FRUIT AND VEGETABLE INTAKE IN POSTMENOPAUSAL WOMEN WITH OSTEOPENIA

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Abstract

INTRODUCTION: Adequate intake of fruits and vegetables as part of the daily diet could help prevent major non-communicable diseases including osteoporosis. Some nutrients abundant in fruits and vegetables have been shown to affect bone health. In the present study we evaluated fruit and vegetable intake in postmenopausal women with osteopenia who had referred to bone mineral densitometry center of Shariati hospital in Tehran.

METHODS: The present cross-sectional study was carried out on 51 healthy postmenopausal women aged 45-60 years. Bone mineral density was measured by Dual Energy X-ray Absorptiometry at lumbar spine and total hip. All women were osteopenic according to WHO criteria. Food groups' intake was assessed by 2 days 24 hour recall. Bone resorption was calculated by measuring carboxy-terminal telopeptide of type I collagen (crosslaps) and bone formation by measuring serum osteocalcin.

RESULTS: No significant correlation was found for current food groups' intake and bone mineral density at either lumbar spine or total hip. Fruit and vegetable intake was significantly negatively correlated with osteocalcin level ($r = -0.4$, $P < 0.001$). Serum osteocalcin level in those who consumed more than 400 grams of fruit and vegetable daily was significantly lower than in the others (18±6.5 compared with 30±13.7, $P<0.05$).

DISCUSSION: Increasing fruit and vegetable intake up to WHO recommendations for prevention of many chronic diseases can also be effective in prevention of osteoporosis and reducing fracture risk in postmenopausal osteopenic women. Intake of at least 400 grams of fruits and vegetables daily can complement what is currently recommended for osteoporosis prevention.

Keywords • Fruit and vegetable intake • Osteoporosis • Non-communicable diseases

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Introduction

Low fruit and vegetable intake is among the top 10 risk factors contributing to attributable mortality.

Adequate intake of fruits and vegetables as part of the daily diet could help prevent major non-communicable diseases. Worldwide, low fruit and vegetable intake is estimated to cause 19% of gastrointestinal cancers, 31% of ischemic heart diseases and 11% of strokes.[1] Osteoporosis is also a non-communicable disease which occurs mostly in the elderly.

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It is speculated that the prevalence of this disease will dramatically increase by the year 2050,[2] most likely due not only to the aging population but also to adverse changes in lifestyle and diet.[3]

Identification of dietary factors that contribute to bone loss should lead to effective interventions to reduce bone fractures.

Research on diet and bone metabolism or bone mineral density has focused primarily on calcium and vitamin D. Recently there has been interest in the individual effects of other nutrients such as magnesium, potassium, copper, zinc, vitamin C, vitamin K, protein, fatty acids and sugars.[4]

Bone is a complex living tissue, and it is logical that a wide spectrum of micronutrients contribute to its maintenance. Because of that complexity, it may sometimes be misleading to examine nutrients individually.

Nutrients are packaged together in foods and therefore associations seen with a single nutrient may, in fact, be due to a more complex constellation of other nutrients consumed contemporaneously.

Fruits and vegetables are important components of a healthy diet and some nutrients abundant in fruit and vegetables have been shown to affect bone health.[5-9]

Studies have demonstrated that markers of bone metabolism may be more useful in predicting rates of bone loss than a single measurement of current BMD.[10] Thus in the present study we assessed fruit and vegetable intake of postmenopausal women with osteopenia and examined the relationship between nutrients and food groups' intake with bone mass and bone metabolism markers.

Materials and methods

Subjects in the present study were 1-10 year post-menopausal women aged 45-60 years who had referred to bone mineral densitometry center of Shariati Hospital in Tehran, Iran. All subjects were osteopenic according to the WHO criteria.[11]

Non-smoking women who had not taken any medications or did not suffer from any condition likely to affect their bone metabolism were chosen.

Each woman's weight (while wearing light clothing and no shoes) was recorded using a balance-beam scale to the nearest 0.5 kg. Height was measured with a stadiometer to the nearest 0.5 cm. Body mass index (BMI) was calculated according to the following formula: [weight (kg) / (height (m)) ^{2}].

Bone mineral density (BMD) was assessed by dual-energy X-ray absorptiometry (DEXA) at the lumbar spine (lumbar vertebrae 2-4) and total hip.

A blood sample was collected after an overnight fasting of 12-14 hours and bone metabolism was assessed using two markers, i.e. the serum marker of bone formation, osteocalcin (OC), and serum marker of bone resorption, crosslaps (CL). Both bone markers were measured using ELISA method and Nordic Bioscience Diagnostic (Denmark) kits.

Usual dietary intake was assessed using two days of 24-hour food recall.

Using the manual for household measures, cooking factors and edible portion of foods, the amount of consumed foods was converted to grams. Data was analyzed using Statistical Program for Social Sciences (SPSS) (version 11.5). Descriptive statistics were determined for all variables. The relationships between non-dietary and dietary variables, bone mass and bone metabolism were assessed using Pearson correlations.

Based on fruit and vegetable intake, subjects were grouped as those with high intake (>400 grams of fruits and vegetables daily) or low intake (<400 grams of fruits and vegetables daily). Student t-test was used to compare means and chi square test was used to compare frequency of variables. A P value of <0.05 were considered significant.

Results

Fifty-one osteopenic women with mean age of 55.2± 3.6 years were studied. Duration of menopause was 5.9±2.9 years. Fifty-seven percent of the subjects used calcium and vitamin D supplements. The characteristics of the study population are shown in Table 1.

Positive correlation was observed between the two bone metabolism markers, OC and CL (r=0.5, P<0.001). Duration of menopause was negatively correlated with OC (r= -0.4, P<0.01) and also CL (r= -0. 4, P<0.05). Age was negatively correlated with OC (r= -0.4, P<0.05) but no significant correlation was seen with CL.

Mean dietary intake of food groups are shown in Table 2. Consumption of milk and milk products, meat and meat alternatives, cereals and grains, fats and oils and sweets did not differ significantly between the low and high fruit and vegetable consumption groups.

Dietary intake of food groups correlated with neither total hip nor lumbar spine BMD. Pearson's correlations between food groups' intake and bone metabolism markers are shown in Table 3. Daily vegetable intake (excluding potatoes) as well as fruit intake significantly and negatively correlated with OC. Considering fruit and vegetable intake as one variable also showed a significant negative correlation (r= -0. 4, P<0.001).

Non-dietary variables were also compared in fruit and vegetable consumption groups.

No significant difference was observed for age, menopause duration, BMI, and BMD between the two groups. OC level was significantly lower in those taking more than 400 grams of fruits and vegetables daily (18±6.5 compared with 30±13.7, P< 0.05). CL level was also lower in those taking high amounts of fruits and vegetables but the difference was not statistically significant (0.65±0.27 compared with 0.74±0.41, P> 0.05).

TABLE 1. Characteristics of studied subjects

Age (y)	*55±4
Duration of menopause (y)	6±3
Anthropometric characteristics	
Height (cm)	156±6.6
Weight (kg)	70.5±11
BMI (kg/ m^2)	29±4
Bone Mineral Density and Bone Metabolism Markers	
Total hip BMD (g/cm^2)	0.08±0.896
Spine BMD (g/cm^2)	0.999±0.08
Osteocalcin (µg/l)	20.3±9.5
Crosslaps (µg/l)	0.67±0.3

*Means ± SD

TABLE 2. Reported intake of food groups according to fruit and vegetable consumption groups

Food groups	Total (n=51)	Fruit and vegetable Consumption groups	
		(n=38) > 400 gram/d	< 400 gram/d (n=13)
Cereals and Grains (g/d)	272±80*	281 ±85	248±62
Milk and Milk products (g/d)	204±304	313±213	277±180
Meat and Meat alternatives (g/d)	83±51	88±57	682 ±25
Fruits (g/d)	456±270	**456±252	195±89
Vegetables (g/d)	192±115	**218±118	116±62
Fats and Oils (g/d)	21±12	21±12	19±13
Sweets (g/d)	86±53	87±52	84±59

* Means ± SD

** Significantly different from the other consumption group, P<0.05

TABLE 3. Pearson correlation coefficients between food groups' intake and bone metabolism markers

Food groups	Osteocalcin		Crosslaps	
	Correlation coefficient	P value	Correlation coefficient	P value
Cereals and Grains (g/d)	-0.1	P>0.5	-0.1	P>0.3
Milk and milk products (g/d)	-0.2	P>0.3	-0.2	P>0.09
Meat and meat alternatives (g/d)	-0.2	P>0.2	-0.04	P>0.7
Fruits (g/d)	-0.3	P<0.05	0.01	P>0.9
Vegetables (g/d)	-0.3	P<0.05	-0.05	P>0.7
Fats and Oils (g/d)	0.2	P>0.1	0.3	P>0.05
Sweets (g/d)	0.2	P>0.08	0.2	P>0.09

Discussion

In the present study we examined the association between dietary intake and indices of bone mass as well as bone metabolism in postmenopausal osteopenic women. Our findings show that daily consumption of 400 grams of fruit and vegetables does not correlate with current total hip and lumbar spine BMD, but is associated with lower serum levels of bone metabolism markers, especially OC. In another study on the rural population of Tehran we showed higher BMD in heels of women consuming more than 1.5 servings of vegetables daily but no significant correlation was observed for fruits.[12]

Tucker et al showed a significant positive correlation between fruit and vegetable intake and BMD in Framingham Osteoporosis Study.[7] A similar correlation was reported by New et al in 45-55-year-old women.[5] They showed a positive correlation between nutrients abundant in fruits and vegetables including potassium and magnesium and bone mass.

In the present study we could not show any significant correlation between dietary intake of fruit and vegetables and current BMD for several reasons.

In order to evaluate dietary intake of the subjects we used 24-hour food recall for two days. Other studies have used different methods including food record and food frequency questionnaire. Use of different techniques and validity and reliability of methods can explain the difference in reported results. Meanwhile, our study population consisted of osteopenic women whose BMD was lower than the normal population.

However, more studies on larger populations are needed to determine the exact association between fruit and vegetable intake and BMD in osteopenic women.

As changes of BMD are very slow and occur over the years, in order to evaluate the association between fruit and vegetable intake and bone health, we used bone metabolism markers which change more rapidly than BMD and could show the effects of current diet on bone in a cross-sectional study. Effects of dietary intake, especially fruit and vegetable intake on bone metabolism markers are not widely studied.

New et al[5] showed lower urinary excretion of deoxypyridinoline in women with high intake of potassium and magnesium. Urinary excretion of pyridinoline was also lower in women with high intake of beta-carotene. Because fruits and vegetables are the main dietary sources of these nutrients, New et al concluded that high intakes of fruits and vegetables can also reduce bone resorption. In the present study, serum levels of both bone markers were lower in those consuming more than 400 grams fruits and vegetables daily, but the lower level was only statistically significant for osteocalcin, which may be due to the low sensitivity of the resorption marker used, or to the small number of subjects studied.

After menopause secretion of estrogen decreases significantly, leading to higher rates of bone turnover.[13] Higher bone turnover is associated with more bone loss.[14] Studies have shown that higher levels of bone metabolism markers are inversely related to BMD.[15] The higher the rate of bone turnover, the higher will be the bone loss in osteopenic women. Because of lower bone mass compared to the normal population, osteopenic women are at greater risk of bone fractures.[16,17]

Findings of the present study demonstrate the positive effect of fruit and vegetable intake on the process of bone loss in osteopenic women. One of the mechanisms explaining the effects of fruit and vegetable intake on bone health is the acid-base hypothesis. Studies have shown that low fruit and vegetable intake is associated with higher metabolic acid load.[18,19] In humans with normal kidney function, the acid-base balance is dependent on the ability of kidneys to excrete excess acid and the availability of a base for buffering.[20] Fruits and vegetables provide a natural source of base to buffer the acid produced by other dietary components. In the acute phase, potassium and sodium contained in the blood-fluid barrier are the first line of defense for buffering metabolic acidosis, thus sparing the bone tissue.[20]

In the chronic state of metabolic acidosis, bone crystals are dissolved to provide calcium, carbonate and citrate for buffering.[20] Much of the work to support these observations has been done in adults or animal models.[21-22] However, studies in rats have shown that giving vegetable concentrates protected the bone independently of potassium content, as this persisted after buffering with potassium citrate. The authors suggest that these vegetable extracts may contain other, yet unknown, pharmacologically active compounds.[23-24]

Whereas our study does provide support for the reduction of bone metabolism rate in post-menopausal women as a result of higher intake of fruits and vegetables, it does have some limitations.

This study was cross-sectional, and thus we cannot confer causality between diet and bone metabolism.

The sample was small, limited to 51 osteopenic women, and thus our results cannot be generalized to all women. However, our results suggest that increasing fruit and vegetable intake up to 400 grams daily, which is recommended by WHO for prevention of many chronic diseases, can also be effective for osteoporosis prevention. Intervention studies are recommended to determine the exact amount of fruits and vegetables for obtaining a positive effect on bone health.

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