ORIGINAL ARTICLE

Relationship Between Serum Leptin and Adiponectin and Bone Mass with Energy Intake and Nutrients in 40-60 Year-Old Postmenopausal Women

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Adequate nutrition is crucial for growth and maintenance of the body skeleton health; nutrients consumed affect leptin and adiponectin levels and bone mass. This study was done to determine the relationship between serum leptin, adiponectin and bone mass with energy intake and nutrients in postmenopausal women, 40-60 years old.

Material and Methods: The present cross-sectional study was done on 85 postmenopausal women, aged 40-60 years. Samples of fasting blood were taken to determine serum concentrations of leptin and adiponectin and bone mineral density was measured by the DXA method in the two areas of L2-4 and the femoral neck. Food intake was documented using questionnaires including food frequency and data was analyzed by FP2 software.

Results: Leptin had a negative relationship with energy intake, protein and magnesium and a positive relationship with carbohydrate; there was a positive relationship between adiponectin and energy and carbohydrate intakes. BMD of femur had a negative relationship with energy and carbohydrate, while it had positive relationship with calcium, and there was direct and significant relationship between BMD of the spine and zinc intake.

Conclusion: Increase in consumption of carbohydrates and decrease in consumption of protein led to increase in leptin levels. Consumption of calcium and zinc can have a protective effect on bones.

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Introduction

Adequate nutrition is crucial for growth and maintenance of the body's skeletal health. Although bone diseases have complicated etiologies, adequate nutrition can delay their development. Of these diseases, osteoporosis is the most common, and can drastically decrease quality of life. Providing bone synthesizing nutrients before osteoporosis develops is vital. Not only are calcium, phosphorus and vitamin D essential for producing normal bones and ensuring normal function, but other nutrients also have fundamental roles in bone construction and function. Some of the other nutrients that affect bone are magnesium, vitamin K, vitamin A, fluoride, copper, manganese, iron, zinc, boron and also protein and caffeine.[1]

Leptin, an ob gene product, is a small polypeptide hormone that is originally produced by adipocytes,[2,3] and strongly correlated with body fat mass.[4] This hormone has several physiologic functions that are not limited to energy balance. Recent studies show that leptin inhibits bone synthesis by affecting the hypothalamus.[5] Adiponectin, a new adipocytokine highly expressed in the adipocytes,[6] regulates energy homeostasis and has anti-inflammatory and anti-aterogenic effects.[7] This cytokine is a collagen-like protein has been recognized as adipocyte specific protein, and is conversely correlated to body mass index.[9] One study[10] shows that leptin and energy intake are directly correlated, whereas another study[11] reports a negative correlation. Also two studies assessed effects of carbohydrate consumption on serum leptin concentration and demonstrated that increase in carbohydrate consumption caused an increase in serum leptin concentration.[12,13] A positive correlation was seen between energy expenditure and bone mineral density (BMD) in two studies[15,22] but Abraham et al reported the negative effects of energy on bone mineral density. [22]

This study was done to determine the relationship between serum leptin, adiponectin and bone mass with energy intake and nutrients in postmenopausal women, 40-60 years old.

Materials and Methods

The present cross-sectional study was done on 85 postmenopausal women, 40-60 years old, that referred to the bone mineral densitometry center of Tehran's Imam Khomeini hospital using a randomized sampling method. Females excluded were those on hormone therapy or used drugs affecting bone mass, such as corticosteroids, antiepileptics, thyroid hormones, antidepressant tablets, heparin, antiacids, thiazid diuretic, beta blockers, anti vitamin k substances, bisphosphonates, or those who had any bone, liver or, renal diseases, or had a history of hysterectomy. Data collected on persons who had the inclusion criteria, included ages of menarche and menopause, history of diseases and utilization of drugs, multivitamin and calcium. Semi-quantities food frequency questionnaires, the reliability and validity of which had been determined, were completed to obtain nutritional information. Then bone mineral density and bone mineral content (BMC) in L2-4 area and femoral neck of these women was measured by IQ.DPX made by Lunar Co, USA with Dual X-Ray absorptiometry. Based on the World Health Organization (WHO) definitions, subjects were categorized in three groups; "osteoporotic" (bone mineral density ≥2.5 standard deviation from the mean of the young women population, 20-29 years old, "osteopenic" (bone mineral >1 standard deviation and <2.5 standard deviation from the mean of the normal young women population, and "normal" (bone mineral density ≤ 1 from the mean of bone mass in normal young women).

Blood samples were collected from all cases after 12-14 hours fasting, centrifuged, and sera were stored at -80°C; serum leptin and adiponectin concentrations were measured by ELISA using a Bio Vendor Co. kit (the interassay coefficient of variation for leptin kit: 6.8%, the intra-assay coefficient of variation leptin kit: 5.4%, the interassay coefficient of variation adiponectin kit: 7.5%, the intra-assay coefficient of variation adiponectin kit: 6.8%).

Descriptive data were reported as maximum, minimum, and mean±SD. Correlation between quantitative variables was tested, using Pearson's coefficient. One-way Anova was utilized for assessment of correlation between nutrients and groups of bone mineral density. Analysis of semi-quantitative food frequency questionnaire was done by FP2 software. SPSS version 11.5 was used for statistical analysis of data.

Results

Mean and standard deviation of age of participants was 52.4±5.4 years. Mean and standard deviations of bone mineral density, serum leptin and adiponectin and other baseline characteristics of the subjects are summarized in table 1.

Of 85 female participants, bone mineral density of the femoral neck was normal in 35 women; 47 women had osteopenia and 3 had osteoporosis. Daily intakes of energy, macronutrients, calcium, phosphorus, magnesium, vitamin C and zinc are shown in table 2. No significant differences were observed between either macronutrients or micronutrients assessed. Table 3 shows the correlation between leptin and adiponectin and the intakes of some nutrients.

Intakes of energy, protein and magnesium were negatively and significantly related to serum leptin and a positive relationship was seen between intakes of carbohydrates and serum leptin; a significantly positive relationship was also observed between energy and carbohydrate intakes and adiponectin.

Table 1. General characteristics of the female population studied

Variable	Mean±SD	Minimum	Maximum
Age(y)	52.46±5.46	40	60
Femoral BMD(g/cm^2)	0.7447±0.83	0.5630	1.1010
Spine BMD(g/cm^2)	37.23±6.68	26.37	61.99
Leptin(ng/dL)	26.9±8.7	11.5	47.5
Adiponectin(μg/dL)	10.7±3.0	4.2	16.9

Table 2. Mean and standard deviation of daily intakes of energy, macronutrients, calcium, phosphorus, magnesium, vitamin C and zinc

Daily energy and nutrient intake	Normal (n=35)	Osteopenia (n=47)	Osteoporosis (n=3)
Energy(kcal)	1774±443*	1975±625	1751±290
Protein(g)	70.7±16.1	74.9±22.1	73.1±17.7
Carbohydrate(g)	245±74	281±108	247±96
Lipid(g)	63.8±12.7	69.1±25.3	58.6±16.3
Calcium(mg)	1118±309	1214±357	1203±281
Magnesium(mg)	277±77	293±106	94±65
Vitamin C(mg)	87.9±11.3	81.2±12.5	76.6±10.6
Zinc(mg)	10.7±2.5	10.8±3.5	10.8±4.1

*mean±SD

Table 3. Pearson correlation test correlations between leptin and adiponectin with intake of macronutrients, calcium, phosphorus, magnesium, vitamin C and zinc

Nutrients	Leptin		Adiponectin	
	r	p-value	r	p-value
Energy(kcal)	-0.26	0.01	0.25	0.02
Protein(g)	-0.25	0.02	0.13	0.21
Carbohydrate(g)	0.27	0.01	0.30	0.004
Lipid(g)	-0.16	0.12	0.15	0.16
Calcium(mg)	-0.15	0.16	0.15	0.17
Magnesium(mg)	-0.22	0.03	0.11	0.29
Vitamin C(mg)	-0.15	0.15	0.16	0.14
Zinc(mg)	-0.19	0.06	0.12	0.27

Correlations between femoral BMD and spine BMC with intakes of some nutrients are shown in table 4. A significantly inverse correlation was observed between energy and carbohydrate intakes and femoral BMD. There was positive association between calcium and BMD; also between zinc intake and spine BMC, a significant and positive relation was observed.

Table 4. Pearson correlation coeffecients between femoral neck bone mineral density and spine bone mass content with intake of macronutrients

Nutrients	Femoral neck bone mineral density		Spine bone mass content	
	r	P	r	p
Energy(kcal)	-0.22	0.04	0.06	0.55
Protein(g)	-0.21	0.05	0.16	0.14
Carbohydrate(g)	-0.24	0.02	-0.04	0.71
Lipid(g)	-0.13	0.22	0.15	0.16
Calcium(mg)	0.28	0.001	0.11	0.31
Magnesium(mg)	-0.18	0.09	0.18	0.09
Vitamin C(mg)	-0.08	0.43	0.13	0.21
Zinc(mg)	-0.12	0.27	0.22	0.04

Discussion

The present study aimed at determining relationships between serum leptin, adiponectin and bone mass and energy and nutrient intakes. Regarding intakes of macronutrients, energy, calcium, magnesium, vitamin C and zinc and energy in the three groups, normal, osteopenic and osteoporotic, based on recommended dietary allowances (RDA), no deficiencies were observed. Zinc and vitamin C intakes of the women studied, were slightly higher than the RDAs of these nutrients, for an age-matched group, showing that intakes were adequate; however, in the case of magnesium intake these women had a deficiency. The RDA for magnesium in women aged ≥31 years old is 320 mg, whereas the means of intakes in all three study groups, were less than this value.

Data of one study[11] showed that energy restriction in rats causes increase in serum leptin, indicating that when energy intakes of rats decrease, their serum leptin levels increase, results which confirm the findings of our study.

Two studies assessing the effect of carbohydrate consumption on serum leptin concentration also support other results of this study;[12,13] in both studies, increase in carbohydrate consumption caused increases in serum leptin concentration; Romon et al showed that serum leptin levels have a direct correlation with insulin; hence consumption of carbohydrates, can increase blood insulin and serum leptin levels as well.

The present study showed a negative correlation between protein intake and serum leptin levels. One study[14] reported that rats consuming diets with 5-8% casein had higher serum leptin levels than rats on diets with 20% casein; these findings show that with decrease of protein in the diet of rats, their serum leptin levels increase, results that are in agreement with those of the present study.

Our results showed that when protein intakes decrease, total dietary intakes increase and if an individual becomes overweight, since body weight is related to serum leptin levels, serum leptin concentrations increase following decrease in protein intakes.

A positive relationship was seen between BMD and calcium intake, an expected outcome since calcium is vital to bone health. In study done by Ilich et al, on the relationship between BMD and calcium, in healthy postmenopausal women, a positive and significant relationship between BMD and dietary calcium was seen;[15] a study of Chinese postmenopausal women, done by Ho et al[16] reported a significant relationship between calcium intake and BMD changes. Other interventional studies showed the effect of calcium in delaying decrease of bone density in some areas, especially cortical bones e.g. beginning and end of the femur; these studies also reported that the total body in comparison with the specific areas mentioned was more sensitive to calcium intake.[16-20] A negative association was seen between energy and carbohydrate consumption in this study with BMD. Although in some studies,[15,21] a positive relationship between energy and BMD was seen, one study[22] showed that energy consumption after menopause had a negative effect on BMD[22], a result in agreement with findings of this study.

Studies reported that positive relationship between zinc intake and BMC, similar to the significant positive relationship in our study; however in one study, it was seen that zinc has a negative effect on BMD, which could be a result of the study participants having diabetes type 2, because diabetes impairs zinc metabolism.[23]

Zinc is essential for enzymes that play a role in collagen synthesis in osteoblasts; alkaline phosphatase, one of the most important enzymes in osteoblasts, needs zinc to function.

To conclude, increases in leptin concentration, resulting from increased carbohydrate consumption and decreased protein consumption, can adversely affect bones. However, calcium and zinc intakes have protective effects on bone and skefetal health, confirming that, individuals with appropriate nutrition and balanced diets can have appropriate bone mass.

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