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Epidemiology of osteoporosis in postmenopausal women aged 47 to 60 years

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ABSTRACT

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Osteoporosis is a disorder having the characteristic features of low bone mass and structural degeneration. There are several factors affecting the prevalence of osteoporosis in postmenopausal women, such as age, age at menarche, duration of menopause, dietary or nutritional intakes, life style and level formal education. In connection with the increasing global prevalence of osteoporotic fractures, the purpose of the present study was to determine the prevalence and the influencing factors of osteoporosis in postmenopausal women. A cross-sectional study, involving 203 postmenopausal women aged 47-60 years, was conducted in 4 villages of Mampang Prapatan subdistrict, from February to April 2010. Bone mineral density (BMD) of lumbar spine 1-4, femoral neck, and left radius was measured by dual-energy X-ray absorptiometry (Lunar DPX Bravo Nomusa densitometer, GE Medical Systems) at Budi Jaya Hospital, Jakarta. The T-score threshold, defined as ≤ -2.5 was used to identify subjects with osteoporosis The results of the study showed that the highest prevalence of osteopenia of 45.8% was found in the femoral neck, while the highest prevalence of osteoporosis of 30% was found in the distal radius. Age, duration of menopause, and number of pregnancies yielded a significant correlation with BMD of the lumbar vertebrae and the distal radius. Body mass index (BMI) was also significantly correlated with BMD of lumbar vertebrae, femoral neck and distal radius. Effective strategies for the prevention and management of osteopenia and osteoporosis are needed.

Keywords: Menopause, osteoporosis, BMD, postmenopausal women

INTRODUCTION

Osteoporosis is a disorder having the characteristic features of low bone mass and structural degeneration, promoting the development of brittleness of the bones and increasing the risk of fractures of the bones of the pelvis, vertebral column, and wrist. To date, the global prevalence of osteoporotic fractures is increasing.[1,2] Osteoporosis is a "silent" disorder, because the loss of minerals occurs without discernable symptoms, and is also age-related. At the age of around 30 years the bone mass ceases to increase and the function of healthy bone is to maintain the existing bone mass as long as possible.[3]

In women the loss of bone mass increases several years after menopause, then decreases

again, while in men the loss of bone mass occurs more slowly, until at the age of 60-70 years the loss of bone mass in men and women is comparable. It has been estimated that in the United States around 13-18% women over the age of 50 years suffer from osteoporosis, while around 37-50 % have a low bone mass (osteopenia).[4]

The occurrence of fractures in old age is related to the fragility of bone. With the introduction of the bone densitometer, the measurement of bone fragility has been standardized. In postmenopausal women aged 55 years and over the possiblity of fractures should be kept in mind, in connection with the process of osteoporosis. The risk of fractures increases 1.5-3 times or more for a decrease of bone mineral density (BMD) by 1 standard deviation (SD). According to the criteria of the World Health Organization (WHO), osteoporosis is defined by a bone mineral density value (T score) of –2.5 or lower, while osteopenia is present if the T score is >-2.5 up to -1, and the bones are normal if the T score is >-1.[5]

Several risk factors are correlated with the occurrence of osteoporosis and contribute to the probability of an individual suffering from osteoporosis. There are several risk factors that are controllable, such as sex hormones, anorexia nervosa, dietary intake of calcium and vitamin D, consumption of medications such as longterm corticosteroids, life style, smoking, consumption of alcohol and coffee, and hyperparathyroidism. On the other hand, gender, age, body size, ethnicity, and family history are uncontrollable risk factors for osteoporosis.[6]

According to a study by Pietschmann et al., the prevalence of fractures of the vertebrae, pelvic bones, and distal bones of the forearm in white American women aged 50 years or more is estimated at around 40%, while in white American men it is around 13%. From this study it was also apparent that the risk of fractures increased in women as compared to men. Osteoporotic fractures is related to pain and disability, and also increases the mortality rate. The mortality rate after hip fracture in women is 4 times higher than in men.[7] Vertebral fractures are the cause of longterm morbidity in women and mortality in women as well as men. Costs of treatment of fractures are higher in women than in men. The objective of this study was to determine the prevalence of osteoporosis and several of its risk factors in postmenopausal women aged 47 to 60 years.

METHODS

Design of the study

A cross-sectional design was used in this study, conducted in the catchment area of Mampang Prapatan Health Center, from February to April 2010.

Subjects of the study

The study subjects were postmenopausal women aged 47 to 60 years, selected according to the following inclusion criteria: having entered natural menopause, duration of menopause >1 year and <10 year, not consuming longterm steroids, not suffering from chronic diseases, capable of active communication, and willing to participate in this study. The exclusion criteria were: acute infectious diseases, diabetes mellitus, functional abnormalities of the kidneys and liver, history of cancer, history of hysterectomia, hormonal therapy. The selection of the study subjects was performed using cluster random sampling from four villages *(kelurahan)*, i.e. Kuningan Barat, Mampang Prapatan, Tegal Parang, and Pela Mampang, in the area of Mampang Prapatan subdistrict, South Jakarta.

Measurements

Weight and height were measured with the subjects wearing light clothing and no shoes. Height was determined by means of a portable microtoise accurate to 0.1 cm and weight was measured with Sage portable scales accurate

to 0.1 kg. Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of the height (in meters). The obtained BMI values were independent of age and gender. BMI classification for the Asia-Pacific region were as follows: underweight if BMI <18.5, normal if BMI 18.5-22.9, overweight if BMI between 23-24.9, obese I if BMI between 25-29.9, and obese II if BMI ≥ 30.[8]

The instruments and methods for evaluating BMD were standardized to minimize interobserver variation. BMD (mg/cm2) was measured by dual-energy X-ray absorptiometry (Lunar DPX Bravo Nomusa densitometer, GE Medical Systems) at Budi Jaya Hospital, Jakarta. The results given were those for the mean BMD values of L1–L4 at the spine, femoral neck, and left radius. Demographic data were collected through interviews using a structured questionnaire, followed by physical examination for measurement of blood pressure.

Statistical analysis

Univariate analysis was conducted on background characteristics, and normality of the data distribution was evaluated by means of the Kolmogorov-Smirnov test. Normal data distributions were expressed as mean, standard deviation, and percentage. Pearson correlation analysis was used to determine correlations between age, duration of menopause, number of pregnancies, and BMI on the one hand and BMD on the other. For nonnormally distributed data, Spearman's rho was used. Statistical analyses was done using SPSS software for Windows version 15.0 (SPSS Inc., Chicago), while statistical significance was set at $p< 0.05$.

Ethical clearance

Ethical clearance was issued by the Research Ethics Committee, Medical Faculty, Trisakti University. Written informed consent was obtained from all subjects in this study, duly legalized by attached signature or thumb print. Identity of all study subjects was kept confidential and only used for research purposes.

RESULTS

In this study there were 203 women meeting the inclusion criteria, with the following characteristics: age between 47 and 60 years, mean age 53.3 ± 5.15 years, mean age at menarche 14.35 ± 1.74 years; mean duration of menopause 4.45 ± 2.21 years, with a range of 2-7 years; mean number of pregnancies 4.96 ± 2.49 , with a range of 2-7 pregnancies.

Mean BMI was 28.8 ± 4.55 kg/m^2, with most of postmenopausal women (61.58%) in this study being overweight, while 7.08% was underweight and 30.54% in the normal category. Mean lumbar vertebral T-score was -1.62 ± 1.03 g/cm^2, mean femoral neck T-score -1.00 ± 0.93 g/cm^2, and mean distal radius T-score was -1.91 ± 1.16 g/cm^2. With regard to formal education of the study subjects, 50.7% finished primary school, but only 9.4% attended senior high school (SMA) or higher institutions of learning. The majority of subjects (52.7%) was unemployed at the time of the study (Table 1).

The presence of osteroporosis is inferred from the BMD value, expressed as the T score, which compares BMD to mean bone density of young adults. In the present study, the prevalence of osteopenia of the lumbar vertebrae was found to be 28.1%, that of the distal radius was 23.2% and the highest prevalence of osteopenia was in the femoral neck, accounting for 45.8% of subjects. Regarding the prevalence of osteoporosis, in the lumbar vertebrae it was 20.2%, and in the femoral neck 4.9%, with the highest prevalence of 30% in the distal radius (Table 2).

The results of a simple linear regression analysis between age, duration of menopause, number of pregnancies on the one hand and BMD on the other, showed that advanced age

Table 1. Characteristics of study subjects (n=203)

Characteristic	n (%)
Age (years)	53.30 ± 5.15
Age at menarche (years)	14.35 ± 1.74
Duration of menopause (years)	4.45 ± 2.21
Number of pregnancies	4.96 ± 2.49
Blood pressure (mmHg)	
Systolic	124.7 ± 20.49
Diastolic	78.55 ± 12.02
Body Mass Index	
Underweight	16 (7.88)
Normal	62 (30.54)
Overweight	125 (61.58)
Weight (kg)	59.45 ± 10.97
Length (cm)	148.83 ± 5.17
BMD (T Score)	
Right femur	-1.00 ± 0.93
Lumbar vertebrae	- 1.62 ± 1.03
Left radius	- 1.19 ± 1.16
Education	
None	21 (10.3)
Did not finish primary school	20 (9.9)
Finished primary school	103 (50.7)
Junior high school *(SMP)*	40 (19.7)
Senior high school *(SMA)*	17 (8.4)
Academy / University	2 (1.0)
Employment	
Entrepreneur	18 (8.9)
Public servant (PNS)	1 (0.5)
Businessman	46 (22.7)
Unemployed	107 (52.7)
Other	31 (15.3)

Abbreviation BMD, bone mass density

leads to a reduction in BMD. A significant reduction in BMD was seen in the lumbar vertebrae and distal radius. For lumbar BMD a value of p=0.012 was found, for the distal radius p=0.039, while for the femoral neck p=0.367. Simple linear regression analyis between BMI and BMD revealed that BMI positively affected BMD, in the sense that higher BMI values were related to higher BMD. BMD scores of the lumbar vertebrae were significant at p=0.000, while BMD scores of the femoral neck and distal radius were both significant at p=0.000 (Table 3).

DISCUSSION

The prevalence of osteoporosis in postmenopausal women aged 47 to 60 years, based WHO criteria using T scores, was 20.2% in the lumbar vertebrae, while the highest prevalence of osteoporosis of 30% was found in the distal radius. Similar results were obtained in postmenopausal women aged 50 to 64 years in Germany, with a prevalence of osteoporosis of 23.3%.[1] In comparison, a Thai study reported that the prevalence of osteoporosis in the lumbar spine of Thai postmenopausal women aged 50 to 54 years and 55 to 59 years, was 9.4% and 22.6%, respectively. In the femoral neck the prevalence of osteoporosis in the age groups 50-54 years and 55-59 years was 4.9% and 10.3%, respectively.[9] However, differring results were encountered in a study conducted at the Nutritional Research and Development Center of the Indonesian Department of Health *(Pusat Penelitian dan Pengembangan Gizi [Puslitbang] Depkes)*, yielding a prevalence of osteoporosis of 10.3%.[10]

The type of osteoporosis found in the present study was primary osteoporosis due to estrogen deficiency. As is commonly accepted,

Table 2. Distribution of osteopenia and osteoporosis by BMD site in postmenopausal women (n=203)

BMD Site	**Osteopenia (n,%)**	**Osteoporosis (n,%)**
Lumbar vertebrae	57 (28.1)	41 (20.2)
Right femoral neck	93 (45.8)	10 (4.9)
Left distal radius	47 (23.2)	61 (30.0)

Abbreviation BMD, bone mass density

Table 3. Correlation between several risk factors and BMD scores

	Lumbar vertebrae	Femoral neck	Distal Radius
Age[**]	-0.175 (0.012)[*]	-0.065 (0.357)	-0.145 (0.039)[*]
Duration of menopause[#]	-0.215 (0.002)[*]	-0.129 (0.066)	-0.182 (0.009)[*]
No. of pregnancies[**]	-0.210 (0.003)[*]	-0.138 (0.050)	-0.179 (0.011)[*]
BMI[#]	0.311 (0.000)[*]	0.305 (0.000)[*]	0.366 (0.000)[*]

[#] Pearson correlation coefficient; **: Spearman's rho; *significant ($p < 0.05$). The values in parentheses are p value; Abbreviation: BMI, body mass index

estrogen plays an important role in osteoblasts and mineral homeostasis. In addition, estrogen also has extraskeletal effects in the form of decreased absorption of calcium in the intestines, which leads to increased parathyroid hormone levels and increased bone degradation in postmenopausal women. According to Mawie et al.[11] up to 49.5% of postmenopausal women have estradiol levels of ≤5 pg/ml, while a positive correlation was found between estradiol levels and T score in the femoral neck region. Estradiol inhibits the generation and activity of osteoclasts, the inhibition being mediated by upregulation of osteoprotegerin.[7] The results of the correlation test showed a correlation between age and BMD, with increasing age leading to decreasing BMD in the lumbar vertebrae and the distal radius. In old age (>60 years), the type of osteoporosis encountered is senile osteoporosis as a result of the aging process, with the occurrence of osteoblastic dysfunction in trabecular and cortical bone, thereby increasing the risk of fractures of the vertebrae and pelvic bones.[7,12] In their lifetime women will lose 50% of their trabecular bone mass and 30% of their cortical bone mass, and half of the loss occurs within 10 years after menopause.[13] Sakondhavat et al.[14] have stated that the prevalence of osteoporosis increases proportionally with advancing age and duration of menopause in the lumbar vertebrae as well as the femoral neck. Zhai et al.[2] reported that with increasing age a significant loss of bone mass occurs in the vertebrae and femoral neck of postmenopausal women, the relationship between loss of bone mass and age not being linear, but quadratic. In contrast, Liu-Ambrose et al.[15] found no relationship between loss of bone mass and age.

In the present study the duration of menopause appears to have a significant impact on the reduction in BMD of the lumbar vertebrae and distal radius. In women entering menopause, there is a loss of bone mass of 1-2% annually for a period of 5-10 years. The loss of bone mass is particularly rapid in trabecular bone, with fractures of the vertebrae and distal radius comprising the frequently encountered clinical manifestations. Trabecular bone is affected by several factors, such as BMI, age, estradiol levels and physical activity.[16,17] In postmenopausal women there is a decrease in trabecular bone mass due to age and diminished estradiol levels. At the start of menopause the mean loss in trabecular bone mass is reportedly between 1.8% and 2.3% in the veterbral column and 1.0-1.4% in the pelvic bones. After 5 years of menopause the mean decrease in BMD is 7-10% in the vertebral column and 5-7% in the pelvic bones, thus increasing the risk of fractures.[18] Finkelstein et al. [13] showed that the decline in BMD occurs significantly in late perimenopause and is extremely rapid in the first postmenopausal year. Li et al.[19] also found a significant decrease in BMD occurring with increasing age and duration of menopause.

Mean BMI in the present study was 28.8 kg/m^2, and on the basis of the BMI

classification used, most subjects were in the overweight category (obese I = 25-29.9 kg/m^2). The simple linear regression results indicate the presence of a positive correlation between BMI and BMD. BMI is representative of total body fat. Several studies demonstrated that body weight and adipose tissue may influence BMD in several ways, such as the following: an overweight individual has a greater weight bearing load, body weight in adolescents affects peak bone mass, and in postmenopause adipose tissue is converted into active estrogens (estrones), so that obese postmenopausal women have higher endogenous estrogen levels.[20] Adipose tissue synthesizes leptins that are associated with bone mass, body weight and reproduction. Leptins are associated with osteoblasts, which stimulate mineralization of the bones, regulate bone formation and inhibit the generation of osteoclasts. Circulating leptins are related to BMI and size and geometry of hand bones, while in regulating body weight leptins are linked to eating habits and energy utilization.[21,22] Sukumar et al.[23] reported similar results, in that BMI values were closely correlated with BMD scores in trabecular and cortical bone, with serum parathyroid hormone levels, and with decreased serum 25-hydroxy vitamin D levels. Similarly, Felson [20] found that BMI values were more closely correlated with BMD in older women than in men. Genetic factors are strongly correlated with bone mineral composition and body composition, and in 70-80% of cases are of influence in determining peak bone mass.

The mean number of past pregnancies was 5 and correlation analysis indicated that frequency of pregnancies significantly decreased BMD. Pregnancy and lactation are associated with changes in calcium homeostasis, which lead to decreases in BMD. It is common knowledge that during pregnancy maternal calcium is transferred to the fetus, and the amounts transferred increase in the second and third trimesters, when calcium is required for the development of fetal bones. As a compensatory change, during pregnancy there is a 50% increase in the absorption of calcium from intestines, as a result of raised levels of 1,25 dihydroxy-vitamin D and estrogen, thus protecting the body against the effects of calcium loss from the bones. During pregnancy parathyroid hormone levels are also raised, leading to mobilization of calcium from the bones.[24,25] On the other hand, a higher frequency of pregnancies may protect against postmenopausal loss of bone mass, because pregnancy is associated with increased body weight, increased absorption of calcium from the intestines, and cumulative exposure to estrogens, and older age at menopause.[26] Several studies found supportive evidence for a positive correlation between number of pregnancies, BMD, and reduction in prevalence of femoral fractures. Streeten et al.[27] showed that the number of pregnancies was associated with increased BMD values in the hip, which was related to increased BMI during pregnancy. Lenora et al.[28] did not find any influence of the number of pregnancies and duration of lactation on BMD in middle-class women, which was related to nutrional intake during pregnancy.

The present study found three factors possibly associated with the high prevalence of osteoporosis, viz.age, duration of menopause, and number of pregnancies. In addition, genetic factors should receive due consideration. Deng et al.[29] reported that genetic factors play an important role in BMI and BMD of the spine and hip in ethnic Han Chinese. Lazcano-Ponce et al.[30] stated that genetic factors impact on BMD and peak bone mass at the ages of 20-30 years, and on postmenopausal loss of bone mass. Furthermore, girls and young adult women whose mother had a history of osteopenia or osteoporosis, would have a similar experience. In the present study the majority of subjects (70.9%) had a low level of formal education (primary school or lower), while Ho et al.[31] in China found that 50.5% of their subjects

were in this category. They also found that a higher level of education was associated with a lower prevalence of osteoporosis. In developing countries, educational level is an essential marker of socio-economic status. Education is closely linked with life style, dietary intakes (especially of high-calcium foods, vegetables, and nutrients with an impact on bone mass), and intakes of nutrients and calcium during pregnancy and lactation. Socio-economic status is also associated with nutrition in childhood and adolescence, which is reflected in body height and age at menarche. In addition, life style activities, such as consumption of alcohol, smoking, and habitual participation in sports and physical activities, are of influence on BMD. [31]

The present study was not exempt from several limitations. Firstly, the study design was of cross-sectional type and thus was unable to prove that the osteoporosis was the outcome of several risk factors. Secondly, the study did not collect data on life style of postmenopausal women, as an influencing factor on the prevalence of osteoporosis.

CONCLUSIONS

The prevalence of osteoporosis in postmenopausal women aged 47 to 60 years was 20.2% and 30% respectively for the lumbar spine and distal radius. Several factors, such as age, duration of menopause, number of pregnancies, and BMI, affected the risk for osteoporosis. Public health promotional activities should be implemented in view of the relatively high prevalence of osteoporosis. Futher studies are also needed on the factors associated with osteoporosis and on prevention and management of primary osteoporosis.

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