

Osteoporosis in Different Age-Groups and Various Body Mass Index (BMI) Ranges in Women Undergoing Bone Mass Measurement at King Chulalongkorn Memorial Hospital

Kunthida Rithirangsiroj MD*,
Krasean Panyakhamlerd MD*, Sukanya Chaikittisilpa MD*,
Tawatchai Chaiwatanarat MD**, Nimit Taechakraichana MD*

* Department of Obstetrics and Gynecology, King Chulalongkorn Memorial Hospital, Bangkok, Thailand

** Division of Nuclear Medicine, Department of Radiology, King Chulalongkorn Memorial Hospital, Bangkok, Thailand

Objective: To determine percentage of osteoporosis at femoral neck and lumbar spine (L1-L4) in women with different age group and various BMI ranges.

Material and Method: The present study was conducted in 4,528 women of ≥ 40 years who underwent first BMD measurement at King Chulalongkorn Memorial Hospital between 2000 and 2010. Bone mineral density (BMD) of femoral neck (non-dominant side) and lumbar spine (L1-L4) was measured by Dual-energy x-ray Absorptiometer (DXA). The percentage of osteoporosis was determined by WHO cutoff value using Thai nationwide reference database.

Results: The percentages of osteoporosis at femoral neck (FN) in age group of 40 to 49, 50 to 59, 60 to 69, and ≥ 70 years were 6.2%, 7.4%, 24.4%, and 51.8% respectively. The corresponding figures for lumbar spine (LS) were 3.4%, 5.6%, 12.7%, and 20.9% respectively. The percentage of osteoporosis seems to increase strikingly after 60 years at both sites. The percentage of osteoporosis at FN in underweight, normal weight, overweight and obesity were 52.1%, 20.3%, 15.7%, and 9.4% respectively. The corresponding figures for LS were 22.8%, 12%, 4.8%, and 5.9% respectively. Over 30% of women of age ≥ 60 years with BMI of less than 23 kg/m² had osteoporosis by the studied criteria.

Conclusion: The percentage of osteoporosis seemed to be increasing with age and declining with BMI. Using the WHO cutoff value and Thai reference database, the percentage of femoral neck osteoporosis appeared to be higher than the lumbar spine. In the present study, the authors found that women of ≥ 60 years with BMI of less than 23 kg/m² posed a substantial percentage of osteoporosis.

Keywords: Osteoporosis, Bone mineral density (BMD), Body mass index (BMI)

J Med Assoc Thai 2012; 95 (5): 644-9

Full text. e-Journal: <http://www.jmat.mat.or.th>

Osteoporosis is a worldwide health issue with increasing disease prevalence not only in the north-western countries but also in Asia and Latin America. Of various possible sites of fragility fractures, vertebral and hip fractures are associated with pronounced morbidity and excess mortality. Avoidance of debilitating fracture consequences is best achieved by identifying patients at risk and providing appropriate therapeutic intervention. For instance, low

body weight and body mass index (BMI) were shown to be predictive of osteoporosis and associated with an increased fracture risk⁽¹⁾.

Osteoporosis is considered as the disease of the young but manifests in aging. In the United States, one third of women between 60 and 70 years have osteoporosis. Women at 75 years of age or over have an osteoporotic fracture rate as high as 80 to 90%⁽²⁾. In Thailand, the proportion of the aging population (over 60) was 7.2% in 1990 and is expected to increase to 15.2% in 2020^(3,4). The prevalence of osteoporosis in Thailand was between 13 and 19% according to a nationwide survey during 1998/1999⁽⁵⁾. With increasing life expectancy, osteoporosis is likely to be one of the major health problems in the upcoming decade.

Correspondence to:

Rithirangsiroj K, Department of Obstetrics and Gynecology, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

Phone: 0-2256-4241

E-mail: choyu56@hotmail.com

Nevertheless, osteoporosis is preventable particularly in those with modifiable risk factors. Treatment costs are always higher in terms of economic and social valuation compared to prevention. To detect those at risk of osteoporosis or high bone-loss tendency ahead of time would help in cost-effective decision-making with appropriate health intervention either medical or non-medical modalities.

The diagnosis of osteoporosis using operational definition by WHO criteria has been well accepted. The cutoff value of bone mineral density (BMD) ≤ -2.5 standard deviation (SD) as criteria of osteoporosis varies in its absolute value among communities due to the differences in "peak young adult mean" of different ethnic groups. In Thailand, Limpaphayom K et al conducted a nationwide survey to develop Thai reference database and found that the absolute cutoff values of osteoporosis using the WHO criteria are ≤ 0.682 g/cm² and ≤ 0.569 g/cm² for lumbar spine (L1-L4) and femoral neck, respectively⁽⁵⁻⁷⁾. As a result, the prevalence of osteoporosis using the above cutoff values was between 13 and 19%. The authors, then, decided to use this nationwide information to determine the percentages of osteoporosis at femoral neck and lumbar spine (L1-L4) in different age groups and/or different BMI ranges in women visiting King Chulalongkorn Memorial Hospital (KCMH). The authors also determined the percentage of osteoporosis in the same group of population using KCMH urban database that results in absolute cutoff values ≤ 0.765 g/cm² and ≤ 0.593 g/cm² for lumbar spine (L1-L4) and femoral neck, respectively⁽⁸⁾.

Material and Method

This cross-sectional, hospital-based study was conducted between 2000 and 2010 on women age ≥ 40 years who sought first BMD measurement at KCMH. The authors excluded women with suspected skeletal abnormalities such as those with a history or imaging evidence of osteoarthritis, scoliosis, collapsed spine, and spondylosis. Based on the prevalence of osteoporosis at the femoral neck at age 70 to 74 years of 49.6%⁽⁵⁾ with an acceptable error of 3.0%, it was estimated that a sample size of at least 1,067 per age group was required. Age was categorized into four groups of 40 to 49, 50 to 59, 60 to 69, and ≥ 70 years. The samples were 4,268 cases. The present study was approved by the Institutional Review Board and informed consent was obtained from all subjects. The present study was conducted in accordance with the Helsinki Declaration in 1975 and as revised in 1983.

Operation definition of osteoporosis

Osteoporosis

A skeletal disorder characterized by compromised bone strength predisposing to an increased risk of fracture⁽⁹⁾.

A cutoff value of BMD ≤ -2.5 SD compared to peak young adult mean using Thai nationwide reference database. The corresponding absolute values are ≤ 0.569 g/cm² and ≤ 0.682 g/cm² for femoral neck and lumbar spine (L1-L4), respectively⁽⁶⁾.

The authors also used the cutoff value of BMD ≤ -2.5 SD compared to peak young adult mean of the KCMH urban reference database. The corresponding values are ≤ 0.593 g/cm² and ≤ 0.765 g/cm² for femoral neck and lumbar spine (L1-L4), respectively⁽⁸⁾.

Body mass index was calculated as weight (in kilograms)/height (in meter square). The authors used the BMI ranges according to the WHO Asia-Pacific guideline for Asian adults *i.e.*, BMI < 18.5 kg/m² as underweight, 18.5-22.9 kg/m² as normal weight, 23-24.9 kg/m² as overweight and ≥ 25 kg/m² as obesity⁽¹⁰⁾.

Measurement

Weight and height were measured with subjects wearing light clothing and no shoes.

BMD was measured at lumbar spine (L1-L4) by dual-energy x-ray absorptiometry (Hologic QDR-2000 densitometer; Osteometer, Harlev, Denmark). The results given were those for the mean values of femoral neck and lumbar spine. The coefficients of variation for the hip and spine phantom during the year in which the present study was undertaken were $< 1\%$.

Analysis

The percentages of osteoporosis were determined using both the Thai nationwide (urban and rural population)⁽⁶⁾ and the KCMH reference database⁽⁸⁾. The latter was developed by recruiting people in the catchment area (urban).

Results

Four thousand five hundred and twenty-eight women aged ≥ 40 years were recruited into the present study. Using the Thai nationwide reference database⁽⁶⁾, the percentages of osteoporosis among women undergoing first BMD measurement at KCMH are $< 10\%$ in women aged < 60 years. The percentages increase markedly after the age of 60 years. The highest

percentages of osteoporosis are at the age ≥ 70 years (Table 1, Fig. 1).

When comparing the percentages of osteoporosis in the present study with different BMI ranges, the highest percentages of osteoporosis are in the underweight group (BMI $< 18.5 \text{ kg/m}^2$) *i.e.*, 52.1% in femoral neck and 22.8% in lumbar spine (Table 2, Fig. 2).

When considering the percentages of osteoporosis in the underweight with different age groups, the percentages are more than 30% in all age groups at femoral neck (Fig. 3).

The authors also found that women of ≥ 60 years with BMI of less than 23 kg/m^2 had a high percentage of femoral neck osteoporosis ($> 30\%$) as in women aged ≥ 70 years or those with BMI $< 18.5 \text{ kg/m}^2$

When used the KCMH urban reference database⁽⁸⁾, the percentages of osteoporosis was higher at both femoral neck and lumbar spine (L1-L4) when compared to the use of the Thai nationwide database^(5,6). The percentages of osteoporosis were higher in every age group (Table 3, 4).

Table 1. Percentages of femoral neck and lumbar spine (L1-L4) osteoporosis in different age-groups

Age-group (years)	Osteoporosis at femoral neck (BMD $\leq 0.569 \text{ g/cm}^2$)*	Osteoporosis at lumbar spine (L1-L4) (BMD $\leq 0.682 \text{ g/cm}^2$)*
40-49	6.2%	3.4%
50-59	7.4%	5.6%
60-69	24.4%	12.7%
≥ 70	51.8%	20.9%

* The Thai nationwide cutoff value (urban and rural population)⁽⁶⁾

Table 2. Percentages of femoral neck and lumbar spine (L₁-L₄) osteoporosis in different BMI ranges

BMI ranges (kg/m ²)	Osteoporosis at femoral neck (BMD $\leq 0.569 \text{ g/cm}^2$)*	Osteoporosis at L1-L4 (BMD $\leq 0.682 \text{ g/cm}^2$)*
< 18.5	52.1%	22.8%
18.5-22.9	20.3%	12.0%
23-24.9	15.7%	4.8%
≥ 25	9.4%	5.9%

* The Thai nationwide cutoff value (urban and rural population)⁽⁶⁾

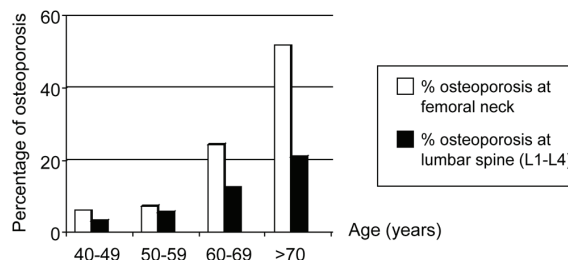


Fig. 1 Osteoporosis at femoral neck and lumbar spine (L1-L4) in different age-groups when using the Thai nationwide cutoff value [the Thai nationwide cutoff value (urban and rural population)⁽⁶⁾]

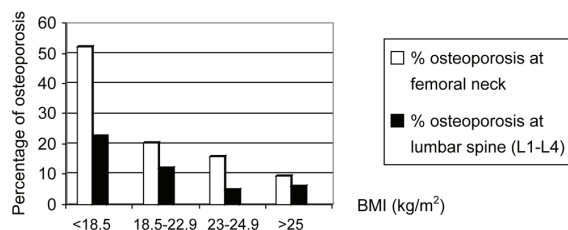


Fig. 2 Osteoporosis at femoral neck and lumbar spine (L1-L4) in different BMI ranges when using the Thai nationwide cutoff value [the Thai nationwide cutoff value (urban and rural population)⁽⁶⁾]

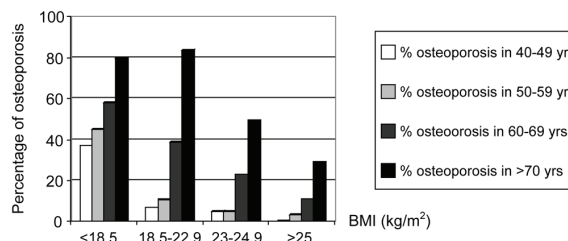


Fig. 3 Osteoporosis at femoral neck in different age-groups and BMI ranges [the Thai nationwide cutoff value (urban and rural population)⁽⁶⁾]

Discussion

With accelerated bone loss after menopause, the prevalence of osteoporosis appears to be higher farther to the time since menopause. Determination of the magnitude of the problem will allow us to anticipate socioeconomic reverberation of these preventable chronic conditions. Prevention of osteoporosis is important since there is a window of opportunity to maximize peak bone mass and a critical time to slow down bone loss in order to reduce the risk of osteoporotic fractures later in life.

Table 3. Osteoporosis at femoral neck using the Thai nationwide (A) and KCMH (B) reference databases

Age-group (years)	Osteoporosis at femoral neck	
	Cutoff value of A ⁽⁶⁾ (BMD < 0.569 g/cm ²)	Cutoff value of B ⁽⁸⁾ (BMD < 0.593 g/cm ²)
40-49 (n = 1,284)	80 (6.2%)	144 (11.2%)
50-59 (n = 1,641)	122 (7.4%)	231 (12.1%)
60-69 (n = 1,107)	270 (24.4%)	372 (33.6%)
≥ 70 (n = 488)	253 (51.8%)	318 (65.2%)

Table 4. Osteoporosis at lumbar spine (L1-L4) using the Thai nationwide (A) and KCMH (B) reference databases

Age-group (years)	Osteoporosis at lumbar spine (L1-L4)	
	Cutoff value of A ⁽⁶⁾ (BMD < 0.682 g/cm ²)	Cutoff value of B ⁽⁸⁾ (BMD < 0.765 g/cm ²)
40-49 (n = 1,284)	43 (3.4%)	94 (7.3%)
50-59 (n = 1,641)	92 (5.6%)	258 (15.7%)
60-69 (n = 1,107)	141 (12.7%)	387 (35.0%)
≥ 70 (n = 488)	102 (20.9%)	238 (48.8%)

The percentages of osteoporosis either at the lumbar spine or femoral neck of women below 60 years were less than 10% when using the Thai nationwide reference database⁽⁶⁾. Nevertheless, it rose progressively with increasing age. The percentages of osteoporosis among women with different BMI ranges increased with decreasing BMI (Table 2). The highest percentages of osteoporosis were in the underweight groups (BMI < 18.5 kg/m²), *i.e.*, 52.1% in femoral neck and 22.8% in lumbar spine (L1-L4). When considering the percentages of osteoporosis in the underweight with different age groups, the percentages were more than 30% in all age groups at femoral neck (Fig. 3). It is noticeable that women of ≥ 60 years with BMI of less than 23 kg/m² had a high percentage of femoral neck osteoporosis (> 30%) as in women aged ≥ 70 years or those with BMI < 18.5 kg/m². This implies that the presented population who are 60 years of age or over with BMI below 23 kg/m² may need BMD measurement due to its high risk nature.

On the other hand, when using KCMH urban database⁽⁸⁾, the results reveal higher percentages of osteoporosis in the same population. This is probably because the Thai nationwide database included the studied population both rural and urban, which averaged the reference values among the communities whilst the KCMH data recruited population in the catchment area, which represented women in the urban area. With higher cutoff values of the KCMH database

due to higher peak bone mass of the referenced population, the percentages of osteoporosis are higher at both femoral neck and lumbar spine (L1-L4).

The percentages of osteoporosis in the present study differ from the findings in other Thai studies *e.g.*, Limpaphayom K et al (2001)⁽⁵⁾ and Jarupanich (2007)⁽¹¹⁾ found that the prevalence of osteoporosis were higher at lumbar spine than the femoral neck. This is vice versa to the present study. The discrepancy may be due to the difference in the studied population, reference database, and criteria used to determine osteoporosis.

It is well known that occupation, lifestyle, underlying diseases and medication used may affect bone health and increase risk of osteoporosis. Nevertheless, it should be kept in mind the importance of the cutoff value used to define osteoporosis. As T-score is the number of standard deviations above or below the peak young adult mean, the differences in absolute value of average peak bone mass in different communities will certainly affect prevalence or percentage of osteoporosis. The present study confirms the difference in percentages of osteoporosis when using different cutoff values of those derived from a nationwide survey, mostly rural women, and the KCMH study, which represented urban information. With higher cutoff value of the KCMH database, the percentage of osteoporosis tended to be higher compared with those of nationwide cutoff value.

The advantage of the present study counts on its large sample size that may lessen skewing of small-scale study. Nevertheless, due to its retrospective nature, the present study could not rule out the possibility that some women might receive hormone prior to the bone mass measurement and did not take into account some health risk behaviors such as smoking, familial history, underlying diseases, current medication, or the nature of menopause that may affect bone density. However, most of the women who had first BMD measurement at KCMH were drug naive. Generally, women seek their first BMD scan because they want to know whether they need osteoporosis treatment. The results only represented women who came to visit the hospital for BMD measurement that are walk-in people the authors encounter in their daily service. In addition, this is a hospital-based study, which may not represent the real magnitude of problem of the country.

Conclusion

The percentages of osteoporosis seem to be increasing with age and decreasing with BMI. Using the WHO cutoff value and Thai nationwide reference database, the percentages of femoral neck osteoporosis appeared to be higher than the lumbar spine. The present study was intended to look at the percentage of osteoporosis in women visiting KCMH who had different age groups and various BMI ranges. It may not be applicable to other groups of population that might have different population characteristics. Nevertheless, what the authors learned from the present analysis revealed an interaction of age group and BMI ranges that showed that those who are over 60 years of age with BMI under 23.5 kg/m² were at high risk of osteoporosis. This is different from the latest Thai osteoporosis guideline that indicates that women after 65 years of age or those with BMI below 19 kg/m² are indicated to have BMD measurement.

Acknowledgement

The authors wish to thank Mrs. Thanimporn Ninlagarn, Mr. Issorn Lowmepol, the research coordinator for their assistance to the present study.

Potential conflicts of interest

None.

References

1. Morin S, Tsang JF, Leslie WD. Weight and body mass index predict bone mineral density and fractures in women aged 40 to 59 years. *Osteoporos Int* 2009; 20: 363-70.
2. Peck WA. The world health burden of osteoporosis: today and the future [abstract]. Data presented at the 4th International Symposium on Osteoporosis Hong Kong; March 27-31, 1993.
3. National Economic and Social Development Board. Population projection for Thailand 1990-2020. Bangkok: Office of Prime Minister, Human Resources Planning Division; 1995: 17-9.
4. Cooper C, Campion G, Melton LJ III. Hip fractures in the elderly: a world-wide projection. *Osteoporos Int* 1992; 2: 285-9.
5. Limpaphayom K, Taechakraichana N, Jaisamrarn U, Bunyavejchevin S, Chaikittisilpa S, Poshyachinda M, et al. Prevalence of osteopenia and osteoporosis in Thai women. *Menopause* 2001; 8: 65-9.
6. Limpaphayom K, Taechakraichana N, Jaisamrarn U, Bunyavejchevin S, Chaikittisilpa S, Poshyachinda M, et al. Bone mineral density of lumbar spine and proximal femur in normal Thai women. *J Med Assoc Thai* 2000; 83: 725-31.
7. Kanis JA, Melton LJ 3rd, Christiansen C, Johnston CC, Khaltsev N. The diagnosis of osteoporosis. *J Bone Miner Res* 1994; 9: 1137-41.
8. Poshyachinda M, Chaiwatanarat T. Assessment of bone mineral density in normal Thais. *ASEAN J Radiol* 1996; 11: 1-13.
9. National Institutes of Health. Osteoporosis prevention, diagnosis, and therapy. NIH Consensus Statement 2000; 17: 1-36.
10. World Health Organization, Western Pacific Region. The Asia-Pacific perspective: redefining obesity and its treatment. Australia WHO/IASO/IOTF; 2000.
11. Jarupanich T. Prevalence and risk factors associated with osteoporosis in women attending menopause clinic at Hat Yai Regional Hospital. *J Med Assoc Thai* 2007; 90: 865-9.

โรคกระดูกพรุนในแต่ละกลุ่มอายุและช่วงดัชนีมวลกายของสตรีที่ได้รับการวัดมวลกระดูกในโรงพยาบาลจุฬาลงกรณ์

กุลธิดา ฤทธิรงค์โรจน์, กระเชียร ปัญญาคำเลิศ, สุกัญญา ชัยกิตติศิลป์, ธวัชชัย ชัยวัฒน์รัตน์, นิमित เตชไกรชนะ

วัตถุประสงค์: เพื่อศึกษาร้อยละของภาวะกระดูกพรุนที่ตำแหน่งคอสะโพก (femoral neck) และตำแหน่งกระดูกสันหลังส่วนเอวข้อที่ 1 ถึง 4 (lumbar spine L1-L4) ตามกลุ่มอายุและช่วงดัชนีมวลกายของสตรีไทยที่ได้รับการวัดค่าความหนาแน่นกระดูกในโรงพยาบาลจุฬาลงกรณ์

วัสดุและวิธีการ: ทำการศึกษาในสตรีอายุตั้งแต่ 40 ปีขึ้นไปจำนวน 4,528 ราย ที่ได้รับการวัดค่าความหนาแน่นกระดูกเป็นครั้งแรกที่โรงพยาบาลจุฬาลงกรณ์ ตั้งแต่ปี พ.ศ. 2543 ถึง พ.ศ. 2553 การตรวจค่ามวลกระดูก ตรวจวัดตำแหน่งคอสะโพกข้างที่ไม่ถนัด และกระดูกสันหลังส่วนเอวข้อที่ 1 ถึง 4 โดยใช้เครื่อง Dual-energy X-ray Absorptiometer (DXA) พิจารณาค่าร้อยละของภาวะกระดูกพรุนในแต่ละกลุ่มอายุและช่วงดัชนีมวลกายตามเกณฑ์การวินิจฉัยภาวะกระดูกพรุนขององค์การอนามัยโลก และใช้ค่าอ้างอิงความหนาแน่นของสตรีไทยทั่วประเทศเป็นเกณฑ์

ผลการศึกษา: พบภาวะกระดูกพรุนที่ตำแหน่งคอสะโพกตามกลุ่มอายุ 40-49, 50-59, 60-69 และ ≥ 70 ปี ร้อยละ 6.2, 7.4, 24.4 และ 51.8 และที่ตำแหน่งกระดูกสันหลังส่วนเอวข้อที่ 1 ถึง 4 ร้อยละ 3.4, 5.6, 12.7 และ 20.9 ตามลำดับ ค่าร้อยละของภาวะกระดูกพรุนมีแนวโน้มเพิ่มอย่างรวดเร็วภายหลังอายุ 60 ปี ในทั้งสองตำแหน่งที่ทำการศึกษา พบภาวะกระดูกพรุนที่ตำแหน่งคอสะโพกตามช่วงของดัชนีมวลกาย น้อยกว่าเกณฑ์, ตามเกณฑ์, มากกว่าเกณฑ์ และอ้วน ร้อยละ 52.1, 20.3, 15.7 และ 9.4 และที่ตำแหน่งกระดูกสันหลังส่วนเอวข้อที่ 1 ถึง 4 ร้อยละ 22.8, 12, 4.8 และ 5.9 ตามลำดับ นอกจากนี้พบว่า มากกว่าร้อยละ 30 ของสตรีที่อายุตั้งแต่ 60 ปีขึ้นไป และมีดัชนีมวลกายน้อยกว่า 23 กิโลกรัม/ตารางเมตร มีภาวะของกระดูกพรุน

สรุป: พบภาวะกระดูกพรุนเพิ่มขึ้นตามอายุที่มากขึ้นและตามการลดลงของค่าดัชนีมวลกาย และเมื่อใช้เกณฑ์การวินิจฉัยภาวะกระดูกพรุนขององค์การอนามัยโลก และค่าอ้างอิงความหนาแน่นกระดูกของสตรีไทยทั่วประเทศ เป็นเกณฑ์พบว่าภาวะกระดูกพรุนที่ตำแหน่งคอสะโพกมากกว่าที่ตำแหน่งกระดูกสันหลังส่วนเอวข้อที่ 1 ถึง 4 ในการศึกษาพบว่าในสตรีที่อายุตั้งแต่ 60 ปี และมีดัชนีมวลกายน้อยกว่า 23 กิโลกรัม/ตารางเมตร มีภาวะกระดูกพรุนในอัตราที่สูง
