# ความสัมพันธ์ของดัชนีทางโภชนาการและการออกกำลังกายต่อความหนาแน่นมวลกระดูกในกลุ่มผู้หญิงไทยวัยหมดประจำเดือนซึ่งมีภาวะกระดูกบาง/กระดูกพรุน

# RELATIONSHIP OF NUTRITIONAL INDICES AND PHYSICAL ACTIVITY TO BONE MINERAL DENSITY IN OSTEOPENIA/OSTEOPOROSIS THAI POSTMENOPAUSAL WOMEN

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## บทคัดย่อ

กระดูกพรุนเป็นโรคที่สามารถป้องกันได้โดยการดูแลวิถีการใช้ชีวิตประจำวัน การตรวจพบภาวะกระดูกพรุนได้เร็วจะเป็นทางที่เหมาะสมที่สุดในการตรวจหาปัจจัยเสี่ยง และลดภาวะกระดูกพรุนเพิ่มขึ้น วัตถุประสงค์ของงานวิจัยนี้ เพื่อศึกษาและระบุปัจจัยเสี่ยงทางสิ่งแวดล้อม ทั้งอาหารและรูปแบบกิจกรรมซึ่งสัมพันธ์กับภาวะกระดูกพรุนในผู้หญิงไทยวัยหมดประจำเดือน โดยผู้หญิงไทยวัยหมดประจำเดือน จำนวน 331 คน เป็นกลุ่มประชากรที่ศึกษาเก็บข้อมูลในปี พ.ศ. 2550 ถึง พ.ศ. 2557 รูปแบบการศึกษาเป็นแบบตัดขวาง มีการเก็บข้อมูลแบบสอบถาม ผลชีวเคมีในเลือด และค่าความหนาแน่นมวลกระดูก (DEXA) ในอาสาสมัครหญิงวัยหมดประจำเดือน ซึ่งเป็นผู้เข้ารับการรักษาในคลินิกวัยทอง ภาควิชาสูติศาสตร์นรีเวชวิทยา คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล จากผลการศึกษา พบความชุกภาวะกระดูกพรุนในกลุ่มประชากรที่ศึกษามีภาวะกระดูกบางร้อยละ 46.5 กระดูกพรุนร้อยละ 28.4 (แบ่งตามความหนาแน่นมวลกระดูก T-score)

หลังจากการปรับอายุและดัชนีมวลกายเพื่อวิเคราะห์ข้อมูลจากแบบสอบถาม พบว่า น้ำหนัก ส่วนสูง ดัชนีมวลกาย การออกกำลังกาย การรับประทานอาหารที่มีโปรตีน รวมถึงค่าชีวเคมีในเลือดได้แก่ แคลเซียมและฟอสฟอรัส มีความสัมพันธ์กับค่าความหนาแน่นมวลกระดูก ดังนั้นควรมีการตระหนักถึงสถานการณ์โรคกระดูกพรุนในประเทศไทย การศึกษานี้แนะนำว่าการออกกำลังกายและการรับประทานอาหารเป็นปัจจัยสำคัญในการลดความเสี่ยงการเกิดโรคกระดูกพรุน การศึกษาในอนาคตควรมีการศึกษาในเชิงปริมาณและระยะยาวของอาหารและสารอาหารที่เกี่ยวข้องกับการลดความเสี่ยงโรคกระดูกพรุน

**คำสำคัญ:** กระดูกพรุน ผู้หญิงไทยวัยหมดประจำเดือน ค่าความหนาแน่นมวลกระดูก แบบสอบถามการออกกำลังกายและการรับประทานอาหาร

## Abstract

Osteoporosis associates with lifestyle factors. To identify the environmental factors both of the dietary and activity patterns associated with osteoporosis in Thai postmenopausal women. The study population was derived from the data during 2007 to 2014. This cross-sectional study was performed in 331 Thai postmenopausal female volunteers, who attended the menopause clinic post-operation follow up clinic, Department of Obstetrics and Gynecology, Ramathibodi Hospital, Bangkok, for a physical check-up and bone mineral scan by dual-energy x-ray absorptiometry (DEXA). The prevalence of Thai postmenopausal women in this study were osteopenia (46.5%) and osteoporosis (28.4%) (classified by T-score bone mineral density; BMD at any sites). After adjustment for age and BMI, the data from questionnaire were analyzed. Weight, height, BMI, exercise, protein-sourced food, and biochemical parameters including calcium and phosphorus levels were associated with BMDs. The public health care system should concern in osteoporosis situation. The lifestyle factors, especially dietary factor, are associated with bone mineral density (BMD). This research recommended that exercise and dietary are very important factors for reducing the risk of osteoporosis. Further investigations with quantitative analysis of food and nutrient consumption and long-term follow-up should be investigated.

**Keywords:** Osteoporosis, Postmenopausal women, Bone mineral density, Nutritional indices and physical activity

## Introduction

With an aging worldwide population, osteoporosis has rapidly become a public health problem because loss of bone density rises to significant morbidity and mortality [1]. Osteoporosis is characterized by bone strength predisposing to an increased risk of fracture [2]. The prevalence of osteoporosis amplified over past few years. Fractures of hip, vertebral and distal forearm have been regarded as the typical osteoporotic fractures [3]. Osteoporosis is three times more common in women than in men because women have a lower peak bone mass and the hormonal changes at the menopause [3]. In each year, cost of all osteoporotic fractures have been estimated to be 20 billion US $in USA, 30 billion€ in EU union [4]. Even in Thailand, average total cost of hip fracture treatment in 1 year was nearly the national GDP per year [5]. Osteoporosis may be preventable from the intervention of environmental factors. The early detection of osteoporosis is the best way to identify the risk factors, and then to reduce them for osteoporosis progression.

## Objectives

The objective in this study was to identify the environmental factors both of the dietary and activity patterns associated with osteoporosis in Thai postmenopausal women.

## Methods

The study population was derived from the data during 2007 to 2014. This cross-sectional study was performed in 331 Thai postmenopausal female volunteers, who attended the menopause clinic post-operation follow up clinic, Department of Obstetrics and Gynecology, Faculty of medicine, Ramathibodi Hospital, Bangkok, for a physical check-up and bone mineral density scan (DEXA). The same gynecologist conducted physical examinations throughout this study. The exclusion criteria for each subject group were defined as minor ailments and typical diseases such as hypertension, mild to moderate of vascular disease and diabetes mellitus that may have affected their bone metabolism and the vitamin supplementation. This protocol was approved by the Ethical Committee of the Faculty of Medicine, Ramathbodi hospital, Mahidol university (MURA2008/996) and informed consent was obtained from each participant. All subjects were measured BMD by DEXA instrument (Luna, Prodigy, USA) at Ramathibodi Hospital, Bangkok. The position included anterior-posterior spine, lumbar spine (LS) 1-4, femoral (head of neck, wards, trochanter, total), distal forearm (ultra-distal radius (UD), radius, total radius), and total body bone mineral density. The definition of osteoporosis was made using the WHO T-score criteria (T-score $\leq$ -2.5), by using the BMD value for Asian as a reference. Body weight of each individual dressed in light clothing was measured using a carefully calibrated beam balance (Detecto®), as well as the height of each individual was measured using a vertical-measuring rod; BMI was calculated as weight divided by the square of height. Arm span and arm span/height ratio were calculated. Socio-demographic information was collected through interviewing and questionnaires. The age, marital status, place of origin, alcohol consumption, coffee intake, physical activity and smoking habits were assessed through questionnaires. Blood parameter such as calcium, phosphorus, albumin, and total protein were collected from routine measurement in medical record.

Data were tested for normal distribution and could not be verified as normal distribution, and then non-parametric test was used. Median, range and 95% confident interval (95%C.I.) of median were used for the measurement of central tendency and the dispersion of the data, respectively. Mann-Whitney U test was used for the analysis of difference in median of variables between two independent groups and the Kruskal-Wallis H Test was used for the analysis of difference between three or more than three independent groups. Spearman’s Rank correlation was tested for the correlation of biochemical parameter calculation. Percentage was used to calculate proportions. Chi-square test and Fisher’s exact test were used to test the association on appropriate proportion.

## Results

The prevalence of osteoporosis of each BMD was presented in Table 1. Osteopenia had a higher prevalence than osteoporosis subjects. To separate the disease status, osteoporosis/osteopenia and control groups were classified by BMD for analysis. Age, anthropometric data and food frequencies between osteoporosis/osteopenia and control groups were showed in Table 2. Age and BMI of osteoporosis/osteopenia subjects were significantly higher than control subjects. The highest percentage of age distribution in osteoporosis/osteopenia was 56-65 years old, whereas the control subjects were the range of 46-55 years old. The height, arm span, height/arm span ratio, kyphosis family history, fracture history, exercise, sunlight exposure, alcohol consumption, and smoking behaviors were quite similar between the two groups.

**Table 1** The prevalence of osteoporosis, osteopenia and control in each bone position classified by T-score bone mineral density (BMD).

| BMD positions | Osteoporosis N (%) | Osteopenia N (%) | Control N (%) |
|---|---|---|---|
| Lumbar spine L1 | 30 (10.9) | 104 (37.7) | 142(51.4) |
| Lumbar spine L2 | 40 (14.0) | 109 (38.1) | 137 (47.9) |
| Lumbar spine L3 | 18 (6.3) | 79 (27.6) | 189 (66.1) |
| Lumbar spine L4 | 11 (3.8) | 101 (35.3) | 174 (60.8) |
| Total lumbar spine (L1-4) | 15 (5.2) | 101 (35.2) | 171(59.6) |
| Femoral neck | 6 (2.2) | 101 (36.3) | 171 (61.5) |
| Femoral wards triangle | 58 (20.8) | 141 (50.5) | 80 (28.7) |
| Femoral trochanter | 6(2.2) | 58 (20.8) | 215 (77.1) |
| Total hip | 7 (2.5) | 55(19.7) | 217 (77.8) |
| Radius ultra-distal | 73 (24.1) | 107(35.3) | 123 (40.6) |
| Radius | 28 (9.3) | 93 (31.0) | 179(59.7) |
| Total radius | 40 (13.2) | 100 (33.1) | 162 (53.6) |
| Total body | 7(2.7) | 76(29.1) | 178(68.2) |

BMD, bone mineral density ($g/cm^2$), for osteoporosis; T score$\leq$-2.5, for osteopenia; T-score$\leq$-1, >-2.5

**Table 2** Demographic, anthropometric, and some food consumption data in osteoporosis/osteopenia and control subjects.

| | Number (%) | | |
|---|---|---|---|
| **Parameters** | **Osteoporosis/osteopenia** | **Control** | ***p value**** |
| **Age (year)** | | | |
| Lowest to 45 | 6(2.4) | 12(14.5) | |
| 46-55 | 68(27.4) | 41(49.4) | 0.001 |
| 56-65 | 133(53.6) | 26(31.3) | |
| 66-75 | 41(16.5) | 4(4.8) | |
| **BMI (kg/m$^2$)** | | | |
| <25 | 192(77.4) | 42(51.9) | 0.001 |
| ≥25 | 56(22.6) | 39(48.1) | |
| **Arm span/height ratio** | | | |
| ≥1 | 196(85.2) | 62(80.5) | NS |
| <1 | 34(14.8) | 15(19.5) | |
| **Fracture history** | | | |
| Yes | 32(1.3) | 5(6.0) | NS |
| No | 209(86.7) | 78(94.0) | |
| **Sport /house work** | | | |
| (min/week) | | | NS |
| <120 | 122(54.2) | 38(52.8) | |
| ≥120 | 103(45.8) | 34(47.2) | |
| **Sun light exposure time** | | | |
| **(min/week)** | 116(48.7) | 40(50.6) | |
| <60 | 122(51.3) | 39(49.4) | NS |
| ≥60 min/week | | | |
| **Alcohol** | | | |
| Yes | 5(2.0) | 0(0.0) | NS |
| No | 243(98.0) | 83(100.0) | |
| **Smoking** | | | |
| Yes | 0(0) | 0 (0.0) | NS |
| No | 248 (100.0) | 83 (100.0) | |
| **Protein-source food (cup)** | | | |
| <2.3 | 121(53.3) | 33(42.3) | NS |
| ≥2.3 | 106(46.7) | 45(57.7) | |

| Parameters | Number (%) Osteoporosis/osteopenia | Control | *p value** |
|---|---|---|---|
| **Dairy food (glass)** | | | |
| <3 | 130(54.2) | 48(58.5) | NS |
| ≥3 | 11(45.8) | 34(41.5) | |
| **Vegetable (cup)** | | | |
| <7 | 197(83.1) | 62(77.5) | NS |
| ≥7 | 40(16.9) | 18(22.5) | |
| **Fruit** | | | |
| Yes | 12(5.0) | 80(98.8) | NS |
| No | 229(95.0) | 1(1.2) | |
| **Coffee** | | | |
| Yes | 139(57.0) | 58(70.7) | NS |
| No | 105(43.0) | 24(29.3) | |

*Based on the results of the chi-square test, $p<0.05$ was considered statistically significant, NS; not significant

Food frequency data distributions showed no significant difference in percentages between two groups (data did not show). Medians, ranges and 95% confidence interval (95% C.I.) of age, anthropometric and biochemical parameters in the osteoporosis/osteopenia and control subjects were analyzed as showed in Table 3. Osteoporosis/osteopenia subjects were older than control subjects while they had lower BMI than control subjects (p=0.01). Height in osteoporosis/osteopenia was significantly lower than in control group while arm span, and height/arm span ratio were not significant difference between groups. All of biochemical parameters were not show any statistical difference between groups.

**Table 3** Parameters in the osteoporosis/osteopenia and control subjects.

| Parameters | Groups: Osteoporosis/osteopenia Median (n=248) (Range) | Osteoporosis/osteopenia 95% C.I. | Control Median (n=83) (Range) | Control 95% C.I. | *p-value** |
|---|---|---|---|---|---|
| Age (year) | 59.0 (41.0-75.0) | 58.0-60.0 | 53.0 (36.0-72.0) | 52.0-54.0 | 0.01 |
| BMI (kg/m$^2$) | 22.63 (15.46-33.41) | 22.21-23.04 | 24.88 (19.35-39.54) | 23.73-26.20 | 0.01 |
| Waist/hip ratio | 0.81 (0.68-1.05) | 0.80-0.82 | 0.82 (0.68-0.97) | 0.81-0.84 | NS |

| Parameters | Groups: Osteoporosis/osteopenia Median (n=248) (Range) | 95% C.I. | Groups: Control Median (n=83) (Range) | 95% C.I. | p-value* |
|---|---|---|---|---|---|
| Height (cm.) | 155.0 (138.0-170.0) | 155.0-156.0 | 156 (146.0-179.0) | 153.9-158.0 | 0.038 |
| Arm span (cm.) | 158.0 (133.0-181.0) | 157.5-159.0 | 158.0 (146.0-176.0) | 156.0-160.0 | NS |
| Height/arm span ratio | 0.98 (0.88-1.07) | 0.97-0.99 | 0.98 (0.92-1.07) | 0.96-0.99 | NS |
| Calcium (mg/dL) | 9.4 (7.8-10.8) | 9.3-9.4 | 9.4 (8.5-10.6) | 9.3-9.5 | NS |
| Phosphorus (mg/dL) | 3.8 (1.3-5.7) | 3.8-3.9 | 3.8 (2.9-5.0) | 3.7-4.0 | NS |
| Total protein (g/L) | 75.6 (66-89.8) | 75.2-76.4 | 76.9 (68.10-85.30) | 75.4-77.8 | NS |
| Albumin (g/L) | 45.0 (34.7-54.7) | 44.5-45.4 | 44.8 (37.30-52.60) | 44.3-44.5 | NS |

95% C.I., 95% confidence interval; * Based on the results of the Mann-Whitney U Test (two-tailed), *$p<0.05$ was considered statistically significant, NS; not significant.

The correlation coefficients between each anthropometric and biochemical parameter in all subjects were demonstrated in this study. Age and BMI correlated significantly with all bone mineral densities (BMD) (data did not show). Sunlight exposure, exercises, food frequencies, and biochemical parameters correlated with BMD levels as showed in Table 4. After adjustment for age and BMI, the quantitative data from questionnaire were analyzed. Not only exercise (sport and house work activities) positively correlated with hip BMD levels ($p<0.05$), but the food frequencies also showed the positive correlation between the protein intakes to all parts of hip and radial in BMD measurement, however sunlight exposure time, dairy food, and vegetable did not show any significant correlation. The correlation between nutritional indicators as calcium, inorganic phosphorus, total protein, and albumin in serum with BMD were investigated. Serum calcium showed the positive correlation to most sites of BMD except femoral trochanter, femoral wards, total hip, 33% radius, and total body BMD.

**Table 4** Correlation coefficients of sunlight exposure, exercise, food frequency, and biochemical parameter to bone mineral density in all subjects.

| | **LS1** | **LS2** | **LS3** | **LS4** | **LS1-4** | **Total** | **HN** | **HTRO** | **HW** | **HTOL** | **RUD** | **R33** | **RTOL** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sunlight exposure** | 0.012 | 0.020 | 0.060 | 0.043 | 0.022 | 0.001 | 0.043 | 0.063 | 0.035 | 0.054 | 0.044 | 0.016 | 0.012 |
| **Exercise** | 0.019 | 0.032 | 0.63 | 0.012 | 0.034 | 0.058 | 0.054 | **0.153*** | 0.065 | **0.165*** | 0.009 | 0.002 | 0.004 |
| **Protein-food** | 0.084 | 0.740 | 0.980 | 0.118 | 0.105 | 0.090 | **0.200*** | **0.201*** | **0.168*** | **0.238*** | **0.123*** | 0.090 | 0.105 |
| **Dairy food** | 0.133 | 0.130 | 0.128 | 0.170 | 0.150 | 0.698 | 0.152 | 0.089 | 0.178 | 0.147 | 0.101 | 0.045 | 0.041 |
| **Vegetable** | 0.049 | 0.057 | 0.043 | 0.78 | 0.084 | 0.127 | 0.102 | 0.052 | 0.088 | 0.096 | 0.071 | 0.078 | 0.068 |
| **Albumin** | 0.020 | 0.051 | 0.049 | 0.045 | 0.015 | 0.048 | 0.087 | 0.128 | 0.104 | 0.060 | 0.040 | 0.018 | 0.123 |
| **Total protein** | 0.102 | 0.029 | 0.074 | 0.065 | 0.068 | 0.042 | 0.098 | 0.043 | 0.055 | 0.052 | 0.066 | 0.108 | 0.042 |
| **Calcium** | **0.364*** | **0.366*** | **0.393*** | **0.381*** | **0.392*** | **0.214*** | 0.337 | 0.144 | 0.208 | **0.270*** | 0.228 | **0.352*** | 0.213 |
| **Inorganic Phosphors** | 0.115 | 0.133 | 0.132 | 0.227 | 0.161 | 0.030 | 0.083 | 0.083 | 0.063 | 0.048 | 0.049 | 0.051 | 0.192 |

L; lumbar spine, total; total femoral, HN; femoral neck, HTRO; femoral trochanter, HW; femoral wards, HTOL; total hip, RUD; ultra-distal radius, R33, 33% radius, RTOL; radius total; *$p$<0.05 was considered statistically significant.

## Conclusions and Discussion

In Thailand, osteoporosis is concerned as a public health problem and becoming more serious. Many researches had been showed the prevalence of osteoporosis in Thai population with a risk group as Thai postmenopausal women [5-7]. In this present study, there were 46.5% and 28.4% of osteopenia and osteoporosis, respectively. Similar to a recent report of Northern Thai women was presented 48.0% and 26.9% of osteopenia and osteoporosis, respectively [7]. The common sites of BMD measurement including lumbar spines, hip and forearm are the high-risk sites of fracture. This study, the prevalence of osteoporosis at lumbar spines (L1-L4), femoral neck, and forearm bone were 6.0%, 2.2%, and 24.1%, respectively. Previous studies reported the prevalence of lumbar spine (L1-L4) osteoporosis was found for 10.0%, 0.6% of femoral neck osteoporosis [6] while 19.3% at femoral neck, 24.7% at lumbar spine, 18.5% at ultra-distal radius observed for the prevalence of osteoporosis in 2002 [8]. The different percentage of osteoporosis in these studies might affected by the environmental factors as and the variation of life styles.

In this study, the highest prevalence of osteoporosis was found at forearm. Studying on the forearm has some advantages over at the axial skeletal sites including lower cost, lower radiation exposure time and dose, faster scanning time, and more comfortable than the axial skeletal. Moreover, it is not affected by abnormal calcification or degenerative changes as in the antero-posterior spinal BMD measurement [9]. The diagnosis of osteoporosis is assessed by BMD measurement, which has showed to correlate with bone strength, and also it is a predictor of fracture risk. This study found a positive correlation of the BMD from various skeletal sites such as lumbar spines, hip, and radial by bivariate correlation analysis and BMD score were significant higher in osteoporosis/osteopenia than control subject according to previous studies [7], [10]. Bone mineral density measurement of radial bone (distal forearm) might be used to predict the central sites BMD such as hip and spine in Thai women. However, the predicting accuracy should be investigated later.

The important component of osteoporosis prevention is to identify the risk factors as in a part of this study. The osteoporosis/osteopenia group had the significantly older age, lower BMI and lower height than control subject. According to other studies [11-12], the bone loss increases with age in female. In elderly women, this is explained by a gradual loss of BMD, often referred to as age-related senile bone loss, which starts in midlife and continues over time [13].

A positive correlation between these anthropometric measurements and bone mass was documented as well as this present study. Weight, height, and BMI were clearly associated with BMD [14]. Body mass index (BMI), a measure of body composition, might be associated with risk of osteoporosis. Some reports have linked BMI with osteoporosis suggesting that a heavier frame, especially lean body mass may protect against bone loss [15-16]. Loss of height was one of the known consequences of aging, however arm span or height-arm span ratio value did not associate with BMD or study groups in this study as in previous study [17]. Anthropometric measurement showed that women with a lower BMI have a significantly higher risk of osteoporosis compared with control women. Many studies have demonstrated that lifestyle factors, especially dietary factors, are associated with bone mineral density (BMD). Protein intake, vitamin intake, and salt intake, which might be associated with bone homeostasis [18]. A brief food and habit frequency questionnaires were used in this cross-sectional survey and categorized into low and high range by based on the frequencies for all subjects (adapted from Shin and collogues) [18]. Exercise or total physical activities were found a significant correlation with hip trochanteric bone mineral density. It might be the influence of site- specific effect from muscular forces through localized pressure on bone [19]. However, the appropriated types and duration of physical activity to prevent age-related loss of bone mass in postmenopausal women need more studies. Although many studies have documented the relationships between BMD and smoking [20], this study was not investigated its relationship because all subjects were non-smoker.

Protein-source food was showed a positive correlated with BMD as well as previous studies [18], [21]. Protein is an essential nutrient that is incorporated into the organic matrix of bone for collagen synthesis upon, which mineralization occurs [22]. The previous studies had observed that subjects with greater protein intake had higher BMD and less bone loss [21]. Protein-energy malnutrition was found in the elderly and was a risk factor for bone loss, osteoporosis, and fracture [23]. The actual portions or weight of food intake were not able to collect. Therefore, lack of information of micronutrients and macronutrients limits the biological relevance of the results. Other food was not showed the association with BMD such as dairy source food, salt intake, or mineral from vegetable sources suggesting that dietary habit might not be large enough to enable detection of possible associations with BMD [18].

Epidemiological studies have consistently demonstrated that low calcium consumption resulting in an increased prevalence of bone fractures [24]. Moreover, some studies explained the positive correlation of calcium intakes with BMD at the lumbar spine [25]. This present study, calcium status, serum calcium showed a positive correlation with BMD at various sites of bone in all subjects. Calcium is essential to bone at all stages of life because it is one of the main bone-forming minerals [26]. Furthermore, increasing calcium intake will also increase calcium absorption, increase the circulating ionized calcium concentration, and suppress parathyroid hormone and biochemical markers of bone turnover [25]. Not only calcium but phosphorus level also showed a significant correlation with only BMD at lumbar spine. Phosphorus is a mineral that is a part of bone structure, and also bone metabolism pathway. Adequate phosphorus intake is essential for bone building during growth and low serum phosphate will limit bone formation and mineralization [27]. Phosphorus deficiency might be a marker of general nutritional inadequacy, similar to protein deficiency as seen in the elderly, and consequently leading to an increased risk of fracture [27]. A diet adequate in calcium with moderate protein and sufficient phosphorus related to higher bone density [28]. The limitations in this present study were observed. Due to the cross-sectional characteristic of the study limits the causal inferences, the discovered association could not be investigated prospectively.

The prevalence of osteoporosis in Thai postmenopausal women was a third. The public health care system should concern in osteoporosis situation. Weight, height, BMI, exercise, protein-source food, biochemical parameters including; calcium and phosphorus levels were associated with BMD. This research recommended that exercise and dietary are very important factors for reducing the risk of osteoporosis. Further investigations with quantitative analysis of food and nutrient consumption and long-term follow-up should be investigated.

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