# Dietary intake and serum bone related chemistry and their correlations in postmenopausal Iranian women

*Nazila Farrin, MSc, Ali R. Ostadrahimi, MD, PhD, Soltan A. Mahboob, PhD, Sousan Kolahi, MD, Mostafa Ghavami, MD.*

## ABSTRACT

الأهداف : لتحديد مقدار التناول الغذائي وكيمياء العظام ذات الصلة بترقق العظام وعلاقتهما لدى النساء الإيرانيات بعد سن اليأس.

الطريقة : أجريت دراسة على شريحة عرضية ( 58 امرأة إيرانية سليمة ) بعد سن اليأس، في مستشفى سيناء – تبريز – إيران، خلال الفترة ما بين يناير 2005م وحتى أغسطس 2006م. تم قياس مصل الكالسيوم، الفوسفات، المغنيسيوم، وأكالين الفوسفات بواسطة طريقة التحليل الذاتي وبطريقة قياس موجات الراديو المناعية ( PTH ). تم تقييم مقدار التناول الغذائي بواسطة تسجيل مقدار التناول اليومي–3. تم تقييم كثافة معدن العظام بواسطة الأشعة السينية ومقياس الامتصاص ( DXA ) للعامود الفقري وعظم الفخذ الأيسر. أجريت المقارنة بين متوسط المجموعات باستعمال اختبار الطريقة الواحد ( ANOVA )، تم استخدام العديد من الخطيات والنكوصات لفحص العلاقة بين العوامل الغذائية وعلامات الكيمياء ذات الصلة بالعظام.

النتائج : بناءً على نتائج الفقرات القطنية للعامود الفقري ( BMD )، تم تصنيف النساء ( عدد=58 ) إلى ثلاثة مجموعات : طبيعية ( عدد=18 )، مصابة بقلة العظام ( عدد=22 )، ترقق العظام ( عدد=18 ). كان متوسط مصل الكالسيوم، الفوسفات، المغنيسيوم فوسفات ألكالين لدى المجموعات الثلاثة ضمن الحدود الطبيعية. كان مصل ( PTH ) لدى المجموعة المصابة بترقق العظام أعلى من المجموعتين الاخريتين. كان مقدار التناول الغذائي للكالسيوم لدى مجموعة ترقق العظام أقل بشكل ملحوظ من المجموعة الطبيعية ( p=0.01 ). أظهرت نتائج تحليل النكوص الخطي علاقة ملحوظة بين مقدار تناول الكالسيوم و( PTH ) ( r= –0.61, p=0.001, B= –0.032 ).

خاتمة : تقترح هذه النتائج، أن النساء بعد سن اليأس بحاجة إلى التثقيف حول ترقق العظام والقياسات الوقائية ذات الصلة مثل : أثر التغذية على صحة العظام، والمقدار الكافي من تناول الغذاء والأطعمة الغنية بالكالسيوم.

**Objective:** To determine dietary intake and bone related chemistry of osteoporosis and their correlations in postmenopausal Iranian women.

**Methods:** A cross-sectional study was carried out on 58 healthy Iranian, postmenopausal women from January 2005 until August 2006, at Sina Hospital, Tabriz, Iran. Serum calcium, phosphorus, magnesium, and alkaline phosphatase were measured using auto analyzer and parathyroid hormone (PTH) by immune radio metric assay. Dietary intake was assessed by 3-day dietary record. Bone mineral density (BMD) was assessed by dual-energy x-ray absorptiometry (DXA) at the lumbar spine and left femur. Comparison between means of the groups was carried out using one-way analysis of variance test. To examine the correlation between dietary factors and bone related chemistry markers, multiple and linear regression was used.

**Results:** According to the results of lumbar spine BMD, women (n=58) were classified into 3 groups: normal (n=18), osteopenia (n=22), and osteoporosis (n=18). The mean serum calcium, phosphorus, magnesium, and alkaline phosphatase in 3 groups were in the normal range. Serum PTH in the osteoporosis group was higher than other groups. The mean dietary calcium intake in the osteoporosis groups was significantly lower than the normal group ($p=0.01$). The results of analyzing by linear regression, showed a significant correlation between calcium intake and PTH (r=-0.61, $p=0.0001$, B=-0.032).

**Conclusions:** These findings suggest that postmenopausal women need to be educated regarding osteoporosis and the related preventive measures, such as the effect of nutrients on bone health, and the adequate intake of dairy products and calcium rich-foods.

Osteoporosis is a major public health problem in the Western World and is increasing in the developing world.[1] It is a chronic degenerative disorder that develops insidiously with advancing age, but that has antecedents in our heredity and in environmental influences over our complete lifespan.[1,2] Osteoporosis clinically is silent until it manifests by fractures. Osteoporosis affects a large population of post-menopausal women.[3] Fractures of the spine and proximal femur are the most important consequences of osteoporosis, resulting in significant morbidity, excess morality, and escalating costs.[4-6] Although age is an independent risk factor for fractures, bone mineral density (BMD) is one of the strongest predictors of subsequent fractures.[7] In elderly women, bone resorption is markedly increased but bone formation cannot match the increased rate of bone resorption.[4] Estrogen deficiency is a primary determinant in the increased bone turnover in menopausal women.[8] The numerous factors are involved in the occurrence of osteoporosis such as: growth hormones, physical activity, gender, ethnicity, other diseases such as liver and kidney diseases, medications, and environmental factors, especially nutrition.[2,9] Despite the intense clinical and scientific work, relating to menopause, many aspects of the biochemical changes, particularly calcium metabolism, are poorly characterized.[10-12] The cross-sectional studies have indicated that the menopause is associated with rises in some serum and bone markers.[5,8,10] Nutrition is an important modifiable factor in the development and maintenance of bone mass and the prevention and the treatment of osteoporosis.[13,14] Roughly 80-90% of bone mineral content is comprised of calcium and phosphorus. Protein is another crucial nutrient and incorporated into the organic matrix of bone for collagen formation, upon which mineralization occurs.[15] Adequate calcium intake plays an important role in the prevention of osteoporosis. Low calcium intake has been found to be one of the risk factors for osteoporosis among Asian women.[16] Considering the importance of osteoporosis in decreasing the life quality of postmenopausal women and regarding the significant role of nutrition in the incidence of osteoporosis, the present study was conducted to determine dietary intake and serum bone related chemistry and their correlations in postmenopausal Iranian women.

**Methods.** This study was approved by the Ethics Committee of Tabriz University of Medical Sciences, Tabriz, Iran. All patients signed an informed consent for participation in this study. The present cross-sectional study was conducted on 58 volunteer postmenopausal women, (58.29 ± 0.89 years) who were referred to the Rheumatology Department of Sina Hospital in Tabriz, Iran from January 2005 until August 2006. Inclusion

criteria included: age over 50 years, no anti-osteoporosis treatment, at least 5 years history of menopause, good overall health, living completely independently, no history of early menopause, ovarianectomy, hysterectomy, and smoking. The women had not taken any medications or suffered any diseases to affect their bone metabolism such as hormone replacement therapy (HRT), epilepsy, and hypertension medications, vitamin and mineral supplements, and diseases such as liver, kidney, and Paget diseases. All participants filled a general questionnaire on health, menopausal status, any HRT and other medication use. To estimate energy and nutrient intakes, participants were instructed on how to keep a 3-day food record and were asked to record their food intakes over 3 nonconsecutive days (which included one weekend day). Written instructions and sample food records were distributed and reviewed with each subject to ensure complete and accurate recording. The subjects were instructed to maintain their usual food intake while recording, and to record all foods and beverages immediately after consumption. The records solicited information on the following items: date and time of consumption (breakfast, lunch, dinner, or snack time) and type of food consumed. The estimation of portion size was aided by household measuring utensils and estimation of dimensions (in cm) and weight (in g) when possible. All records were viewed and checked for clarity and completeness by a dietitian, and were analyzed for energy and macro and micronutrients intake using Nutrition III for Windows software. Serum calcium, phosphorus, magnesium, alkaline phosphatase (ALP) and parathyroid hormone (PTH) were the bone related chemistries in the present study. These markers were measured as they are major factors in calcium homeostasis, bone metabolism, and pathogenesis of age-related bone loss that cause secondary osteoporosis. When evaluating nutritional factors in relation to bones, particularly dietary calcium, it is important to examine the serum level and detect common possible deficiencies or abnormalities in the elderly. Blood was collected after 10-12 hours fasting in the morning. An antecubital venous sample was collected in a 5 ml Vacutainer tube. Then samples were centrifuged (Beckman, California, USA) at 3000 g for 10 minutes at 4°C. The serum was immediately frozen at -70°C (Snijder, Tilburg, Holland) and was kept for analysis. We measured serum calcium, phosphorus, magnesium, and ALP using AutoAnalyzer (Abbott Park, Illinois, USA) and PTH by Immuno Radio Metric Assay (IRMA) (Genesys, USA). The BMD of postmenopausal women was assessed by dual-energy

x-ray absorptiometry (DXA) (Hologenic QDR 2000, Bedford, USA) at the lumbar spine (lumbar vertebrate 2-4) and left femur (femoral neck, femoral trochanter, and femoral words triangle).

The SPSS (version 11.5) was used for all statistical analysis. All the reported data were expressed as mean ± SEM. Comparison between averages of the groups was carried out using one-way analysis of variance test. To examine whether bone markers were associated with current energy and macro and micronutrients, multiple and linear regression was used. The significant value of $p$ was <0.05.

**Results.** In this study, women (n=58) according to t-score BMD of the spine (because there was suitable distribution of 3 groups) were classified into 3 groups: normal (n=18), osteopenia (n=22), and osteoporosis (n=18). There were no significant differences in years

of menopause between the 3 groups. The mean daily dietary energy, macronutrients (carbohydrate, protein, and fat), calcium, phosphorus and magnesium, and recommended daily allowance levels (RDA), according to the bone status in all subjects, are shown in **Table 1**. The mean daily energy, protein, carbohydrate, fat, and phosphorus in the osteopenia group were higher than the normal group. The mean daily calcium intake in the osteoporosis group was significantly lower than the normal group. There was no deficiency in energy, protein, and phosphorus intakes in all groups as compared with RDA, but the mean daily calcium intake in the normal group was 87.66% RDA, and in other groups was lower than RDA. The mean daily magnesium intake was lower than RDA in the 3 groups (**Table 1**). Calcium (82.5%) and magnesium (99%) dietary intake of postmenopausal was lower than RDA. The mean serum calcium, phosphorus, magnesium,

**Table 1** - The mean dietary energy, macronutrient (carbohydrate, protein, and fat), calcium, phosphorus, and magnesium intake in 3 groups of postmenopausal women (n=58).

| Energy and nutrients | (1) normal (n=18) | | (2) osteopenia (n=22) | | (3) osteoporosis (n=18) | | Total (n=58) | | Post HOC | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Daily intake | %RDA | Daily intake | %RDA | Daily intake | %RDA | Daily intake | %RDA | *$P$ (1,2) | *$P$ (1,3) |
| | | | | mean ± standard error | | | | | | |
| Energy (kcal) | 2134.7±160.5 | 112.3±6.1 | 2632.8±136.3 | 145.7±9.2 | 1970.1±107.7 | 103.0±5.7 | 2269.1±86.9 | 120.3±5.4 | 0.04 | 0.83 |
| Protein (g) | 68.7±5.0 | 137.4±7.5 | 95.5±67.6 | 190.2±14.6 | 67.6±5.3 | 135.6±10.5 | 81.4±4.5 | 154.4±7.6 | 0.009 | 0.75 |
| Carbohydrate (g) | 308.7±21.1 | - | 385.4±26.1 | - | 283.1±16.2 | - | 329.9±13.9 | - | 0.05 | 0.54 |
| Fat (g) | 78.4±13.4 | - | 83.6±6.9 | - | 69.5±6.9 | - | 77.6±5.3 | - | 0.15 | 0.88 |
| Calcium (mg) | 1052.6±43.6 | 87.6±7.5 | 936.9±88.3 | 78.0±7.0 | 774.6±59.6 | 64.5±6.1 | 922.4±42.5 | 76.7±6.7 | 0.32 | 0.01 |
| Phosphorus (mg) | 902±67.4 | 128.8±8.5 | 1134.3±75.5 | 161.5±10.7 | 765.9±41.7 | 108.5±6.1 | 933.6±43.5 | 132.9±7.0 | 0.002 | 0.81 |
| Magnesium (mg) | 112.8±13.2 | 32.2±5.1 | 136.2±15.5 | 41.4±4.9 | 93.0±6.1 | 29.6±1.8 | 115.5±7.7 | 34.4±2.2 | 0.59 | 0.90 |

*$p$ = one-way analysis of variance

**Table 2** - The mean serum calcium, phosphorus, magnesium, alkaline phosphatase, and parathyroid hormone (PTH) levels in 3 groups of postmenopausal women (n=58).

| Serum biomarkers | (1) normal (n=18) | (2) osteopenia (n=22) | (3) osteoporosis (n=18) | Total (n=58) | Post Hoc | |
|---|---|---|---|---|---|---|
| | | | | | *$P$ (1,2) | *$P$ (1,3) |
| | | mean ± standard error | | | | |
| Calcium (8.8-10.8 mg/dl) | 9.2±0.7 | 9.4±0.0 | 9.3±0.1 | 9.3±0.0 | 0.473 | 0.731 |
| Phosphorus (2.5-5 mg/dl) | 4.0±0.4 | 3.4±0.0 | 3.3±0.0 | 3.5±0.1 | 0.174 | 0.162 |
| Magnesium (1.9-2.5 mg/dl) | 3.9±1.8 | 2.1±0.0 | 2.1±0.0 | 2.8±0.6 | 0.797 | 0.840 |
| Alkaline phosphates (64-306 U/l) | 237.6±49.9 | 262.0±14.1 | 266.6±14.6 | 258.3±18.6 | 0.85 | 0.80 |
| PTH (<40 pg/ml) | 27.6±2.2 | 31.4±4.1 | 46.7±3.5 | 37.0±2.7 | 0.009 | 0.001 |

*$p$ = one-way analysis of variance
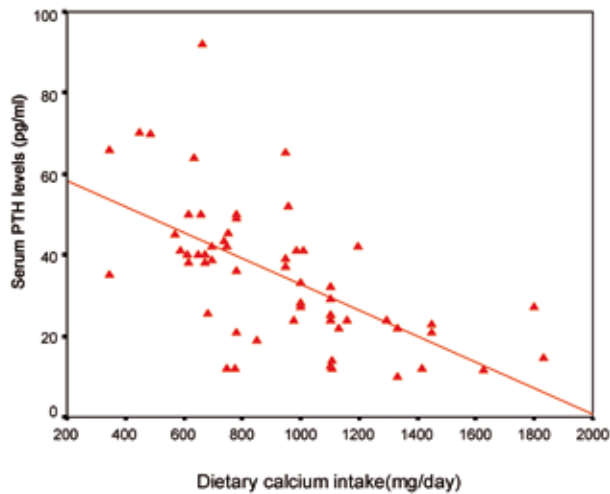
**Figure 1** - Correlation between dietary calcium intake and parathyroid hormone (PTH) levels in all subjects (r=-0.61, *p*=0.0001, B=-0.032).
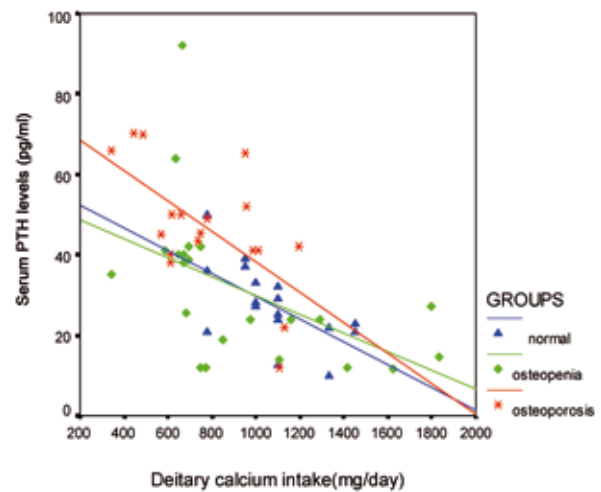


**Figure 2** - Correlation between dietary calcium intake and parathyroid hormone (PTH) level in 3 groups. Normal: r=-0.61, *p*=0.06, B=-0.028. Osteopenia: r=-0.5, *p*=0.01, B=-0.023. Osteoporosis: r=-0.6, *p*=0.005, B=-0.038.

ALP, and PTH levels according to bone status in postmenopausal women, are presented in **Table 2**. The mean serum calcium, phosphorus, magnesium, and ALP in the 3 groups of postmenopausal women were in the normal range, and differences between the 3 groups by one-way ANOVA test were not significant. The serum PTH level in the osteoporosis group was higher than other groups, and serum PTH level differences between the normal, osteopenia, and osteoporosis groups were significant. Among dietary factors, only calcium, and among bone markers, only PTH, showed a significant correlation with each other. The correlation between dietary calcium intake and PTH levels in all subjects is presented in **Figure 1**, and the correlation between daily calcium intake and PTH in the 3 groups is presented in **Figure 2**. The results of analyzing by linear regression, showed a significant correlation between calcium intake and PTH level (r=-0.61, *p*=0.0001, B=-0.032).

**Discussion.** The present study expands our knowledge of bone related chemistry and dietary intake and their associations in postmenopausal women. In the present study, there was no deficiency in energy and macronutrients intake. Chee et al's study[16] on dietary intake of Malaysian postmenopausal women aged 50-64 years is consistent with our study. Other studies showed that mean energy and macronutrients intake were lower than our results.[15,17] In comparison with Macdonald et al's research[18] that was carried out on women in the menopausal transition, mean intake of energy and carbohydrate intake is higher in our study, because of the Iranian food culture. In our study, the

mean dietary calcium and magnesium were lower than RDA values, but the mean dietary phosphorus intake was higher than RDA values. Our finding is consistent with Massé et al's study[17] on mean dietary calcium and phosphorus intake. Chee et al,[16] who noted that the mean calcium intake in postmenopausal women from the 3-day records was lower than RDA values (447±168 mg/day versus 1200 mg/day). McCabe et al[19] reported that mean calcium intake in black and white Indian women was lower than RDA, and phosphorus intake was higher then RDA, which is in agreement with our results. The results of Tucker et al's study[20] on dietary pattern in older adults (69-93 years) in the Framingham osteoporosis study, showed that calcium intake was lower than RDA in both men and women, again consistent with our results. McCabe et al[19] reported that magnesium intake of black Indian women was lower than RDA, but magnesium intake in white Indian women was higher than black women. In Tucker et al's study,[20] the mean magnesium intake was higher than our results, and Ricci et al[21] reported that the mean magnesium intake in postmenopausal women aged 55.9±7.9 years was at the RDA level.

In the present study, we did not observe any deficiency in energy and macronutrients intake, but micronutrients intake such as calcium and magnesium were lower than recommended values. We suppose that it may be due to low knowledge of postmenopausal women of the facts that they should consume a balanced and rich micronutrient diet for healthy bones in the menopause period. In the present study, serum calcium, magnesium, and phosphorus concentrations

were in the normal range in all groups. In a study based on bone turnover markers and PTH levels in surgical versus natural menopause, Garcia-Perez et al[22] found that the mean serum calcium, phosphorus, and magnesium levels in both groups were normal, which is in agreement with our results. Our finding is consistent with that of Klevay et al,[23] who noted in women with low dietary magnesium, serum magnesium was normal and also with Riggs et al's study.[24]

In our study, serum ALP levels in all groups were no higher than the normal range. Garnero[25] reported that in postmenopausal osteoporosis, levels of bone resorption markers, such as ALP, above the upper limit of the premenopausal range are associated with an increased risk of hip, vertebral, and nonvertebral fracture, independent of BMD. Cooper et al,[26] noted that the serum ALP level in postmenopausal women by 1-10 years before calcium and vitamin D supplementation was in the normal range, also in our results there were no significant differences in the mean serum ALP levels between normal and other groups, while the mean dietary calcium intake of the normal group was higher than others.

In our findings the mean serum PTH concentration in the osteoporosis group was high, but in normal, and osteopenia groups was lower than the osteoporosis group. In all subjects without classification groups, the mean serum PTH level was near the upper end of normal range. Von Muhlen et al[27] in the Rancho Bernardo study noted that in US postmenopausal women aged 50-97 years, serum levels of PTH indicative of hyperparathyroidism were around 18%. Bergstrom et al,[28] reported that, in postmenopausal women with a forearm fracture the prevalence of primary hyperparathyroidism was 6.7%. The results of analyzing by linear regression showed the significant correlation between calcium intake and PTH level (r=-0.6, *p*=0.0001, B=-0.032). Jaber et al[29] assessed the effect of calcium on PTH in postmenopausal women and, reported that PTH was raised in osteoporotics with low or moderate intake of dairy products. No significant relationship was shown between dairy product consumption and PTH levels in women with normal BMD. Lau et al's study[30] on milk supplementation on postmenopausal Chinese women indicated that serum PTH concentration was lower and serum 25-hydroxyvitamin D [25(OH)D] level was higher in the milk supplementation group than the control group at 12 months. Dawson-Hughes et al[31] found that supplementation with calcium and calcium + vitamin D in men and women 65 years of age or older, showed that serum PTH decreased 7±12.9 pg/ml in men and 5.5±13.2 pg/ml in women, but in the placebo groups, serum PTH increased.

Bone tissue serves as reservoir of calcium and other minerals that are used by other tissues of the body.

Calcium homeostasis, or the process of maintenance of a constant serum calcium concentration, is almost totally reliant on this bone tissue source of calcium when the diet is inadequate. Adaptation of the homeostatic mechanism of regulation of blood calcium concentration is achieved through 2 calcium-regulation hormones, parathyroid hormone and 1, 25 di hydroxyl vitamin D3 (calcitriol). Endogenous PTH activity, which directly contributes to bone loss, increases in both males and females during the decades of 60s and beyond, even though PTH measurements typically remain within the normal range, but at the high end. Calcium supplementation, typically helps reduce the serum PTH concentration in elderly subjects.[6,32] Our results are limited to postmenopausal women, further studies in premenopausal and the menopause transition will help in increasing life quality.

In conclusion, as there was a significant correlation between calcium intake and serum PTH levels, therefore increasing dairy products and calcium rich-food intake, and distribution of nutritional information by the media or booklets, is highly recommended to maintain BMD in postmenopausal women.

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## Related topics

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