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The Role of Proper Food Habit and Physical Activity Level in Preventing Osteoporosis in Postmenopausal Iranian Women

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ABSTRACT

This study was carried out to investigate the role of dietary components and physical activities in the prevention of osteoporosis in postmenopausal women. In this cross-sectional study, 58 volunteer postmenopausal women participated and filled personal information, physical activity assessment and food frequency questionnaires. Anthropometric measurements and bone measurements were undertaken by experts. Of all 58 cases, 18 were normal, 22 were osteopenic and 18 were osteoporotic. Most of osteoporotic women had low physical activities and low calcium intakes. The mean intake of leafy green vegetables, dairy product, fish and egg in normal women was significantly higher than osteoporotic ones. Most of educated women were normal while the majority of osteoporotic women had only studied in primary school (33.3%). The correlation of dietary intakes and physical activity level with BMD (Bone Mineral Density) indicates that osteoporosis is preventable, so Iranian women's awareness of osteoporosis and its affordable precautions must be increased to help them to prevent the disease.

Key words: Osteoporosis, body weight, calcium, phosphor intake

INTRODUCTION

Osteoporosis is a major public health problem in the western world and is increasing in the developing world (MacDonald *et al*., 2005). Worldwide, about 1 in 3 women and 1 in 12 men over the age of 50 have osteoporosis. The disease is responsible for millions of fractures annually, mostly involving the lumbar vertebrae, hip and wrist. An osteoporotic fracture not only entails high health care costs (Chrischilles *et al*., 1994), but is also frequently associated with the loss of quality of life resulting from deficient healing (Johnell, 1996) and with an increased mortality risk (Center *et al*., 1999). Several risk factors have been proposed to be associated with bone loss (Cumming *et al*., 1997); some factors are modifiable (e.g., weight, physical activity and diet) while some others are non-modifiable (e.g., age, sex and race) (Ross, 1996).

The study of dietary factors in osteoporosis prevention is very importants since improvements in dietary intake could be applied broadly and may represent a non pharmaceutical approach to improving BMD (Ryder *et al*., 2005).

Among the pharmacological treatments, Hormone Therapy (HT), Selective Estrogen Receptor Modulators (SERMs) and bisphosphonate have been shown to be effective either in increasing Bone Mineral Density (BMD) and/or reducing fracture rates (Goltzman, 2002). However, the side effects of these medications, including gastrointestinal tolerance problems in bisphosphonate and the potential malignancies in HT (Reid, 2002), may preclude their long-term use. Growing evidence of the benefits of natural foods for bone health provide an alternative option for prevention and/or treatment of osteoporosis.

Cross-sectional studies have shown that people, including postmenopausal women, healthy women and elderly men, who consume more fruits and vegetables accumulate a higher Bone Mineral Density (BMD) (Chen *et al*., 2006; New *et al*., 2000; Okubo *et al*., 2006; Prynne *et al*., 2006; Tucker *et al*., 2002, 1999; Vatanparast *et al*., 2005; McGartland *et al*., 2004; Tylavsky *et al*., 2004). In addition, increased fruit and vegetable consumption showed benefits for bone health and bone development in young people (Vatanparast *et al*., 2005; McGartland *et al*., 2004; Tylavsky *et al*., 2004).

Physical Activity (PA) has been reported to have beneficial effects on the skeleton by contributing significantly to attainment of peak bone mass (Khan *et al*., 2000; Bailey *et al*., 1999) and maintenance of bone mass later in adulthood (Cashman, 2002).

In order to elucidate the role of modifiable bone loss factors in Iranian women, the present study was undertaken to investigate the dietary components and physical activities which are likely to contribute to osteoporosis in postmenopausal women.

MATERIALS AND METHODS

This was a cross-sectional study in which 58 volunteer postmenopausal women (58.29±0.89 years old) who were referred to Rheumatology Department of Tabriz (a Northwestern city of Iran) Sina hospital from January 2005 until August 2006 were studied.

Inclusion criteria included: more than 50 year old, at least 5 years since the onset of menopause, good overall health, no anti osteoporosis treatment, no vitamin and mineral supplementation, no records of early menopause, oophorectomy, hysterectomy, HRT, or smoking, no history of antiepileptic medication use, no hypertension medications, no records of liver, kidney or Paget's diseases.

Personal data: A questionnaire comprising 30 open ended questions was designed to assess such personal data as age, education, physical activity, medical background, anthropometric measurements and etc. (Appendix).

Anthropometric measurements: All women were weighed without shoes and while wearing light clothing with the use of scales calibrated to 0.05 kg. Height was recorded to the nearest 0.1 cm with the use of a wall-mounted stadiometer and Body Mass Index (BMI) was calculated as weight (kg)/height (m^2).

Bone measurement: BMD (Bone Mineral Density) of postmenopausal women was assessed by Dual-Energy X-ray Absorptiometry (DEXA) at the lumbar spine (lumbar vertebrate 2-4) and left femur (femoral neck, femoral trochanter and femoral words triangle) hologic.

Dietary assessment: Dietary intakes of participants were assessed with the use of a semi-quantitative Food Frequency Questionnaire (FFQ), which included questions on frequency and

portion size of consumption of 46 food items commonly eaten in Iran (Tabriz) during the previous year (Sheikh, 2006). A dietician helped the participants to fill the FFQ and discussed any missing answers with them when necessary. Foods were categorized into the following groups: dairy products, vegetables and fruits, animal proteins, legumes and carbohydrates.

Physical activity assessment: Physical activity level was assessed using metz questionnaire. Participants were instructed how to keep physical activity record and were asked to record their physical activities over 3 days. According to the results of questionnaires, physical activity levels of participants were classified in to three levels: light activity, moderate activity and high activity.

Statistical analysis: The SPSS software (ver. 11.5) was used for all statistical analysis. All the data was reported as Mean±SEM. Comparisons between means were carried out using One-way ANOVA test. Multiple linear regression analysis was used to explore the effects of dietary calcium, vegetable and fruit intakes on BMD. The relationship between physical activity and BMD was assessed by Chi-square and a p-value of less than 0.05 was considered statistically.

RESULTS

DEXA BMD measurements showed that of all 58 cases, 18 were normal, 22 were osteopenic and 18 were osteoporotic (Table 1). Most women from all three BMD groups were overweight and had the BMI values between 25-29.9 kg m^{-2}.

Of 18 women with a normal BMD, 72.2% engaged in moderate physical activity while 77.8% of osteoporotic women reported only light physical activity (Table 2). The use of Chi-square formula proved that there is a significant correlation between bone mass and physical activity level

Table 1: General characteristic of participants

Subject characteristic	Normal (n = 18)	Osteopenic (n = 22)	Osteoporosis (n = 18)	Total (n = 58)
Age (years)	57.110±0.90	58.220±1.23	57.440±1.25	58.290±0.89
Body weight (kg)	66.200±2.16	68.300±2.1	70.160±1.7	68.250±1.19
Height (cm)	157.600±0.98	157.400±3.1	155.600±1.09	156.900±0.67
DEXA BMD* (g cm^{-2})	0.898±0.035	0.748±0.017	0.655±0.012	0.731±0.01
T-score of lumbar spine (L2-L4)	0.490±0.24	-2.010±0.8	-2.960±0.70	-2.180±0.12

BMD*: Bone Mineral Density

Table 2: The frequency and percentage of all cases in terms of BMI range and level of physical activity

	Normal (n = 18)		Osteopenic (n = 22)		Osteoporotic (n = 18)		Total (n = 58)	
BMI classification	N*	Percent	N	Percent	N	Percent	N	Percent
BMI (kg m^{-2}) (normal 18.5-24.9)	5	27.8	7	31.8	3	16.7	15	25.9
Over weight (25-29.9)	9	50.0	10	45.5	10	55.6	29	50.0
Obese I (30-34.9)	4	22.2	4	18.2	3	16.7	11	19.0
Obese II (35-39.9)	-	-	-	-	2	11.1	2	3.4
Obese III (≥40)	-	-	1	4.5	-	-	1	1.7
Physical activity level								
Light PA**	5	27.8	10	45.5	14	77.8	29	50.0
Moderate PA**	13	72.2	12	54.5	4	22.2	29	50.0

N*: Number, PA**: Physical Activity

Table 3: The mean intake of calcium, phosphorus and magnesium

Mean intake of micronutrients	Normal 1 (n = 18)	Osteopenic 2 (n = 22)	Osteoporosis 3 (n = 18)	Total (n = 58)	Post hoc PV*(1, 2)	Post hoc PV*(1, 3)
Calcium (mg day^{-1})	1052.6±43.6	936.9±88.3	774.60±59.6	922.40±42.5	0.32	0.01
Phosphorous (mg day^{-1})	902.0±67.4	1134.3±75.5	765.90±41.7	933.60±43.5	0.002	0.81
Magnesium (mg day^{-1})	112.8±13.2	136.2±15.5	93.03±6.18	115.58±17.7	0.59	0.90

PV*: One way ANOVA; Mean±SEM

Table 4: The mean weakly consumption of foods

Food items	Normal 1 (n = 18) Time/week	Osteopenic 2 (n = 22) Time/week	Osteoporosis 3 (n = 18) Time/week	Total (n = 58) Time/week	PV* (1, 2)	PV* (1, 3)
Milk	9.83±2.34	7.73±1.51	5.39±0.94	7.08±0.87	0.46	0.13
Yogurt	6.05±2.23	3.14±0.52	3.44±0.60	3.96±0.45	0.19	0.34
Cheese	6.65±2.25	5.45±1.25	4.12±1.03	5.40±1.54	0.65	0.25
Dough**	2.33±1.48	1.41±0.70	0.89±0.41	1.32±0.41	0.89	0.87
Dairy product group	24.41±2.32	17.73±1.20	13.84±0.75	17.76±1.26	0.15	0.02
Bread	11.06±1.14	11.27±0.86	10.11±0.84	10.84±0.54	0.75	0.69
Rice	6.78±0.51	7.77±0.70	5.67±0.55	6.81±0.39	0.69	0.48
Macaroni	0.82±0.08	1.19±0.33	0.63±0.13	0.90±0.13	0.92	0.20
Bread and Cereal group	18.56±1.10	20.24±0.90	16.40±1.09	21.91±0.77	0.10	0.22
Fruit group	24.33±3.49	26.41±2.91	21.49±3.33	24.23±1.84	0.31	0.58
Leafy green vegetable	4.33±0.66	1.91±0.42	2.22±0.50	2.75±0.32	0.03	0.04
Red meat	2.08±0.38	3.52±0.46	2.89±0.42	2.87±0.25	0.02	0.11
Poultry	1.51±0.19	1.99±0.32	1.72±0.25	1.75±0.15	0.42	0.58
Fish	1.35±0.29	0.69±0.15	0.67±0.20	0.88±0.12	0.03	0.03
Egg	2.47±0.46	1.74±0.21	1.00±0.20	13.73±0.18	0.31	0.008
Meat group	7.63±0.89	8.13±0.74	6.44±0.55	7.45±0.43	0.86	0.29
Sweet baked products	0.50±0.12	1.78±0.49	1.65±0.45	1.34±0.24	0.05	0.05
Table sugar	8.89±1.64	14.32±2.36	16.33±2.87	13.25±1.37	0.07	0.02
Refined sugar	12.65±1.40	19.20±2.83	20.61±2.81	17.60±1.49	0.15	0.02
Fat group	13.35±0.84	12.86±0.88	11.08±1.30	12.46±0.58	0.44	0.08
Tea	21.78±2.33	29.50±2.43	24.50±2.55	25.58±1.45	0.02	0.29

PV*: One way ANOVA, Dough**: Yogurt drink; Mean±SEM

(PV = 0.002). The results of One-way ANOVA test indicated that normal women had higher calcium intake (Table 3). The results of the analysis by multiple linear regression showed that calcium intake was significantly ($p<0.001$, $\beta = 0.522$, $r = 0.52$) associated with BMD.

The analysis of the food frequency questionnaire showed that subjects with a normal BMD are more likely to consume diets high in dairy products, vegetables, fish, egg and butter (Table 4).

DISCUSSION

Osteoporosis is one of the major public health problems for postmenopausal women worldwide and effects about one third of women aged between 60 to 70 years and two third of those aged 80 years or more (Cashman, 2005). Diet and lifestyle play a crucial role in maintaining the health of this growing portion of the community (Nahim and Straus, 2001).

Physical Activity (PA) has been reported to have beneficial effects on the skeleton by contributing significantly to attainment of peak bone mass (Khan *et al*., 2000; Bailey *et al*., 1999)

and maintenance of bone mass later in adulthood (Cashman, 2002). Moreover, resistance training has beneficial and site-specific effects (Kerr *et al.*, 2001) which improve BMD as well as muscle strength.

In the present cross-sectional study, there was a significant relationship between more physical activity and higher BMD. 72.2% of the subjects in normal group reported moderate physical activity level while 77.8% of the subjects in osteoporosis group reported only light physical activity level (Table 2). Similar correlation was also found in earlier studies by Del Mar *et al.* (2000), Feskanich *et al.* (2002) and Coupland *et al.* (1999).

A recent data analysis of 18 randomized controlled exercise trials showed that aerobics, weight-bearing exercises and resistance training were effective in minimizing bone loss (Bonaiuti *et al.*, 2002). Devine *et al.* (2004) reported that the combination of high physical activity level and calcium consumption was associated with a 5.1% higher total hip BMD than those individuals in the low physical activity and calcium consumption group.

In this study, most subjects were in overweight range (BMI: 25-29.9 kg m^{-2}) and no significant correlation between BMI and BMD was observed.

However, many earlier studies reported that obesity (greater body weight and BMI) is associated with higher BMD (Takata *et al.*, 1999; Murillo-Uribe *et al.*, 2000). The protective effect of obesity on bone loss appears to be related to both mechanical factors and to estrogen synthesis in adipose in adipose tissue (Ribot *et al.*, 1994). Perhaps, the fact that most of these Iranian women were over weight precluded finding a relationship between weight or BMI and BMD.

One of the objectives of this study was to determine the dietary factors which are likely to contribute to osteoporosis in postmenopausal women and to find their correlation with BMD in these women. Several studies have identified the association between dietary intake of different nutrients and BMD, rate of bone loss and fracture incidence in postmenopausal women in western societies (Michaelsson *et al.*, 2003; Tucker *et al.*, 2002) . However, there are no publications about this issue in Iranian postmenopausal women.

The results of the present study showed that the mean calcium intake of normal women was significantly higher than osteoporotic ones (1052.6±43.6 versus 777.4±59.6 mg day^{-1}). The results of the analysis by multiple linear regression showed that calcium intake was significantly ($p<0.001$, $r = 0.52$) associated with BMD. These results are in agreement with the earlier studies by Chee *et al.* (2002) and Ilich *et al.* (2003) that reported a significant relationship between dietary calcium and BMD and Dowson Hughes *et al.* (1997) noted that calcium supplementation for elderly men and women caused decrease in bone loss.

The mean intake of leafy green vegetables, dairy product, fish and eggs in normal women was significantly higher than osteoporotic ones. These findings are consistent with Tucker *et al.* (2002) who studied bone mineral density and dietary patterns in older adults. They observed that women with higher intakes of fruit, vegetables and cereals tended to have higher BMD than did other women.

Cross-sectional studies have shown that people, including postmenopausal women, healthy women and elderly men, consuming more fruits and vegetables accumulate a higher Bone Mineral Density (BMD) (Chee *et al.*, 2002; New *et al.*, 2000; Okubo *et al.*, 2006; Prynne *et al.*, 2006; Tucker *et al.*, 2000, 1999; Vatanparast *et al.*, 2005). In addition, increased fruit and vegetable consumption showed benefits for bone health and bone development in young people (Vatanparast *et al.*, 2005; McGartland *et al.*, 2004; Tylavsky *et al.*, 2004).

Limited evidence is available to explain the effect of vegetable and fruit consumption on bone density. The alkalizing effect of fruit and vegetable consumption has drawn attention as a possible mechanism of their beneficial influence on bone, other plausible mechanisms include the dietary influence of vitamin K and phytoestrogens. Vegetables, herbs and salads which are commonly consumed in the human diet have been shown to affect bone resorption in rats by a mechanism that is not mediated by their base excess but that may be mediated through pharmacologically active compounds (Lanham-New, 2006).

The mean intake of refined sugar and sweet baked products in osteoporotic women was higher than normal ones; this is in agreement with Tucker *et al.* (2002), who reported that women consuming more candy, had lower BMD.

Trichopoulou *et al.* (1997) reported that there was evidence for an inverse association between carbohydrate intake and BMD, but the association was significant only with respect to mono-and disaccharides.

Osteoporosis may be partially prevented by optimizing peak bone mass in younger years, maintaining bone mass in adult years and minimizing bone loss in later years. Adequate intakes of calcium and weight-bearing physical activities have been shown to be effective strategies for building, maintaining and slowing loss of bone mass (Recker *et al.*, 1996; Picard *et al.*, 2000; Cadogan *et al.*, 1997; Snow-Harter *et al.*, 1992; Heinonen *et al.*, 1996; Suleiman *et al.*, 1997). Therefore, to prevent osteoporosis, women need adequate dietary calcium intake, high physical activity level and exposure to sun. Furthermore, the high level of awareness about the disease and its affordable precautions can reduce osteoporosis in Iranian women. Since, BMD (Bone Mineral Density) test is an expensive measurement, a limited number of women could be included in the study and the limited number of subjects might be the reason for some inconsistencies between the results of this study and some previous studies.

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APPENDIX

File Number.....
Date.....

Personal Data
First name .....
Last name .....
Phone Number.....
Home address.....
Job.....
Gender.....
Age.....
Marital status.....
Educational Level.....

Anthropometric Data

Weight ....

Height.....

Waist circumference.....

Body size .....

BMI.....

Ideal body weight.....

Medical History

The onset of menopause.....

Diabetes	Yes	No
Stroke	Yes	No
Cushing	Yes	No
Oophorectomy	Yes	No
Hysterectomy	Yes	No
Antiepileptic medication	Yes	No
Hypertension medications	Yes	No
Liver or kidney diseases	Yes	No
Paget's disease	Yes	No
Vitamin and mineral supplementation	Yes	No
Anti osteoporosis treatment	Yes	No
Hormone therapy	Yes	No
Chemotherapy	Yes	No
Smoking	Yes	No

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