

Short Communication

Nutritional status among postmenopausal osteoporotic women in North West of Iran

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Background: Osteoporosis is a multifactorial disease and one of the most important modifiable factors in the development and maintenance of bone mass is nutrition. **Objective:** The aim of this study was to determine the nutritional status among osteoporotic postmenopausal women in north west of Iran and compare intake of several nutrients important in terms of bone health with the standard values (DRIs). **Design:** Bone mineral density of the left proximal femur, the lumbar spine and total hip were measured using dual-energy X-ray absorptiometry. Ninety-seven postmenopausal osteoporotic women were studied. A validated food frequency questionnaire was used to determine food habits and 24-h recall was used to estimate average energy and nutrient intakes. **Results:** The mean t-score for bone mineral density (BMD) of LS, FN and total hip were -3.15 ± 0.73 , -1.93 ± 0.86 and -1.92 ± 0.88 , respectively. The percentages of participants receiving adequate intake of calcium, vitamin D and vitamin K were 7.2%, 3.1% and 42.3%, respectively. The mean phosphate to calcium ratio was 1.6 ± 0.87 . BMD of femoral neck and total hip was correlated inversely with the amount of energy obtained from fat and positively with energy intake. Among micronutrients studied, calcium was positively correlated with BMD of total hip. **Conclusion:** Most of the postmenopausal osteoporotic women in north west of Iran have a considerable deficiency in terms of energy and some micronutrients such as calcium, vitamin D and magnesium, which can be deleterious for bone health.

Key Words: osteoporosis, postmenopausal, nutritional status, bone density, calcium

INTRODUCTION

Osteoporosis is a major public health problem especially in elderly people and is reaching an epidemic proportion because the elderly population is the most rapidly growing segment of any population. Osteoporotic fractures are claimed to affect 50% of women and 30% of men aged over 50 years.¹ It has been estimated that 1.7 million people globally suffered from osteoporotic hip fractures, in 1990. The number might increase to 6.3 million by 2050.² Postmenopausal women are the most vulnerable group for osteoporosis-related fractures, because of oestrogen deficiency, particularly in the wrist, lumbar spine, and hips.³

There isn't any accurate estimation of the incidence and prevalence of osteoporosis in Iran. The Iranian Multi-center Osteoporosis Study (IMOS) estimated that the prevalence of osteoporosis among women who are older than 50 years is 6 percent, which is less than other countries such as Canada and Japan⁴. Some other smaller studies estimated that more than 40 percent of Iranian postmenopausal women are affected by osteoporosis.⁵

Osteoporosis is a multifactorial disease and several factors such as; genetics, gender, age, race, weight, medical conditions, medication and life style risk factors are

considered to be important determinants of bone mass and risk of osteoporotic fractures. One of the most important modifiable factors in the development and maintenance of bone mass is nutrition. Adequate nutrition plays a major role in the prevention and treatment of osteoporosis. Because calcium and vitamin D are considered the nutrients of the greatest importance in terms of bone health, most studies to date concentrated primarily on the role of these nutrients and paid less attention to others. Therefore the understanding of the influence of nutrition on bone health is limited.⁶ A diet low in calcium is likely to be deficient in many other micronutrients as well, but few studies have addressed these potential relations.

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It is plausible that prevention of bone loss through diet is possible, yet it involves many nutrients such as: potassium, magnesium, vitamin K, protein, saturated fat, phosphorus, vitamin C, sodium, and several trace minerals including manganese, zinc and copper.⁷ Recent reports have also supported the important role of some food groups like milk, fruits, vegetables, meat and seafood on bone health.⁸⁻¹⁰

The aim of this study was to determine nutritional status of osteoporotic postmenopausal women in the north west of Iran and to compare intake of several nutrients, which are important in terms of bone health with the standard values (DRIs).

MATERIALS AND METHODS

The study was performed between May and October 2007. Ninety-seven postmenopausal osteoporotic women were recruited from an original sample of 314 postmenopausal women who were referred to Sheikholrais and Sina densitometry centers. Eligibility criteria included documentation of osteoporosis according to the definition of the World Health Organization (WHO) (<2.5 standard deviations (SD) of normal values)¹¹, age range of 50-70 years old and having postmenopausal age of at least one year. To minimize any known confounding effects on BMD, the subjects with the following conditions have been excluded from the study: on corticosteroid therapy at pharmacological levels for duration of more than 6 months; with rheumatoid arthritis or collagen disease; diabetes mellitus (except for easily controlled, non insulin-dependent diabetes mellitus); evidence of other metabolic or inherited bone disease, such as hyper- or hypoparathyroidism, Paget's disease, osteomalacia, osteogenesis imperfecta and hyperthyroidism.

Information about life style such as physical activity and smoking habits were obtained at the time of BMD assessment. Weight and height were measured in light clothing and without shoes using a scale (Seca, Hamburg, Germany) to the nearest 0.05 kg and a stadiometer (Holtain Ltd, Crymch, United Kingdom) to the nearest 0.1 cm, respectively. Body mass index (BMI) was calculated as weight (kg) divided by height square (m²). The BMD measurements of the left proximal femur (the femoral neck, or FN), the lumbar spine (LS; L2-4) and total hip were performed using dual-energy X-ray absorptiometry (Hologic QDR 2000; Hologic, Waltham, MA, USA). Instruments were calibrated daily and had measurement precisions of 0.008 g/cm² for the spine and 0.013 g/cm² for the femoral neck.

Energy and nutrient intakes were measured using a 3-day 24-h recall (two week days and one weekend day). A validated food frequency questionnaire¹² was also used to determine dietary habits during the previous year. The information was obtained through face to-face interviews, with standard food models, and a variety of measuring tools to evaluate intake. Nutrients were analyzed by Nutritionist III software, version 7.0 (N-Squared computing, Salem, OR, USA), which was modified for Iranian foods.

Total energy intake (EI, kcal), macronutrient (proteins, lipids and carbohydrates) and micronutrient (calcium, phosphate, magnesium, iron, zinc, copper, vitamin D, vitamin K, selenium, vitamin B₆, folate, vitamin B₁₂, vi-

tamin A and vitamin C) intakes were estimated and compared with dietary reference intakes (DRIs).

Statistical analysis was done using SPSS Software (version 11.5). To correlate variables with normal and non-normal distribution, Pearson's and Spearman's correlations respectively were used. The multivariate logistic regression model was used to predict the probable factors involved in osteoporosis. All tests were two-tailed, and $p < 0.05$ was the significance threshold.

RESULTS

A total of 97 postmenopausal osteoporotic women were studied. The mean (\pm SD) age, postmenopausal age and BMI were 61.3 ± 6.00 y, 13.8 ± 6.89 y and 28.9 ± 4.12 (kg/m²). BMD t-score of lumbar spine (LS; L2-4), femoral neck and total hip were -3.15 ± 0.73 , -1.93 ± 0.86 and -1.92 ± 0.88 , respectively. Based on WHO's cut-off point for osteoporosis ($-2.5 < t$ -score), there were 89.7%, 29.2% and 27.8% of participants having osteoporosis on their lumbar spine, femoral neck and hip regions, respectively.

Table 1. Nutrient intakes (food and supplements combined) of postmenopausal osteoporotic women in Iran

Nutrient	Mean \pm SD [‡]	Median	Range	DRI [†]
Calories (kcal/d)	1230 \pm 531	1134	329-3188	2046-2179
Total fat (g/d)	51 \pm 20.3	49	11.5-103	§
Protein (g/d)	42 \pm 21.5	39	10.7-110	46
Calcium (mg)	510 \pm 351.3	436	71-1509	1200
Vitamin D (IU)	124 \pm 728.8	3.75	0-7102	400
Magnesium (mg)	170.9 \pm 349.5	111	13-3406	320
Phosphorus (mg)	670 \pm 392.6	553	131-1995	700
Zinc (mg)	5.12 \pm 3.17	4.52	0.97-21.2	8
Vitamin K (μ g)	97.5 \pm 98.5	68	0-459	90
Selenium (μ g)	90 \pm 131.7	60	0-1180	55
Iron (mg)	9.07 \pm 5.5	7.57	1.5-38	8
Vitamin C (mg)	58 \pm 60.6	49	0-450	75
Vitamin A (Iu)	5312 \pm 9185	1833	0-92678	2331
Folate (μ g) [¶]	122 \pm 113.2	94.5	14-973	400
Vitamin B6 (mg)	1.32 \pm 0.8	1.2	0.1-3.88	1.5
Vitamin B12 (μ g)	12.13 \pm 73.15	1.1	0-633	2.4
Fluoride (mg)	1.39 \pm 4.5	0.227	0- 28.72	3
Fiber (g/d)	5.06 \pm 6.50	3.11	0.1-83	21

[†] DRIs=Dietary Reference Intakes for women 50- 70 years.⁽¹³⁾

[‡] SD=standard deviation.

[§] <25%-35% of total calories from fat, with <10% from saturated fat.

[¶] As dietary folate equivalents (DFE). 1 DFE=1 μ g food folate=0.6 μ g of folic acid from fortified food or as a supplement consumed with food=0.5 μ g of a supplement taken on an empty stomach.

Intake of total energy, fat, carbohydrate, protein, vitamins, and minerals is presented in Table 1. Participants consumed 20.0 kcal/kg/day. The mean dietary percentages of fat, protein, and carbohydrate were 37.5±9.28 %, 13.0±3.43 %, and 49.4±10.2, respectively. Only 7.2% of participants had adequate intake for calcium (>1200 mg/d) and 57 (58.8%) had a calcium intake less than 500 mg/day. Adequate intake for vitamin D (400 IU) was found for 3.1% and about ¾ of participants (75.3%) had a vitamin D intake less than 100 IU/day. Seven participants met the Recommended Dietary Allowance (RDA) for magnesium and 42 (43.3%) had a magnesium intake less than 100 mg/day. Thirty-seven participants (39.8%) met the RDA for phosphorus and mean phosphate to calcium ratio of participants was 1.6 ± 0.87. Forty-one participants (42.3%) received adequate intake for vitamin K and sixty-five participants (67%) received the RDA for selenium.

As it is shown in Table 2, there was a significant correlation between energy intake and femoral neck and total hip BMD. There was also a negative and significant correlation between percents of energy from fat and BMD of femoral neck and total hip. Frequency of dairy products, meat, vegetable and fruit intake was not significantly correlated with BMD at different skeletal regions.

Among the micronutrients reported calcium was positively correlated with BMD of total hip. Also the linear relationship between selenium intake and BMD of total hip and femoral neck was statistically significant. Vitamin C intake was significantly correlated with BMD of total hip. There were no other significant relationships between other micronutrients and BMD at different skeletal regions.

A multivariate logistic regression analysis was performed to determine the role of each mentioned dietary factors in osteoporosis with controlling for other potential confounders (Table 3). For this issue patients with t-score ≤ -2.5 were considered as the diseased group for the region and participants with t-score ≥ -2.5 were considered as reference group. Thus t-score ≤ -2.5 was considered as the dependent variable and factors such as BMI, Energy, % energy from fat and dietary calcium were determined as possible factors for predicting osteoporosis at each assessed region. Dietary calcium intake was found to be associated marginally with the presence of osteoporosis at the hip region. There was also a significant association between proportion of energy from fat and osteoporosis of lumbar spine.

Table 2. Correlation between BMD of different skeletal sites and dietary factors as well as BMI

	BMD Hip		BMD FN		BMD LS	
	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>
BMI	0.006	0.28	0.071	0.19	0.065	0.19
Energy	0.02	0.24	0.041	0.21	0.763	-0.03
% of energy from Fat	0.022	-0.23	0.012	-0.26	0.75	0.03
Ca	0.042	0.21	0.372	0.09	0.261	0.12
Se	0.027	0.23	0.034	0.22	0.769	0.03
Vit C	0.026	0.23	0.106	0.17	0.903	0.01

Table 3. Association between BMI, dietary factors and osteoporosis after adjusting for confounders using multi-variable logistic regression

	Adjusted OR (CI 95%)	<i>p</i>
Hip		
BMI	0.939 (0.831,1.061)	0.316
Energy	1.000 (0.999,1.001)	0.919
% Energy from fat	1.042 (0.986,1.102)	0.147
Dietary Calcium	0.998 (0.996,1.000)	0.051
Lumbar spine		
BMI	0.991 (0.836,1.175)	0.971
Energy	1.001 (0.999,1.003)	0.410
%Energy from fat	0.925 (0.856,0.999)	0.048
Femoral neck		
BMI	0.985 (0.880,1.103)	0.797
Energy	0.999 (0.998,1.000)	0.105
%Energy from fat	1.025 (0.973,1.080)	0.357

DISCUSSION

In this cross-sectional study of postmenopausal osteoporotic women, the consumption of different nutrients, which are important for bone health, was assessed. The results indicated that intake of some important nutrients such as calcium, vitamin D, and magnesium, etc. was significantly less than the recommended levels.

The mean energy intake of the participants was 1230 ± 531 kcal, which is less than the recommended values. It was also lower than the energy intake of American postmenopausal women in CSFII study, which was 1436 Calories.¹⁴ In the present study in spite of the high mean BMI in volunteers (28.9), the mean energy intake was low. This seems confusing however different researchers such as Tooze et al.¹⁵ and Krebs-Smith et al.¹⁶ have shown that about 40 % of the people in particular obese and elderly people whose energy intake was measured using 24-h recall or FFQ, have underreported their energy intake. On the other hand due to the age and literacy of the participants in this study (mostly illiterate), the prospective methods like food records were impossible.

In this study there was a positive association between weight and BMD of different skeletal sites (LS: $r = 0.24$, $p = 0.018$, FN: $r = 0.32$, $p = 0.002$, hip: $r = 0.37$, $p < 0.001$). Other researchers have also reported that bone density has a positive association with weight especially in postmenopausal women.^{17,18} We found a positive association between energy intake and BMD of femoral neck and total hip. The association between energy and bone density may be due to a more direct association between several micro- as well as macronutrients and bone density.¹⁹ Indeed a negative association was found between total fat intake and BMD of femoral neck and total hip. After controlling for other confounders, the association between percents of energy from fat and the presence of osteoporosis in lumbar spine remained significant. Other studies have also found negative associations between fat intake and BMD.^{20,21} Several mechanisms have been suggested, for example, a high-fat diet may reduce the efficiency of calcium absorption through the formation of calcium soaps or may contain high concentrations of retinol, which would increase bone resorption.²⁰ In this study the percentage of calories from fat intake was 37.5% which is high for this age group. It seems that the TLC

diet (consuming 25-35% calories from fat), which is generated for prevention of CHD, also can be useful for bone health.

The other important issue in terms of nutrition and bone health is protein. The relation between dietary protein intake and bone metabolism is controversial.²² Excess dietary protein results in urinary calcium loss, negative calcium balance, and bone loss in young and elderly men and women,²² and these effects are mainly attributable to the high acid load from the metabolism of animal protein. It has been proposed that bone buffers the excess acid load, which results in urinary calcium loss and consequently leads to reduced bone mineral content and bone mass.²³ On the other hand, there is convincing evidence indicating that low protein intake is associated with low BMD and greater fracture risk.²⁴ Some cross-sectional studies, showed a positive association between protein intake and BMD, whereas others did not find any such association or found a negative association.²⁵ In this study, we couldn't show any significant association between protein intake and BMD of different skeletal regions. The mean protein intake in the study population was 42 ± 21.5 g, which is close to the RDA of protein for this age and sex group (i.e., 46 g).

Calcium is the most important nutrient in bone health. In this study more than 90% of the subjects had a calcium intake less than the AI for calcium (1200 mg). Food and Agriculture Organization's report in 1990 demonstrated that the mean calcium intake in the developing world was 344 mg/day,²⁶ which is less than our findings (510mg/day). Despite this lower intake of calcium in the developing world compared with western countries (850 mg/day), these populations did not show higher a prevalence of osteoporosis.²⁶ Possible explanations for this finding could be differences in vitamin D status, salt and animal protein intake, fat intake and physical activity in the populations.²⁰

Milk and dairy products are the most concentrated source of calcium. Dark green vegetables such as kale, collards and broccoli; almonds; soybeans; the small bones of sardines; and clams and oysters are good sources of calcium. There are several reasons for low calcium and dairy product consumption among different populations, such as lack of knowledge, dislike or intolerance of milk and milk products, low socioeconomic status or restriction of dairy products due to fat content.²⁷ Based on personal communications with the participants, these also seem to be the main reasons for low calcium intake in the population under investigation.

Although we found a positive association between calcium intake and total hip BMD, the results of other cross-sectional studies are less convincing. A review of 86 observational studies showed a significant positive associations between calcium intake and bone mass, bone loss or fracture risk in 64 studies; one study reported a positive effect in men only; 19 found no effect and two found a negative effect. Therefore the majority of studies support the hypothesis that high calcium intake protects the skeleton.²⁸

Vitamin D plays an important role in calcium, phosphorous and bone homeostasis. Low serum levels of 25-hydroxy vitamin D are associated with impaired calcium

absorption, reduced renal calcium reabsorption and secondary hyperparathyroidism.²⁹ Vitamin D exists naturally in animal products, and the richest sources are fish liver oils. It is found only in small amounts in butter, cream, egg yolk and liver. More than 95% of our participants had a vitamin D intake below the AI for vitamin D (400 IU). It seems vitamin D insufficiency is a frequent finding among community-dwelling elderly, irrespective of latitude, and an almost universal finding among institutionalized elderly.³⁰ According to the findings of IMOS (Iranian Multicenter Osteoporosis Study) based on serum levels of 25(OH) D, more than 81% of Iranians had vitamin D deficiency and one of the main reasons for this finding is insufficient vitamin D intake.⁴

Phosphorus intake does not seem to influence skeletal health within normal ranges (RDA 700 mg/d), although excessive intake particularly when combined with low calcium intake may be deleterious.³¹ Alternatively, adequate phosphorus intake is essential for bone building during growth, and low serum phosphate will limit bone formation and mineralization.³² The ratio of phosphorus to calcium at any age is probably more important than phosphorus intake alone. In this study although, only about 40 % of the participants had phosphorous intake above the RDA, the mean phosphorus to calcium ratio was 1.6 ± 0.87 which is slightly more than the acceptable range (0.5-1.5).³³

In conclusion, the results of this study showed that most of the postmenopausal osteoporotic women in north west of Iran have a considerable deficiency in terms of energy and some micronutrients such as calcium, vitamin D and magnesium intake, which can be deleterious for bone health. It's suggested that more attention be paid on the nutritional status and issues of elderly women and that more longitudinal and interventional studies be conducted in this population.

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AUTHOR DISCLOSURES

We have no conflicts of interests to declare.

REFERENCES

1. Prince RL. Diet and the prevention of osteoporotic fractures. *N Engl J Med*.1997;337:701-2.
2. Johnell O. The socioeconomic burden of fractures: today and in the 21st century. *Am J Med*. 1997;103:20S-26S.
3. Oeraitiene V, Butenaite V. The evaluation of bone mineral density based on nutritional status, age, and anthropometric parameters in elderly women. *Medicina (Kaunas)*. 2006; 42: 836-42.
4. Larijani B, Resch H, Bonjour JP, Aghai-Meybodi HR, Mohajery-Tehrani MR. Osteoporosis in Iran, Overview and Management. *Iranian J Publ Health*. 2007; A supplementary issue on Osteoporosis:1-13.
5. Mojibian M, Owlia MB, Beiki-Bandarabadi O, Kochak-Yazdi L. Osteoporosis in postmenopausal women. *Iranian Journal of surgery*. 2006;14:71-8.
6. Tucker KL, Chen H, Hannan MT, Cupples LA, Wilson PWF, Felson D, Kiel DP. Bone mineral density and dietary

- patterns in older adults: the Framingham Osteoporosis Study. *Am J Clin Nutr.* 2002;76:245-52.
7. Massé PG, Dossy J, Tranchant CC, Dallaire R. Dietary macro- and micronutrient intakes of nonsupplemented pre- and postmenopausal women with a perspective on menopause-associated diseases. *J Hum Nutr Diet.* 2004;17: 121-32.
 8. Chen Y, Ho SC, Woo JLF. Greater fruit and vegetable intake is associated with increased bone mass among postmenopausal Chinese women. *Br J Nurs.* 2006; 96: 745-51.
 9. McCabe LD, Martin BR, McCabe GP, Johnston CC, Weaver CM, Peacock M. Dairy intakes affect bone density in the elderly. *Am J Clin Nutr.* 2004;80:1066-74.
 10. Zalloua PA, Hsu Y, Terwedow H, Zang T, Wu D, Tang G, et al. Impact of seafood and fruit consumption on bone mineral density. *Maturitas.* 2007;56:1-11.
 11. WHO study group. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Technical report series 843. Geneva: WHO, 1994.
 12. Omidvar N, Ghazi-Tabatabaie M, Harrison GG, Eghtesadi S, Mahboob SA, Pournakht M. Development and validation of a short food-frequency questionnaire for screening women of childbearing age for vitamin A status in north western Iran. *Food Nutr Bull.* 2002;23:73-82.
 13. Earl R. Guidelines for dietary planning. In Mahan LK. , Escott-stump S editors. *Krause's Food, Nutrition & Diet therapy.* 10th ed, W.B.Saunders Company. 2004. p. 633-9.
 14. Wakimoto P, Block G. Dietary intake, dietary patterns, and changes with age: An epidemiological perspective. *J Gerontol A Biol Sci Med Sci.* 2001;56A:65-81
 15. Tooze JA, Vitolins MZ, Smith SL, Arcury TA, Davis CC, Bell RA, DeVellis RF, Quandt SA. High levels of low energy reporting on 24-hour recalls and three questionnaires in an elderly low-socioeconomic status population. *J Nutr.* 2007;137:1286-93.
 16. Krebs-Smith SM, Graubard BI, Kahle LL, Subar AF, Cleveland LE, Ballard-Barbash R. Low energy reporters vs others: a comparison of reported food intakes. *Eur J Clin Nutr.* 2000;54:281-7.
 17. Lei SF, Deng FY, Li MX, Dvornyk V, Deng HW. Bone mineral density in elderly Chinese: effects of age, sex, weight, height, and body mass index. *J Bone Miner Metab.* 2004;22:71-8.
 18. Barrera RN G, Bunout D, Gattás V, Maza MP, Leiva L, Hirsch S. A high body mass index protects against femoral neck osteoporosis in healthy elderly subjects. *Nutrition.* 2004;20:769-71.
 19. Kanis IA. Calcium nutrition and its implication for osteoporosis. Part II. After menopause. *Eur J Clin Nutr.* 1994;48: 833-41.
 20. Macdonald HM, New SA, Golden MHN, Campbell MK, Reid DM. Nutritional associations with bone loss during the menopausal transition: evidence of a beneficial effect of calcium, alcohol, and fruit and vegetable nutrients and of a detrimental effect of fatty acids. *Am J Clin Nutr.* 2004;79: 155-65.
 21. Corwin RL. Effects of dietary fats on bone health in advanced age. *Prostaglandins Leukot Essent Fatty Acids.* 2003; 68:379-86.
 22. Cloutier GR, Barr SI. Protein and bone health: Literature review and counselling implications. *Can J Diet Pract Res.* 2003;64:5-7.
 23. Barzel US. The skeleton as an ion exchange system: implications for the role of acid-base imbalance in the genesis of osteoporosis. *J Bone Miner Res.* 1995;10:1431-6.
 24. Kerstetter JE, Looker AC, Insogna KL. Low dietary protein and low bone density. *Calcif Tissue Int.* 2000;66:313.
 25. Rapuri PB, Gallagher JC, Haynatzka V. Protein intake: effects on bone mineral density and the rate of bone loss in elderly women. *Am J Clin Nutr.* 2003;77:1517-25.
 26. Food and Agriculture Organization of the United Nations. *Yearbook 1990. Vol 44.* Rome: Food and Agriculture Organization, 1991.
 27. Horwath CC, Govan CH, Campbell AJ, Wendy Busby MBChB, FRACP, Scott V. Factors influencing milk and milk product consumption in young and elderly women with low calcium intakes. *Nutrition Research.* 1995; 15: 1735-45.
 28. Heaney RP. Calcium, dairy products and osteoporosis. *J Am Coll Nutr.* 2000;19:83S-99S.
 29. Bouillon R, Carmeliet G, Daci E, Segaert S, Verstuyf A. Vitamin D metabolism and action. *Osteoporos Int.* 1998;8: S13-S19.
 30. Mosekilde L. Vitamin D and the elderly. *Clinical Endocrinology.* 2005;62:265-81.
 31. Nieves JW. Osteoporosis: the role of micronutrients. *Am J Clin Nutr.* 2005;81:1232S-1239S.
 32. Heaney RP. Phosphorus nutrition and the treatment of osteoporosis. *Mayo Clin Proc.* 2004;79:91-7.
 33. Heaney RP, Nordin BE. Calcium effects on phosphorus absorption: implications for the prevention and co-therapy of osteoporosis. *J Am Coll Nutr.* 2002;21:239-44.

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停經且骨質疏鬆的伊朗西北方婦女之營養狀態

背景：骨質疏鬆是一個多因子的疾病，而在骨質發展及維持上的一個最重要的可修飾因子就是營養。目的：本研究目的是要測定居住在伊朗西北方骨質疏鬆的停經後婦女的營養狀態，並且將幾個在骨健康方面重要的營養素攝取與標準值(DRIs)做比較。設計：利用雙能量 X 光吸收儀(DEXA)來測量左側近端股骨、腰椎、及全部髖骨的骨質密度。研究對象為 97 位骨質疏鬆的停經後婦女。利用一個有效的食物頻率問卷來定義研究對象的飲食習慣，並利用 24 小時回憶來評估平均熱量及營養素攝取。結果：腰椎、股骨、及總髖骨的骨質密度平均 t-score 分別為 -3.15 ± 0.73 、 -1.93 ± 0.86 以及 -1.92 ± 0.88 。研究對象中攝取適量鈣、維生素 D 及維生素 K 的人數比例分別為 7.2%、3.1%及 42.3%。平均磷鈣比為 1.6 ± 0.87 。股骨頸及總髖骨的骨質密度與由脂肪而來的熱量呈現負相關，而與總熱量攝取呈正相關。在微量營養素方面，鈣攝取與總髖骨的骨質密度呈正相關。結論：大部分居住於伊朗西北方的停經後骨質疏鬆婦女，在能量及一些微量營養素（例如：鈣、維生素 D、及鎂）的攝取相當不足，這對骨健康是不利的。

關鍵字：骨質疏鬆、停經、營養狀態、骨質密度、鈣