Value and Validation of RCOST and TOPF Clinical Practice Guideline for Osteoporosis Treatment

Chatlert Pongchaiyakul MD*,
Taninnit Leerapun MD**, Sunton Wongsiri MD***,
Thawee Songpattanasilp MD, PhD****, Nimit Taechakraichana MD*****

*Division of Endocrinology and Metabolism, Department of Medicine, Faculty of Medicine,
Khon Kaen University, Khon Kaen, Thailand*
*** Department of Orthopaedics, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*
****Department of Orthopaedics and Physical Surgery, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand*
*****Department of Orthopaedics, Phramongkutklao College of Medicine Phramongkutklao Hospital, Bangkok, Thailand*
*****Menopausal Research Unit, Department of Obstetrics and Gynecology, Faculty of Medicine,
Chulalongkorn University, Bangkok, Thailand*

Objective: *To determine the percentage of postmenopausal women who need treatment using the various criteria as set out in clinical practice guideline published by the Royal College of Orthopaedic Surgeons of Thailand (RCOST) and the Thai Osteoporosis Foundation (TOPF).*

Material and Method: *A cross-sectional investigation conducted at five university hospitals around Thailand, evaluated three categories of criteria according to the RCOST and the TOPF guideline for treatment in postmenopausal women, (1) bone mineral density (BMD) measured by DXA, (2) combined quantitative ultrasonography (QUS) measurement and clinical risk indices (CRI), and (3) FRAX or CRI plus spine radiography.*

Results: *One thousand sixty two woman averaging 60 years of age were recruited for this study. Of those, women with osteoporosis according to DXA, osteopenia plus FRAX, or one major or two minor risk factors comprised between 1 and 22% (category I). Using the QUS T-score in combination with CRI (OSTA or KKOS score ≤ -1) or nomogram criteria, between 11 and 14.4% needed treatment (category II). Using the BMI-based FRAX calculation or CRI (OSTA score of < -4 or KKOS probability of ≥ 80%) plus osteopenia by spine radiograph, between 2.6 and 15.7% needed treatment (category III).*

Conclusion: *Using the RCOST and TOPF clinical practice guideline, only one-fifth of postmenopausal Thai women would be eligible to receive treatment.*

Keywords: *Clinical practice guideline, Osteoporosis, Treatment, Thailand*

With an increase in the aged population from 11% in 2010 to an estimated 14% in 2015, 19.8% in 2025, and nearly 30% by 2050, Thailand will be faced with rising numbers of cases of osteoporosis, fragility fractures, subsequent morbidity, mortality, and heightened health costs[1,2]. Therefore, fracture prevention and early diagnosis of osteoporosis are of great importance, particularly since pharmacological treatment of osteoporosis has proved to be cost-effective.

Correspondence to:
Pongchaiyakul C, Division of Endocrinology and Metabolism, Department of Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.
Phone: 043-363-664, Fax: 043-202-491
E-mail: pchatl@kku.ac.th

In 2010, the Royal College of Orthopaedic Surgeons of Thailand (RCOST) and the Thai Osteoporosis Foundation (TOPF) jointly developed a clinical practice guideline for management of osteoporosis[3]. The guideline was intended to help clinicians identify individuals needing treatment, and to exclude those who were not indicated. The guideline covers a wide range of osteoporosis management strategies including those that can be affected at tertiary, secondary and primary care settings, even though dual energy X-ray absorptiometry (DXA) might not be available.

The guideline included simple tools commonly used in outpatient clinics to identify those at risk and needing treatment, such as: (a) quantitative ultrasound measurement (b) clinical risk indices [Osteoporosis

Self-assessment Tool for Asians (OSTA)][4] and Khon Kaen Osteoporosis Screening (KKOS)[5] (c) nomogram [combination bone mineral density (BMD) T-score with age and body weight][6] (d) clinical risk indices with thoraco-lumbar (TL)-spine radiograph and FRAX (Fracture risk assessment tool from World Health Organization, WHO)[7,8].

Although the guideline has been available nationwide for almost two years, it has never been validated. Moreover, it is important to know which screening and diagnostic criteria are appropriate for postmenopausal Thai women and how many of them would be treated according to the various measurements and tools available. The objectives of the present study were, therefore, (a) to examine the percentage of postmenopausal women who would need treatment according to the different screening and diagnostic criteria as set out in the clinical practice guideline and (b) to determine the association of those criteria - not including BMD measurement - with osteoporosis according to the WHO criteria.

Material and Method
Study design and participants

This cross-sectional study was conducted in five university hospitals in Thailand that included two centers from the Central region (Chulalongkorn and Phramongkutklao Hospitals), one from the North (Suandok Hospital), one from the Northeast (Srinagarind Hospital), and one from the South (Prince Songkhlanagarind Hospital). All of the hospitals are tertiary care settings. The study was conducted in postmenopausal Thai women (not having menstruated for at least 12 months) living in the catchment areas or nearby provinces of these hospitals. The subjects were recruited by advertisement.

The present study was conducted in accordance with the Helsinki Declaration in 1975 as revised in 1983. The present study was approved by the local Ethics Committee of each of the five universities and informed consent was obtained from all of the subjects.

Bone mineral density measurement

Bone mineral density (BMD) was measured at the lumbar spine (LS) and femoral neck (FN) in all of the participants. The measurements were done using dual energy X-ray absorptiometry (DXA) densitometer (two centers with Lunar Prodigy and three centers with Hologic Discovery). The densitometers were standardized by a standard phantom prior to the measurement and all studied sites used the

same protocol. The coefficients of variation of BMD for normal subjects among the centers were 1.5 to 2.0% for LS and 1.3% for FN. Standardization of bone mineral density (sBMD) was performed. The classification of BMD status was based on a previously published reference database for Thai women[9]. Women were diagnosed as having "osteoporosis" if the lumbar spine and/or femoral neck BMD T-score were equal to or less than -2.5 standard deviations (SD) below the young adult mean. Otherwise, they were defined as "non-osteoporosis". Patients were diagnosed as having "osteopenia" if the BMD T-score was between -1 to -2.5 SD below the young adult mean.

Measurement of calcaneus bone density was done using qualitative ultrasonography (QUS) on an Achilles express ultrasound device (Lunar, Madison, WI, USA). The measurement was repeated twice for test-retest reliability by the same technologist. The first and second QUSs were conducted before and after the DXA scan. The duration of both measurements did not exceed 30 minutes. The QUS measurement was expressed as a T-score - a number which was provided by the instrument's on board computer.

Clinical risk indices

Well-trained research nurses interviewed each participant using a standardized questionnaire. Body weight and standing height were measured using an electronic balance scale (accuracy 0.1 kg) and a stadiometer (nearest 0.1 cm) with participants wearing light clothing but no shoes. The Osteoporosis Assessment Tool for Asians (OSTA)[4] and Khon Kaen Osteoporosis Study (KKOS)[5] scores were then calculated using age (yr) and weight (kg)[9,10]. The OSTA score was calculated as 0.2 (weight - age)[9]. The KKOS score estimation is shown in Table 1. The summation of which score (age and weight) was used to evaluate risk.

Nomogram[6]

A nomogram for predicting osteoporosis risk was constructed from age, body weight and the QUS T-score of calcaneus (Fig. 1). A probability of osteoporosis of at least 0.3 is considered high-risk.

Fracture risk assessment tool (FRAX)[7]

The ten-year probability for hip and major osteoporotic fracture was assessed by FRAX. The calculation in FRAX was based on age, BMI, history of prior fracture, hip fracture in parents, steroid use, rheumatoid arthritis, alcohol use, presence or absence of secondary causes of osteoporosis, and using femoral

Table 1. Khon Kaen Osteoporosis Study (KKOS) scoring system

Age (y)	Score	Weight (kg)	Score
< 45	+7.5	< 30	-14
45-49	+6.0	30-34	-12
50-54	+4.5	35-39	-10
55-59	+3.0	40-44	-8
60-64	+1.5	45-49	-6
65-69	0	50-54	-4
70-74	-1.5	55-59	-2
75-79	-3.0	60-64	0
80-84	-4.5	65-69	+2
85-89	-6.0	70-74	+4
> 90	-7.5	75-79	+6
		80-84	+8
		85-89	+10
		> 90	+12

The KKOS score was the sum of age and weight scores
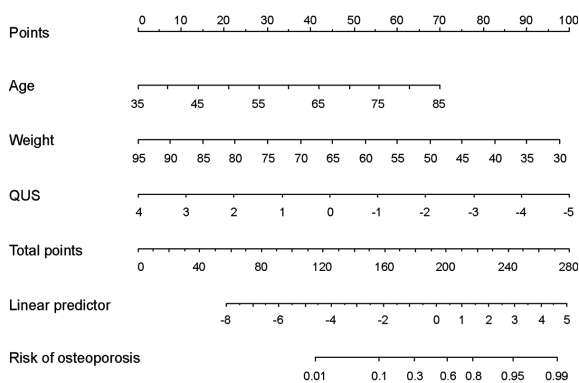KKOS score ≤ -1: high risk, KKOS score > -1: low risk

Fig. 1 Nomogram using age, body weight and QUS T-score

neck BMD T-score or BMI. In order to calculate fracture probability by FRAX, a US-Asian and a Japanese database were used for the baseline calculation. Data acquisition was done between March and June 2010. In order to calculate fracture risk online, a FRAX calculator was used and the 10-year fracture probability for each person was expressed as a percentage.

Guideline for treatment according to RCOST and TOPF[3]

After reviewing the guideline from RCOST and TOPF, the authors categorized the criteria for treatment based on using the DXA or QUS as follows:

Category I (using BMD from DXA)
- BMD at femoral neck and/or lumbar spine ≤ -2.5 SD
- BMD at femoral neck and/or lumbar spine between -1 and -2.5 SD plus
- FRAX 10-year probability of hip fracture ≥ 3% or major osteoporotic fracture ≥ 20% or
- Having a major risk factor *i.e.*, prior fracture after age 40 years, prolonged use of prednisolone ≥ 5 mg/day (more than 3 months), having a secondary cause(s) of osteoporosis or
- Having two minor risk factors *i.e.*, age ≥ 65 years in women or ≥ 70 year in men, body mass index ≤ 19 kg/m², parental history of hip fracture, early menopause (< 45 year), current heavy smoker, or regular alcohol drinking

Category II (without DXA machine and using QUS measurement of calcaneus)
- QUS T-score of calcaneus ≤ -2.5 plus OSTA or KKOS score ≤ -1
- Probability of osteoporosis using nomogram ≥ 0.3

Category III (without BMD from DXA machine or QUS measurement)
- FRAX calculation using BMI with 10-year probability of hip fracture ≥ 3% or major osteoporotic fracture ≥ 20% or
- OSTA score < -4 or KKOS probability ≥ 80% with osteopenia diagnosed by X-ray radiograph at the thoraco-lumbar (T-L) spine

Results

One thousand sixty two women were recruited for the final analysis. Characteristics of the participants are presented in Table 2. The average age for all women was 60 years (range, 36-90). Using the WHO criteria, the prevalence of osteoporosis in the entire sample was 13.7% (145/1,062), 15.4% (164/1,062), and 7.2% (76/1,062) at the lumbar spine, femoral neck, and both sites, respectively. The prevalence at all sites increased with age.

According to the RCOST and TOPF clinical practice guideline, the percentages of postmenopausal women who needed pharmacological intervention using the different screening and diagnostic criteria are presented in Table 3. In category I, using DXA BMD a T-score of ≤ -2.5 of either the LS or FN, 22% of postmenopausal women were indicated for treatment. One to 2.7% of women with osteopenia at the LS or

Table 2. Characteristics of study subjects (n = 1,062 women)

Variable	Mean ± standard deviation
Age (yr)	60.1 ± 8.6
Weight (kg)	57.4 ± 9.3
Height (cm)	153.2 ± 5.7
Body mass index (kg/m^2)	24.4 ± 3.7
Standardized bone mineral density	
Lumbar spine (L1-4)	0.915 ± 0.163
Femoral neck	0.727 ± 0.121
T-score (SD)	
Lumbar spine (L1-4)	-1.06 ± 1.40
Femoral neck	-1.33 ± 1.18
Quantitative ultrasound T-score (SD)	-0.96 ± 1.65
Probability of osteoporosis using nomogram	0.14 ± 0.20
OSTA score	-0.49 ± 2.43
KKOS score	0.12 ± 4.89
KKOS probability	0.31 ± 0.20
10-year probability of major osteoporotic fracture (%)	
Without BMD	
Japanese reference	8.52 ± 6.84
US Asian reference	7.76 ± 5.70
With BMD	
Japanese reference	8.29 ± 6.65
US Asian reference	7.65 ± 5.85
10-year probability of hip fracture (%)	
Without BMD	
Japanese reference	1.92 ± 3.88
US Asian reference	1.60 ± 2.84
With BMD	
Japanese reference	1.62 ± 3.47
US Asian reference	1.38 ± 2.64

FN plus a high fracture risk according to the FRAX calculation needed treatment. Women with osteopenia plus certain risk factors having a higher percentage of treatment required treatment (*i.e.*, 9.5% and 4.1% for one major or two minor risk factors, respectively).

In category II (without DXA BMD), 11% of postmenopausal women needed treatment using the QUS T-score in combination with clinical risk indices (*i.e.*, an OSTA or KKOS score ≤ -1). With a nomogram of ≥ 0.3, 14.4% were indicated for treatment.

In category III (without DXA and QUS BMD), using a BMI-based FRAX calculation, the percentage of treatment was higher when using the Japanese as a reference compared with an US-Asian reference (*i.e.*, 15.7% vs. 12.8% for the 10-year probability of having hip fracture of ≥ 3% and 7.3%

vs. 4.0% for the 10-year probability of having a major osteoporotic fracture of ≥ 20%, respectively). The percentage of treatment was between 2.6 and 8.9% using an OSTA score of < -4 or a KKOS probability of ≥ 80% combined with a diagnosis of osteopenia using an X-ray of the TL-spine. The authors found, however, that the percentage of treatment was not significantly different with the use of clinical risk indices alone (10.5% for OSTA score < -4 and 2.6% for KKOS probability ≥ 80%).

BMD measurement is the gold standard for diagnosis. If subjects have a BMD T-score ≤ -2.5 SD at the LS and/or FN, the patient will be classified as having osteoporosis as presented in Table 4. The risks of having osteoporosis using category II criteria without the aid of DXA are (a) 7.2 to 7.3-fold for a

Table 3. Percentages of postmenopausal women who received treatment using different criteria as per the TOPF and RCOST guideline

Criterion	% (n/total)
Category I	
Osteoporosis at LS	13.7 (145/1062)
Osteoporosis at FN	15.4 (164/1062)
Osteoporosis at LS and FN	7.2 (76/1062)
Osteoporosis at LS and/or FN	22.0 (234/1062)
Osteopenia at LS and/or FN plus FRAX (with BMD)	
Japanese reference:	
10-yr probability of hip fracture ≥ 3%	2.7 (29/1062)
10-yr probability of major osteoporotic fracture ≥ 20%	1.4 (15/1062)
US Asian reference:	
10-yr probability of hip fracture ≥ 3%	1.7 (18/1062)
10-yr probability of major osteoporotic fracture ≥ 20%	1.0 (11/1062)
Osteopenia at LS and/or FN plus 1 major risk factor	9.5 (101/1062)
Osteopenia at LS and/or FN plus 2 minor risk factors	4.1 (44/1062)
Category II	
OSTA score ≤ -1 plus QUS T-score ≤ -2.5	11.8 (125/1062)
KKOS score ≤ -1 plus QUS T-score ≤ -2.5	11.3 (120/1062)
Nomogram ≥ 0.3	14.4 (153/1062)
Category III	
FRAX calculation without BMD	
Japanese reference:	
10-yr probability of hip fracture ≥ 3%	15.7 (1671062)
10-yr probability of major osteoporotic fracture ≥ 20%	7.3 (78/1062)
US Asian reference:	
10-yr probability of hip fracture ≥ 3%	12.8 (136/1062)
10-yr probability of major osteoporotic fracture ≥ 20%	4.0 (42/1062)
OSTA score < -4 plus osteopenia by T-L radiograph	8.9 (94/1062)
KKOS probability ≥ 80% plus osteopenia by T-L radiograph	2.6 (28/1062)

QUS T-score of the calcaneus ≤ -2.5 SD plus an OSTA or a KKOS score ≤ -1 and (b) 9.7-fold for a nomogram of ≥ 0.3. This means that when another method is used for categories II and III, 60% of women are still diagnosed as having osteoporosis. Consequently, these alternative (less expensive and readily available) criteria can be used to identify osteoporosis categories II for treatment.

In category III, the risk for having osteoporosis was 5.1 to 6.4-fold for FRAX with the 10-year probability of a hip fracture ≥ 3% or of a major osteoporotic fracture ≥ 20%, based on a Japanese or US-Asian reference database. Those with an OSTA score of < -4 with osteopenia diagnosed by X-ray radiography at the T-L spine, the risk of having osteoporosis was 9.4-fold greater. Those with a KKOS probability ≥ 80% with osteopenia diagnosed by X-ray radiograph at the T-L spine had a 32.8-fold higher risk.

Using the various criteria, it was found that between 52.7% and 89.3% of postmenopausal women had osteoporosis at the FN and/or LS.

Discussion

The incidence of osteoporosis-related fracture is expected to rise in Thailand as it has already throughout Asia[10]. Osteoporotic fractures can have a devastating impact on the quality of life, leading to chronic pain, further illness, disability, or even death. The appropriate identification of those at high fracture risk is essential. The TOPF and RCOST new guideline helps physicians better identify those at risk of osteoporosis and fracture, resulting in better fracture prevention and management of osteoporosis overall[3]. The guideline defines the clinical decision rules for selecting patients for screening using risk factors and clinical risk indices, DXA measurement and state the

Table 4. Percentage and risk of osteoporosis at lumbar spine and/or femoral neck using BMD T-score ≤ -2.5 SD as a gold standard

Criterion	Percentage of osteoporosis at LS and/or FN	Odds ratio (95% CI)	p-value
Category II			
OSTA score ≤ -1 plus QUS T-score ≤ -2.5	60.0	7.34 (4.94-10.91)	<0.001
KKOS score ≤ -1 plus QUS T-score ≤ -2.5	60.0	7.22 (4.83-10.80)	<0.001
Nomogram ≥ 0.3	63.4	9.76 (6.70-14.21)	<0.001
Category III			
FRAX calculation without BMD			
Japanese reference:			
10-yr probability of hip fracture ≥ 3%	52.7	5.71 (4.02-8.12)	<0.001
10-yr probability of major osteoporotic fracture ≥ 20%	56.4	5.41 (3.36-8.69)	<0.001
US Asian reference:			
10-yr probability of hip fracture ≥ 3%	56.6	6.39 (4.37-9.35)	<0.001
10-yr probability of major osteoporotic fracture ≥ 20%	57.1	5.14 (2.74-9.65)	<0.001
OSTA score < -4 plus osteopenia by T-L radiograph	67.0	9.47 (5.98-15.01)	<0.001
KKOS probability ≥ 80% plus osteopenia by T-L radiograph	89.3	32.89 (9.84-109.99)	<0.001

criteria for receiving treatment. The guideline was developed for use in settings with or without DXA and/or quantitative ultrasound of calcaneus. Despite having been launched in Thailand since early 2011, the guidelines have never been validated and there is no universally-accepted policy for reimbursement.

In the current study, the percentage of those being treated was between 1.0 and 22% with BMD in category I. The numbers were higher when using BMD alone or BMD in combination with risk factors compared to BMD plus FRAX. Without the use of DXA in categories II and III, the percentages of persons getting treatment would be comparable [*i.e.*, using the QUS T-score combined with clinical risk indices, nomogram (11.3-14.4% in category II) and using FRAX alone or clinical risk indices plus T-L spine radiograph (2.6-15.7% for category III)]. Interestingly, the present study revealed that the criteria used for categories II and III had high odds ratio with percentages comparable for giving treatment to category I with the advantage of having the results of a BMD test. Importantly, when using the criteria in categories II and III, 53 to 89% of postmenopausal women indicated for treatment were diagnosed with osteoporosis at the LS and/or FN. The percentages seemed to be more pronounced when using clinical risk indices combined with a QUS T-score or a diagnosis of osteopenia using a T-L spine radiograph.

The osteoporosis guidelines in Thailand have been continuously developed since 2002 by groups of physicians with various fields of expertise (*i.e.*, orthopedic surgeons, endocrinologists, rheumatologists, rehabilitation physicians and gynecologists). Though the latest RCOST and TOPF guideline had three categories of treatment intervention criteria, less than 22% of postmenopausal women would be treated with the addition of the QUS T-score plus clinical risk indices, nomogram, or FRAX criteria to BMD from DXA. The current research was an attempt to look for a more specific guideline to minimize under- and over-treatment with the backdrop of increasingly costly medication. The guideline also provides guidance for physicians working in low-resource settings (*i.e.*, without a BMD machine) that they might have management principles for dealing more effectively with osteoporosis[3].

There were some limitations in the present study. As it is generally known, BMD is an intermediate outcome of risk and treatment evaluation of which fracture is considered to be the final endpoint. The current study attempted to validate the RCOST and TOPF guideline using BMD as benchmark and gold standard in order to estimate more convincingly the percentages of likely candidates for treatment if the guideline was applied to the general population. In other words, according to the proposed treatment criteria in the guideline, how many patients would be indicated for pharmacological intervention?

Wainwright et al[11] reported that in 8,065 women ≥ 65 years of age, 3% (243 cases) had a

new hip fracture during the five years of follow-up. Surprisingly, 42% of those who had a hip fracture did not have osteoporosis of the total hip or lumbar spine. The crude incidence rate of hip fracture was 17.7/1,000 person-years among women with total hip osteoporosis and 4.1/1,000 person-years among women who did not have total hip osteoporosis. It is essential, therefore, for Thailand to have its own information vis-à-vis the percentage of those likely to have fracture once osteoporosis is diagnosed.

In Thailand, Jitapunkul et al[12] reported an incidence of vertebral fracture in women ≥ 50 years of age in a suburb of Bangkok of 32.1/1,000 person-years. The latest Chiangmai report[13] on the estimated cumulative incidence of hip fracture in women ≥ 50 years was 367.9/100,000 person/year. This is noteworthy considering the crude incidence of hip plus vertebral fractures of 3 to 4% with the 4.5 to 15.5% prevalence of fractures reported in the current study. The prevalence comprises old and new fractures whether (or not) they were low or high impact fractures. This raises an important research question, "How can we ensure that the persons who would most benefit from costly anti-fracture medication are being treated?".

Despite all the potential limitations, the present study has as the advantage that the participants represent the Thai population as they were recruited from all parts of Thailand and the sample size was large enough to ensure that the present study could assess even modest effects not possible in similar smaller studies.

In conclusion, when evaluating the RCOST and TOPF clinical practice guideline for Thai postmenopausal women, the authors found that less than 22% of postmenopausal women would be eligible for treatment. Even when the DXA machine is unavailable, the percentage of treatment using clinical risk indices, risk factors, QUS T-score, nomogram, and FRAX criteria in categories II and II were similar and good predictors of osteoporosis risk. The current study also showed that the RCOST and TOPF guideline, though having some limitations, represent the most up-to-date development and can be used with confidence as guidance for osteoporosis management.

Potential conflicts of interest

None.

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คุณค่าและการทดสอบแนวทางเวชปฏิบัติในการรักษาโรคกระดูกพรุนของราชวิทยาลัยออร์โธปิดิกส์แห่งประเทศไทยและมูลนิธิโรคกระดูกพรุนแห่งประเทศไทย

ฉัตรเลิศ พงษ์ไชยกุล, ธนินนิต ลีรพันธ์, สุนทร วงษ์ศิริ, ทวี ทรงพัฒนาศิลป์, นิมิต เตชะไกรชนะ

วัตถุประสงค์: เพื่อประเมินร้อยละของสตรีไทยวัยหมดระดูในการได้รับการรักษาโดยใช้เกณฑ์ต่าง ๆ ตามแนวทางเวชปฏิบัติในการรักษาโรคกระดูกพรุนของราชวิทยาลัยออร์โธปิดิกส์แห่งประเทศไทยและมูลนิธิโรคกระดูกพรุนแห่งประเทศไทย

วัสดุและวิธีการ: เป็นการศึกษาแบบตัดขวางในโรงพยาบาลมหาวิทยาลัยจำนวน 5 แห่งในประเทศไทย โดยทำการประเมินเกณฑ์ต่าง ๆ ที่ใช้ในการให้การรักษาตามแนวทางเวชปฏิบัติการรักษาโรคกระดูกพรุน ซึ่งแบ่งได้เป็น 3 กลุ่ม ได้แก่ 1) กลุ่มที่ใช้ผลตรวจความหนาแน่นของกระดูกโดยเครื่องตรวจความหนาแน่นของกระดูก 2) กลุ่มที่ใช้ผลตรวจความหนาแน่นของกระดูกจากเครื่องอัลตราซาวด์ส้นเท้าร่วมกับดัชนีความเสี่ยงทางคลินิก และ 3) กลุ่มที่ประเมินโดยใช้เครื่องมือทำนายการเกิดกระดูกหักจากองค์การอนามัยโลก (FRAX) หรือ การใช้ดัชนีความเสี่ยงทางคลินิกร่วมกับผลตรวจภาพทางรังสีกระดูกสันหลัง

ผลการศึกษา: มีสตรีวัยหมดระดูจำนวน 1,062 ราย (อายุเฉลี่ย 60 ปี) เข้าร่วมการศึกษา พบว่าสตรีที่ตรวจพบกระดูกพรุนโดยใช้เครื่องตรวจความหนาแน่นของกระดูก หรือ มีกระดูกบางร่วมกับการใช้ FRAX หรือ มี 1 ปัจจัยเสี่ยงหลัก หรือ 2 ปัจจัยเสี่ยงรองที่ต้องได้รับการรักษาคิดเป็นร้อยละ 1-22 (กลุ่มที่ 1) ในขณะที่การใช้ผลตรวจความหนาแน่นของกระดูกโดยเครื่องอัลตราซาวด์ส้นเท้าร่วมกับดัชนีความเสี่ยงทางคลิกนิก (OSTA หรือ KKOS score น้อยกว่าหรือเท่ากับ -1) หรือ โนโมแกรม มีสตรีวัยหมดระดูที่ต้องได้รับการรักษาคิดเป็นร้อยละ 11-14.4 (กลุ่มที่ 2) และการใช้ FRAX โดยอาศัยการคำนวณจากดัชนีมวลกาย หรือ ดัชนีความเสี่ยงทางคลินิก (OSTA score of น้อยกว่า -4 หรือ KKOS probability มากกว่าหรือเท่ากับร้อยละ 80) ร่วมกับผลตรวจภาพรังสีกระดูกสันหลังมีภาวะกระดูกบาง มีสตรีวัยหมดระดูที่ต้องได้รับการรักษาคิดเป็นร้อยละ 2.6-15.7 (กลุ่มที่ 3)

สรุป: เพียง 1 ใน 5 ของสตรีไทยวัยหมดระดูเท่านั้น ที่จะได้รับการรักษาเมื่ออิงตามเกณฑ์จากแนวทางเวชปฏิบัติในการรักษาโรคกระดูกพรุนของราชวิทยาลัยออร์โธปิดิกส์แห่งประเทศไทย และมูลนิธิโรคกระดูกพรุนแห่งประเทศไทย