertebral column relative to the line of gravitation. A change in the position of the center of gravity results in increased activity in the dorsal region, in comparison with the abdominal region.[9] The muscles that maintain the position of the lumbar vertebrae in the erect position are the erector spinae muscles. The erector spinae are type 1 muscles, which are designed for sustained low-level activity. They comprise the spinal, iliocostal, and longissimus muscles, which have the main function of thoraco-lumbar extension (Figure 1).[10] Electromyographic studies have shown that the erector spinae are more rapidly fatigued in patients with LBP than in healthy subjects. The study by Hides found that the multifidus muscle in subjects with LBP have a 31% smaller diameter than in healthy subjects.[11]

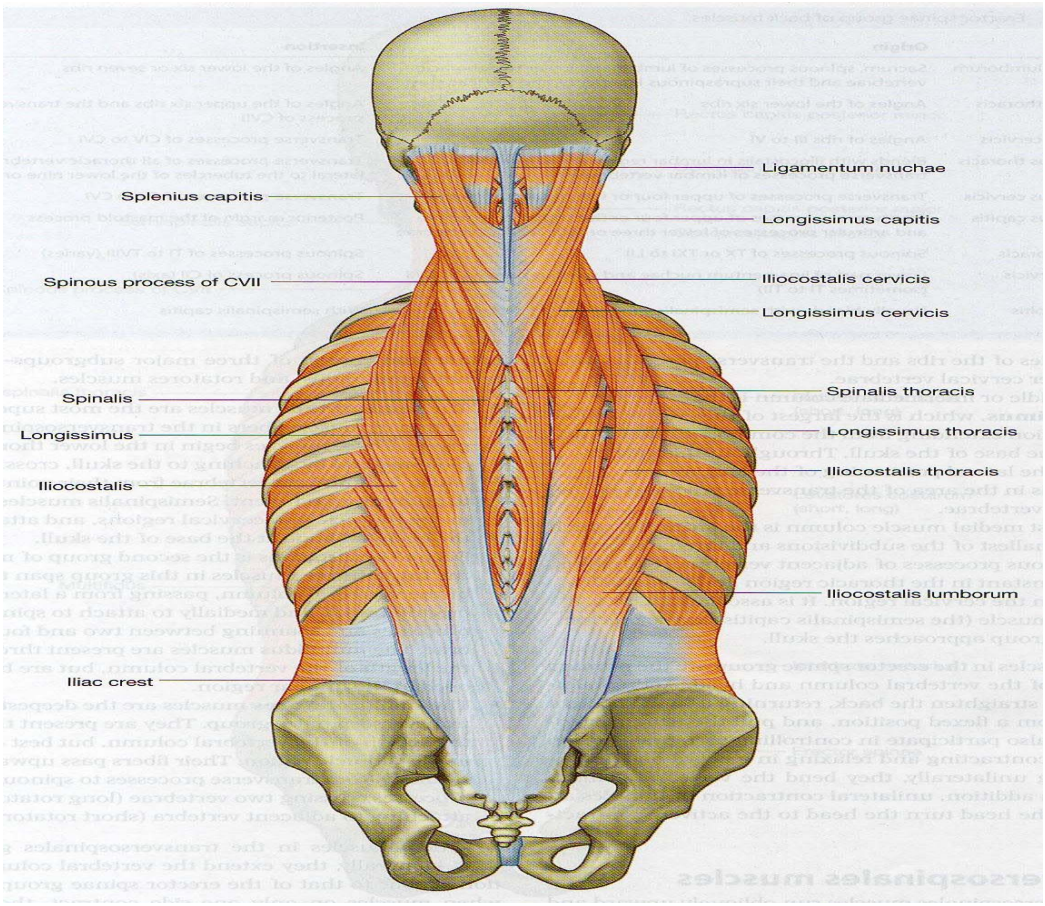

Figure 1. Mm. extensor spinae.[10]

The function of the erector spinae muscles is to support the vertebral column, control its movements, and protect it, particularly in truncal flexion. Protection of the vertebral column may be disturbed if the erector spinae are in fatigued condition, as found in patients with nonspecific LBP. Biering-Sorensen emphasized that the time during which an individual can maintain horizontal thoracolumbar extension without support is a predictor of back pain.[12] A deficiency in isometric lower back muscle endurance is supposed to be a major risk for non-specific LBP.[13] These studies also found decreased proprioceptive input to the erector spinae, causing the patient to be unable to maintain the erect position, leading to decreased overall physical activity, and ultimately to lowered productivity. Several previous studies have demonstrated that management of back pain by thoracolumbar motor control exercises resulted in significant relief of pain, compared with other methods, such as manual therapy and surgical methods.[14]

In postmenopausal women, the organ systems start to experience a decrease in functioning, such as decreased estrogen synthesis, which causes a reduction in bone mineral density (BMD) by activation of osteoclasts, leading to a more rapid bone resorption, in comparison with bone mineralization.[15] BMD is assessed by means of standard bone densitometry and expressed as T-score, according to the following criteria: T score values of $\geq$-1 indicate normal BMD, T scores of <-1 or >-2.5 signify osteopenia (start of osteoporosis), and T scores of $\leq$-2.5 indicate osteoporosis.[16,17] In postmenopausal women, the degenerative process also results in a decreased work capacity of the muscles, including the erector spinae muscles. Assessment of Biering-Sorensen muscle endurance (BSME) for the erector spinae is performed with the patient lying in the prone position, the pelvis, thighs and ankles being fixed by straps, and the arms crossed on the chest. The patient is then asked to perform and maintain horizontal truncal extension, without support to the upper body. The time elapsed in maintaining the upper body in the abovementioned position is recorded as the BSME score of the erector spinae.[18] In connection with the above, the present study was conducted to find correlations of LBP in postmenopausal women with erector spinae endurance and BMD, respectively.

METHODS

Study design

This was a cross-sectional study conducted in Mampang Prapatan district, South Jakarta, from February to April 2010.

Subjects of study

Postmenopausal women residing in Mampang Prapatan district were selected for this study on the basis of inclusion and exclusion criteria. The inclusion criteria used in this study were: women in the age range of 47–60 years, in menopause for at least one year, mobile, capable of communication, in good health, without acute disease, and willing to give written informed consent. Exclusion criteria were: hysterectomy, diabetes mellitus, renal disorders, hepatic disorders, pulmonary disorders, and hormonal therapy during the previous three years. Calculation of sample size according to the formula for cross-sectional studies, with confidence interval of 95% and LBP prevalence of 23.7%, resulted in a minimal sample size of 231. The subjects were selected by simple random sampling in the catchment area of the Mampang primary health center, South Jakarta. Data were collected by interview and physical examination, performed by physiotherapists who had received preliminary training.

Questionnaire

The questionnaire used for the interviews comprised items on the following subject characteristics: age, education, employment,

number of pregnancies, and duration of menopause.

Visual analogue scale

A visual analogue scale (VAS) was used to express the intensity of LBP, as it is a commonly used, quick, reliable, and valid means to measure subjective pain. This scale is a 100-mm horizontal line, where 0 mm indicates "no pain" and 100 mm indicates "unbearable pain".

Bone mineral density

Assessment of BMD was done by means of dual-energy x-ray absorptiometry, using a Lunar DPX Bravo Nosuma densitometer (GE Medical Systems) at Budi Jaya Hospital, Jakarta. The results were expressed as T-scores of the lumbar spine (L1–L4). Categorization of BMD was according to the definition recommended by the World Health Organization, as follows: (i) normal: a value of BMD greater or less than one standard deviation (SD) below the peak bone mass of healthy adults; (ii) osteopenia: a value of BMD between 1.0 SD and 2.5 SD below the average peak bone mass of healthy adults; (iii) osteoporosis: a value of BMD more than 2.5 SD below the average peak bone mass of healthy adults.[17]

Anthropometric measurements

Height, weight, and body mass index (BMI) were measured on all subjects. Height was recorded to the nearest 0.1 cm using a portable microtoise, and weight was measured using Sage portable scales to the nearest 0.1 kg. BMI was calculated as weight (kg) divided by the square of height (m^2). BMI is classified into the following categories for Asian populations: underweight (<18.5 kg/m^2), normal (18.5-22.9 kg/m^2), overweight (23.0-27.5 kg/m^2), and obese (≥27.6 kg/m^2).[18]

Biering-Sorensen test

Erector spinae endurance was assessed by the Biering-Sorensen test, which yields a measure of static endurance of the erector spinae. The BSME test measures the elapsed time during which the participant is still capable of maintaining the unsupported upper part of the body in a horizontal position (Figure 2).

Figure 2. Erector spinae endurance testing

In this test, the load is equal to the weight of the upper part of the body, with torque determined by the lever arm from the pubic symphysis to the upper-body centre of gravity.[19] The patient was positioned prone on a treatment couch with the lower half of the body-below the level of the anterior superior iliac spines-strapped to the couch at the ankles and at the level of the greater trochanter of the femur. The straps were pulled as tight possible without causing undue discomfort to the patient. Before beginning the test patient was allowed to rest the top half of the body on a chair. Then the trunk was raised to the horizontal position with hands crossed over the chest. The test was continued until the participant could no longer control the horizontal posture, or until he or she reached the limit for fatigue or pain. Since preliminary tests on 10 postmenopausal subjects yielded a mean endurance time of 28.5 (±2.3) seconds, normal BSME time for postmenopausal women in the present study was set at 30 seconds (unpublished data). Erector spinae endurance was categorized as good for BSME times of ≥30 seconds, and poor for BSME times of <30 seconds.

Ethical clearance

The study was explained in detail to the subjects and any questions or concerns were addressed and the subjects were informed that they could withdraw from the study at any time. A consent form was read and signed prior to participation in the study, which was approved by the Research Ethical Committee, Faculty of Medicine, Trisakti University.

Data analysis

Data analysis was performed by means of the statistical package for social science (SPSS) program, version 15. All variables related to LBP were compared by means of Student's t test, while Pearson's correlation coefficients were also analyzed. A 5% level of probability was used to indicate statistical significance.

RESULTS

The present study involved 213 postmenopausal women with mean age of 53.5 ± 3.6 years. Most subjects had attended primary school (50.7%) and were unemployed (67.1%). On average the subjects had menopause for 4.4 ± 2.2 years (range 1-10 years) (Table 1).

The majority of the subjects was obese (41.3%), 58.0% complained of LBP within the previous 3 months, and mean VAS score was 2.0 ± 1.9. The Biering-Sorensen test showed that the majority of subjects (57.7%) had BSME times of <30 seconds. Most of the postmenopausal women suffered from osteopenia (49.8%), while 46 (21.6%) had osteoporosis (Table 2).

With advancing age, the proportion of postmenopausal women with osteopororsis tended to increase, with 12.9% in the age range of 46 - 49 years and 22.2% between 55 and 60 years of age (Table 3).

Table 1. Characteristics of study subjects comprising 213 postmenopausal women

Characteristic	n (%)
Age (years)*	53.5 ± 3.6
Range (years)	46 - 60
Educational level	
No formal education	21 (9.8)
Primary school (not finished)	20 (9.3)
Primary school	109 (50.7)
Junior high school	40 (18.6)
Senior high school	19 (8.8)
University/College	4 (1.9)
Employment	
Entrepreneur	19 (8.9)
Government official	2 (0.01)
Trader	49 (23.0)
Unemployed	142 (67.1)
Age at menarche (years)*	14.3 ± 1.7
Duration of menopause (years)*	4.4 ± 2.2
Range (years)	1 - 10
Number of pregnancies*	5.0 ± 2.5
Range	0 - 13

*Mean ± SD

Table 2. Key variables of subjects (n=213)

Variable	n (%)
Height (cm)*	148.8 ± 5.1
Weight (kg)*	59.2 ± 11.1
Body mass index (kg/m^2)*	26.6 ± 4.6
Underweight	10 (4.7)
Normal	30 (14.1)
Overweight	85 (39.9)
Obese	88 (41.3)
Bone mineral density	
Lumbar T-score*	-1.60 ± 1.03
Normal	61 (28.6)
Osteopenia	106 (49.8)
Osteoporosis	46 (21.6)
VAS score*	2.0 ± 1.9
Back pain	
Yes	124 (58.2)
No	89 (41.8)
BSME time	
Good (= 30 seconds)	90 (42.3)
Poor (< 30 seconds)	123 (57.7)

*Mean ± SD

Table 3. Age-specific prevalence of osteopenia and osteoporosis in postmenopausal women

Age range (years)	Lumbar spine L1-4	
	Osteoporosis (%)	Osteopenia (%)
46 – 49	12.9	48.4
50 – 54	23.9	45.7
55 – 60	22.2	54.4

Table 4. Correlation between body mass index and lumbar T-score with VAS in postmenopausal women

Variable	VAS	p
	r	
Body mass index	0.165	0.016
Lumbar T-score	-0.039	0.575

This study found a significant positive linear correlation of BMI with VAS, where subjects with higher BMI scores had correspondingly higher VAS scores (r=0.165;p=0.016). In contrast, lumbar T-scores were not significantly correlated with VAS scores (Table 4).

In postmenopausal women with good erector spinae endurance, the mean VAS score was 1.60 ± 1.74, which was significantly lower than mean VAS score of 2.32 ± 2.10 in postmenopausal women with poor erector spinae endurance (p=0.008) (Table 5). This signifies that a high endurance capacity of the erector spinae muscles was capable of reducing the intensity of LBP in postmenopausal women.

DISCUSSION

In the present study the prevalence of LBP in postmenopausal women was 58.2 %, which differed from the value of 20.8% in a study involving 2.127 women between 35 and 85 years of age, including women in menopause.[20] This difference in LBP prevalence was presumably due to the higher age of the postmenopausal women in the present study, ranging from 46 to 60 years. A cohort study on 438 postmenopausal women in the age range of 72-96 years indicated that 37% of women with incident vertebral deformity reported back symptoms at follow-up, as compared with 23.6% of women without incident vertebral deformity.[21] The present study showed the prevalence of osteoporosis in postmenopausal women in the age groups of 46-49 years, 50-54 years, and 55-60 years to be 12.9%, 23.9%, and 22.2%. respectively. The results of a study in Thailand, involving 1935 women at age 40-

Table 5. Mean VAS score by erector spinae endurance group

Variable	Erector spinae endura	
	Good (n=90)	P
VAS	1.60 ± 1.74	

80 years showed that the prevalence of osteoporosis in those aged 45-49 years and 50-54 years (12.0% and 23.7%, respectively) was similar to the present study results, whereas for the age group of 55-59 years, osteoporosis prevalence was considerably higher (42.7%).[22] A German study found a significantly higher prevalence of osteoporosis of 39% among women. Up to 6 out of 10 women over the age of 75 were estimated to have osteoporosis.[23] The differences in osteoporosis prevalence rates clearly indicates the diversity of factors affecting occurrence of osteoporosis in postmenopausal women, such as life style, climate, culture, and dietary intake.

Many authors report changes in the control of the trunk muscles in people with low back pain. Although there is considerable disagreement regarding the nature of these changes, we have consistently found differential effects on the deep intrinsic and superficial muscles of the lumbopelvic region. Two issues require consideration; first, the potential mechanisms for these changes in control, and secondly, the effect or outcome of changes in control for lumbopelvic function. Recent data indicate that experimentally induced pain may replicate some of the changes identified in people with LBP. While this does not exclude the possibility that changes in control of the trunk muscles may lead to pain, it does argue that, at least in some cases, pain may cause the changes in control. There are many possible mechanisms, including changes in excitability in the motor pathway, changes in the sensory system, and factors associated with the attention demanding, stressful and fearful aspects of pain. A new hypothesis is presented regarding the outcome from differential effects of pain on the elements of the motor system. Taken together these data argue for strategies of prevention and rehabilitation of LBP.[24]

The result of this study agree with previous study confirmed a muscle deficiency model was supported chronic low back pain, and a muscle spasm model was not. After 50 years, the research evidence is suggesting the hypothesis of the hyperactivity-causality model for musculoskeletal pain. The lack of convincing evidence to support the belief in hyperactivity as an etiological factor in musculoskeletal conditions has been pointed out in many of the research reviews contained in this compendium. These data indicate that the body's reaction to injury and pain is not primarily increased muscular tension and stiffness, rather muscle inhibition is often more significant.

Monitoring maximum surface integrated electromyography of lumbar muscles during isometric effort facilitates classification of chronic low-back pain patient. The fact is EMG not a common diagnostic tool in Indonesia, and many health centre don't have one. Otherwise we need to determined trunk stabilization, particularly erector spinae muscle endurence on low back pain patient. Many physician has to make lumbar muscle endurance classification without EMG. This study proved that Biering Sorensen muscle endurence can be done to analyze lumbar muscle endurance. In postmenopausal women that degenerative process already happen in all body system, definitely has different erector spinae muscle endurance classification compare with young age.

The result of this study suggested that postmenopausal women can do as long as 30 seconds or more BSME had lower low back pain incidence. This result supported the previous study that proved that trunk muscle weakness is the low back pain risk factor.[8]

The present study demonstrated that BMI had a significant positive correlation with VAS scores, indicating that postmenopausal women with higher BMI scores experienced higher intensities of LBP. A study on 134 postmenopausal women showed essentially similar results, in which LBP was associated with menopausal symptoms, BMD, duration of menopause, hormonal therapy, obesity, and inactivity.[25] In the post menopausal years, all women experience the physical effects of aging

and may also be affected by the hormonal changes responsible for menopause. These changes can include serious health conditions. The present study revealed that the static erector spinae endurance times were lower in the LBP group compared to the normal group, which was consistent with a study among rice farmers[26] Reduced endurance capacity of erector spinae muscles has been associated with chronic LBP.[27] The decreased erector spinae endurance could be explained as a result of prolonged LBP. Repetitive and accumulative trauma to erector spinae muscles may cause fibrosis and vascular change in the muscles, resulting in decreased erector spinae endurance. However, these explanations may need to be proven by future research. Poor back muscle fitness is believed to be associated with back pain and dysfunction regardless of sex and age.[28] Longitudinal research suggests that a shorter BSME time denotes an increased risk of developing chronic non-specific LBP. Presence of back pain increases the probability of a new vertebral fracture in postmenopausal women with osteoporosis.[20]

Since the present study is cross-sectional and cannot reflect a causal relationship between decreased erector spinae endurance and LBP, future research should focus on a cohort study to investigate this relationship. In addition, future research should emphasize evaluation of the effectiveness of specific back exercise programs for LBP in postmenopausal women.

CONCLUSIONS

The prevalence of LBP and osteoporosis in the postmenopausal women in this study was 58,2% and 21,6% respectively. Subjects with poor erector spinae muscle endurance had more pain intensity according to VAS. Prevention of decreased quality of life in postmenopausal women due to chronic low back pain, requires instructional programs for improving body posture and erector spinae muscle endurance, as well as the program to reduce body weight.

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