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Association between bone discordance and dietary pattern among Iranian postmenopausal women

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Background: Bone discordance considered a new challenge to a diagnosis of osteoporosis, especially among postmenopausal women, there are many causes have been proposed for the occurrence of this phenomenon. This study was conducted to investigate the relation between major dietary patterns and bone discordance in postmenopausal women.

Methods: In this cross-sectional study, 258 postmenopausal women completed demographic data from June 2015 to February 2016. Dietary intake was assessed with a validated food frequency questionnaire (FFQ). Dietary patterns were created by PCA method from 25 food groups. Dual-energy x-ray absorptiometry (DXA) was performed on lumbar (L2-L4) and hip for cases.

Results: Three major dietary patterns were identified by using factor analysis based on baseline intake data: Unhealthy, Mediterranean and Western diet. After analysis, we found 55.41% were concordance and 44.56% (4.26% were in the major discordance group of participants were discordance. We found participants who were in discordance group were younger, and obese participants were more talented to be in the major discordance group. We found an inversely relationship between unhealthy dietary pattern and hip and lumbar Z score, while there was a positive relationship between Mediterranean dietary pattern and hip BMD. No associations were found between dietary pattern and bone discordance.

Conclusion: This study concluded that bone discordance was directly related to obesity. Obese and younger women were at risk of bone discordance. Unhealthy and a Mediterranean dietary pattern were negatively and positively related to bone density among postmenopausal women.

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Introduction

Discordance between two skeletal sites is a commonly observed event in bone densitometry tests (1, 2) which associated with different categories of T score (osteoporosis, osteopenia and normal) at the hip and vertebrae lumbar in an individual patient (3). This phenomenon is more prevalent among postmenopausal women (4). There are five causes have been proposed for occurrence of discordance: Physiologic, Pathophysiologic, Anatomic, Artifactual and Technical reasons (4, 5).

One main purpose to identify of risk factors, associated to discordance which regards to reducing bone complications in various diseases. For example, diseases which caused to decrease hip bone density are consists of; thyroid disorders (6, 7), multiple sclerosis (8) , as well regarding to lumbar density include: cardiovascular disorders (9), hypertension and diabetes type 2 (10, 11). It is remarkable that in terms of nutritional aspects as a risk factor of bone discordance will be evaluated.

Diet is a complex exposure variable. Recent researches showed osteoporosis had relationship with different mechanisms of mineral, vitamin and micronutrient dietary intake (12-14). This study aimed to find a dietary pattern those associated with bone discordance. As previous studies showed, vegetables, fruits and soy pattern(15), prudent dietary pattern(16) or dairy pattern(17) and animal protein source diet(18) are related to hip bone density (19, 20), in the other hand dietary pattern reached in whole grain is associated with higher bone density at both sites (21), several studies have investigated to association between dietary patterns and BMD, fractures. In our investigation, we want to evaluate the relationship between bone discordance and dietary pattern among postmenopausal women for the first time.

Subjects and methods

Study population

DXA data of this cross-sectional study were collected from January 2015 to August 2015. The participants were recruited from Shariati hospital's outpatient bone mineral density center. A total of 258 postmenopausal women were identified. The mean age was 57.9 (6.1) and BMI; 28.6 (4.4), menopause age; 48.3 (3.3). All of the participants provided signed consent form before being interviewed, and the study was ethically cleared by Tehran University of Medical Science (ID number: IR-TUMS-REC1394-2048). Individual information was collected by experienced interviewers with relevant knowledge through face to face interviews. Demographic information inclusive age was collected. The standing height in centimeters (cm) and weight in kilogram (kg) were measured and recorded for all subjects. Body mass index (BMI) was calculated as weight (kg) divided by height (cm) squared and recorded as kg/m2.

BMD measurement

Bone mineral density measured at both lumbar spine (L2-L4) and total hip with dual X-ray absorptiometry using a Lunar DPXMD densitometer (Lunar 7164, GE, and Madison, WI, USA). The method of DXA measurements of this device was Caucasian (non-race adjusted) female normative database for women of all ethnic groups. The WHO diagnosis of osteoporosis (T score $\leq$ -2.5), osteopenia (-2.5 < T score < -1) and normal (T score $\geq$ -1) each patient was categorized. Minor bone discordance happens when different diagnostic classes of T score are found (osteoporosis in one site and osteopenic in the other site or, osteopenic in 1 site and normal on the other site). While diagnosis of osteoporosis just in 1 site and normal range found in the other area, it's considered as major discordance. Bone Concordance is considered as similar bone ineraldensity in both areas (22, 23).

Dietary assessment

Dietary intake was assessed by a semi-quantitative food frequency questionnaire (FFQ) that consisted of 147 foods and beverages (with standard serving sizes) commonly consumed by Iranians. Diets of respondents were based on intakes during the past year. 168-items FFQ has been shown in previous studies to have a good validity and reproducibility, but we use 147-items that were usual and summarized in order to facilitate interview (24). Respondents were asked to report the frequency of consumption of a given serving of each food. Intake of each food item in grams was then determined by multiplying the portion size of daily intake frequency. Consumption of seasonal food items was taken into account based on the period of the year the food items were available. Total energy intake was estimated by adding the energy value of each food in the FFQ. Food energy value was based on the Nutrients Composition of Iranian Foods (25, 26) and the USDA Food Composition Data. To identify dietary patterns, the 147 food items was categorized into 25 food groups based on their similarity of nutrient content, earlier studies about bone disorder in Iran and worldwide (27, 28).

Table1. Characteristic of 264 participants in study of relationship between dietary patterns and bone discordance

	Concordance (53.4 %)			Discordance (42.8 %)			
				Minor. Dis		Major. Dis	
	Both Normal	Both Osteopenia	Both Osteoporosis	Normal Osteopenia Osteoporosis	Osteopenia	Normal Osteoporosis	P Value
N (%)	88(33.3%)	45 (17%)	7 (2.7%)	74 (28%)	27 (10.2%)	11 (4.2%)	
Anthropometry							
Age (yr)	56.3(5.6)	57(5.4)	58.4(6.2)	58.8(6.8)	62.1(5.5)	58.6(5.5)	0.001*
Weight (Kg)	73.0(12.4)	66.9(17.7)	65.4(16)	71.5(10.1)	67.2(10.5)	65.5(6.9)	0.06
Height (Cm)	156.8(10.7)	153.6(17)	154.1(6.5)	155.4(6.8)	154.5(4.5)	154.3(6.2)	0.7
Waist C (Cm)	91.0 (10.9)	85.3(12.3)	85.7(16.6)	92.1(13.4)	88.1(12)	88.1(10.6)	0.09
Hip C (Cm)	107.43(8.1)	101.5(11)	103(13.9)	106.6(9.5)	104.1(9.3)	103.5(3.7)	0.02*
BMI (Kg/Cm^2)	29.6(4.5)	26.5(5.1)	26.6(6.5)	29.3(3.7)	27.9(4)	28(3)	0.004*
FAT%	38.1(5.5)	35.1(7.3)	34.8(8.0)	38(5.3)	35.3(7.2)	35.4(6.6)	0.049*
FAT MASS	28.5(8)	24.3(7.3)	22(11.4)	27.7(7.5)	27.7(7.5)	25.3(6.4)	0.045*
FFM	44(5.5)	39.7(9.5)	40.1(5.3)	42.4(6.7)	41.28(4.7)	38 (9.8)	0.013*
Systolic_ BP (mmHg)	12 .1(1.2)	11.8(1.2)	11.2(1.1)	11.9(1.2)	11.8(1.2)	11.2(0.7)	0.2
Diastolic_ BP(mmHg)	8.1(0.8)	8(0.7)	7.7(0.4)	8(0.7)	10.7(0.7)	7.7(0.4)	0.1
Biochemical component measurements							
Glucose	101.2(30.1)	93.4(9.3)	102(16.5)	94.1(11.5)	96.5(10.1)	94.2(10.6)	0.26
Total-Chol	202.8(35.8)	199.5(38.6)	204.7(22.1)	203.4(36.1)	214.8(38)	180.1(44.6)	0.20
TG	137.9(78.3)	114.6(63.6)	149.7(99)	124.5(63.7)	151(72.7)	105.8(46.2)	0.24
HDL	43.5(10.6)	48(13.7)	44.5(13.5)	44(9.1)	42.8(10.2)	46.5(10.2)	0.34
LDL	104.5(26.4)	101.9(26.9)	103.4(12.2)	107.4(25.9)	114.1(26)	89.9(29.7)	0.13

WHR waist to hip ratio, Hip C Hip circumference, Waist C Waist circumference, BMI body mass Index, BMD bone mineral density, Dis; Discordance Osteoporosis: T-score ≤ -2.5, Osteopenia - 2.5 < T-score < - 1, *P values < 0.05 were significance.

Statistical analyses

Descriptive statistics such as mean and SD was used to summarize continuous variables. The correlation between hip and the lumbar T score was evaluated by Kappa test (29). For evaluation normal distribution of quantitative variables Kolmogorov–Smirnov test was conducted. To compare the presence of significant difference between discordance groups of variables, one-way ANOVA was used and also for dietary pattern tertiles. Dietary patterns were derived using factor analysis (principal component). To reduce complexity of data, 147 food items were categorized into 25 groups. In general, food grouping was based on food and nutrient composition similarity. The factors were rotated via an orthogonal transformation (the varimax rotation) to obtain a simpler structure with greater interpretable. We found three numbers of factors for best results, and inspection of scree plot. All subjects had each dietary pattern score by weighing their intake of each food contributing to that pattern by the relative contribution of those foods. The multi-nominal regression model was used to determine the relationship between bone discordance and dietary pattern. P values less than 0.05 were taken to indicate statistical significance. Statistical analyses were performed using SPSS 19.0.

Results

Basal characteristic of participants

Participants were excluded if they affected by any acute or chronic inflammatory disease such as heart, liver and kidney disorders or medical history of alendronate intake, alcohol or drug abuse. The average age and BMI of participants were 57.8 (± 6.1), 28.6 (± 4.4) kg/m2; respectively. The kappa test was conducted for discordance evaluation. The kappa test showed a significant correlation between the T score in the lumbar spine and total hip ($p < 0.0001$) but this relationship was weak ($\kappa = 0.26$), which means that there is discordance between two regions. Participants divided into the 6 groups to evaluate the bone discordance and concordance, including: concordance (55.41%) -both normal (34.10%), both osteopenia (18.60%), both osteoporosis (2.71%) - and discordance (44.56%) that divided into two groups; minor discordance (40.3%) - normal vs. osteopenia (29.84%), osteopenia vs. osteoporosis (10.46%) – and Major group (4.26%). Participants' characteristics on the basis of this grouping were shown in table 1; age ($p = 0.001$), hip circumference ($P = 0.02$), BMI ($P = 0.004$), FAT mass ($P = 0.045$), FAT% ($P = 0.049$) and also, weight ($p = 0.06$), waist circumference ($p = 0.09$) as marginal relationships. We found, women who were in the major discordance had lower age, as a whole, it seemed participants in discordance group were younger than the others. On the other hand, obese women were more talented to be in a major discordance situation (Table1).

Dietary pattern extraction

Factor loading and variance of each dietary pattern is shown in Table 2. Factor 1 was loaded on a high consumption of oil and butter, refined grain, organ meat, sugar, pickles, legume and soy, potato, salt and flavor, high fat dairy and starchy vegetables. Therefore, factor 1 was designated unhealthy pattern. Factor 2 was labeled as Mediterranean dietary pattern because it was loaded by a high consumption of olive, fruits, dried fruits, low fat dairy, vegetables, nuts, white meat and whole grain. Factor 3 was heavily loaded with sweet and dessert, processed meat, egg and fast food. Therefore; we considered this factor as western pattern (Table 2). The scree plot dropped after third factor, factor 1 (Eigen value 6.3) explaining 16.1% of the variance, factor 2 (Eigen value 2.2) explaining 12.94%, and factor 3 (Eigen value 1.4) explaining 10.7%.

Baseline characteristic according to dietary patterns

General characterizations of participants at baseline study are presented in table3 according to tertile of each food pattern. One-way ANOVA analyses showed, participants in the highest tertile of unhealthy dietary pattern had higher waist circumferences ($P = 0.04$), and had lower hip and lumbar Z score ($P = 0.04$, $P = 0.02$, respectively)

Table2. Factor loadings matrix for three dietary patterns identified from the Food Frequency questionnaire (147 items, divided to 25 food groups).

	Component		
	Unhealthy	Mediterranean	Western
Oil & Butter	0.699	-	-
Sugar	0.661	-	-
Legume & Soy	0.640	-	-
Organ meat	0.639	-	-
Refined grain	0.606	-	-
Pickles	0.562	-	-
Fruit juice	0.524	-	-
Salt & Flavor	0.445	-	-
High. Fat dairy	0.443	-	-
Starchy vegetables	0.407	-	-
Caffeinate	0.364	-	-
Olive	-	0.710	-
Fruits	-	0.646	-
Vegetables	-	0.635	-
Low fat dairy	-	0.619	-
Nuts	-	0.575	-
Dried fruits	-	0.573	-
Whole grain	-	0.483	-
White meat	-	0.439	-
Red meat	-	-	-
Sweet & Dessert	-	-	0.657
Snack	-	-	0.643
Egg	-	-	0.635
Process meat	-	-	0.598
Fast food	-	-	0.496
Variability (Eigen value)	16.1% (6.3)	12.9 % (2.2)	10.7% (1.4)

Number of factors; 3. Food groups with absolute values <0.30 are not shown for simplicity. The varimax rotation.
Total variability is 39.8 %.

than participants in first tertile. We found women in the last tertile of Mediterranean pattern was older ($P = 0.04$) and had higher hip BMD and the lumbar Z score ($P = 0.04$) than other participants. There were no association between the western dietary pattern with anthropometric parameters and bone mineral density at any site (Table 3).

Relationship between dietary pattern and bone discordance

We use Cross Tab Test to find the relationship between dietary pattern and bone discordance. Our analysis showed there were no significant relationships between discordance situation (concordance, major discordance and minor discordance) and any type of dietary patterns, such as Unhealthy ($P= 0.42$), Mediterranean (P=

Table3. Bone density characteristic between dietary patterns tertiles

	Unhealthy			Mediterranean			Western		
	Q1	**Q3**	**P**	**Q1**	**Q3**	**P**	**Q1**	**Q3**	**P value**
N (%)	**86**	**86**		**86**	**86**		**86**	**86**	
Anthropometry									
Age (yr)	58.1(5.9)	57.5(6.3)	0.8	57.6(6.5)	59.2(6)	0.04	58.4(6.1)	57.3(6.2)	0.4
Weight (Kg)	69.3(13.6)	72.1(12.4)	0.2	70.1(11.8)	70.2(15.7)	0.9	72(15.7)	69.5(11.1)	0.2
Height (Cm)	154.1(14.9)	155.7(5.6)	0.5	153.9(7.9)	154.8(15)	0.2	154.8(11.7)	155.2(11.9)	0.9
Waist C (Cm)	87.7(10.3)	92.3(12)	0.04	90.6(12.4)	87.6(11)	0.1	90.2(11.3)	88.3(13.1)	0.3
Hip C (Cm)	104.2(8.3)	106.8(10.4)	0.18	105.6(10.3)	105.3(9.7)	0.9	105.9(8.5)	104.9(10.4)	0.7
BMI (Kg/Cm^2)	28.1(4.1)	29.4(4.5)	0.1	29.1(4.5)	27.8(4.6)	0.1	28.4(4.5)	28.4(4.4)	0.6
FAT%	36.8(5.8)	37.3(6.7)	0.8	36.6(7)	37(5.8)	0.7	36.6(5.7)	37(6.8)	0.7
FAT MASS	26.2(8)	28.1(7.7)	0.2	27.2(7.7)	26.4(8.2)	0.6	26.2(7.7)	26.9(7.8)	0.3
FFM	41.4(7.6)	42.9(6.8)	0.3	42.7(5.9)	41.2(7)	0.3	42.4(6.4)	42.2(6.9)	0.7
Systolic_ BP (mmHg)	11.9(1.1)	11.8(1.2)	0.7	11.8(1.2)	11.9(1.2)	0.5	12(1.4)	11.7(1)	0.2
Diastolic_ BP(mmHg)	8(0.8)	8.9(0.7)	0.3	8(0.8)	8.9(0.7)	0.2	8.2(0.7)	8.7(7.8)	0.5
Bone density measurements									
Hip BMD	0.93(0.14)	0.92(0.15)	0.5	0.906(0.127)	0.914(0.122)	0.04	0.911(0.121)	0.932(0.15)	0.4
Hip T	-0.55(0.98)	-0.74(0.93)	0.4	-0.75(1.06)	-0.7(1)	0.2	-0.72(1.01)	-0.6(1.07)	0.6
Hip Z	0.12(0.87)	-0.20(0.85)	0.04*	-0.18(0.96)	0.83(0.83)	0.1	-0.12(0.89)	-0.03(0.89)	0.6
Lumbar BMD	1.025(0.160)	1.010(0.156)	0.08	1.007(0.166)	1.038(0.171)	0.1	1.011(0.164)	1.051(0.172)	0.2
Lumbar T	-1.34(1.25)	-1.49(1.26)	0.1	-1.54(1.28)	-1.2(1.43)	0.1	-1.51(1.26)	-1.23(1.43)	0.2
Lumbar Z	-0.39(1.17)	-0.72(1.28)	0.02*	-0.66(1.2)	-0.44(1.28)	0.09*	-0.57(1.23)	-0.39(1.24)	0.5

WHR waist to hip ratio, BMI body mass index, FFM free fat mass, TBW total body water, BMD bone mineral density.
P values < 0.05 were significance. *P<0.05.

0.87) and western dietary (P= 0.64) patterns.

Discussion

In our cross sectional study, most of the patients of discordance group were from minor category and the prevalence of major discordance (4.26%) in our study was similar to many other researches (4, 5, 30-32). In accordance with our results Vokes et al found lower BMD in the lumbar spine was more prevalent between both major and minor discordance (33).

El Maghraoui et al, reported in their studies, 4 out of every 10 people had bone discordance, that in our study, almost half of the nearly. In addition, as we found in our investigation Mounch et al, represented obesity and menopause situation are the most important factors which related to bone discordance. While positive associations between obesity and fat percentage with major bone discordance were found, previous studies showed a positive relationship between BMI and higher hip BMD due to the protective role of body weight load on hip density more than lumbar, so this major discordance was justified.

Factor analyses found three dietary patterns among postmenopausal Iranian women, including: Unhealthy, Mediterranean and Western dietary patterns. The main results showed that unhealthy dietary pattern was inversely correlated with lower hip and lumbar Z score. The unhealthy dietary pattern is a high fat and sugar, that is high in high-fat dairy, caffeine drinks and sugary products, increased bone turnover significantly in both sites (34).

Mediterranean dietary pattern includes, high intakes of olive oil, nuts, fruits and vegetables may lead to less bone resorption in both sites. Recent studies have confirmed this relationship (35) and a few ones did not approve it (36). Lin et al (37) examined the association between DASH diet (rich in fruits and vegetables) and sodium intake with bone turnover markers, he found the DASH diet significantly declined bone turnover at each level of sodium intake especially in lowest level. In Japanese premenopausal women who high intake of green vegetables, fruits, fish and shellfish had higher BMD than women with low intake of meat and processed meat (38).

On the other hand EH, van den Hooven et al (39) found high consumption of low fat dairy products, whole grains and vegetables in adolescence is associated with higher BMD and BMC as was seen in our study. In a study by Shin S, et al (40) for detecting a property diet to osteoporosis prevention found a fruit-milk-whole grain dietary pattern had positively associated with greater bone mineral density in Korean healthy women. Minerals including calcium, potassium and magnesium found in abundance in fruits and vegetables may have a protective effect on bone health, because of their alkali properties (41, 42). These results are physiologically founded because bone matrix behaves as a base contributing to buffer the acid load (34).

Dietary K intake was associated with urinary Ca excretion, in the previous study was done by Rafferty K et al (43) determined potassium intake from meat and milk that had more effect on Ca intestinal absorption than fruits and vegetable dietary intake so the Ca absorption effect is increased several times in the prudent dietary pattern.

In the present study, Franca NAG de et al (37) showed a pattern rich in caffeinated beverage and sweet foods could lead negative effects in femur BMD and total body BMD, but none of the pattern extracted of our study did not show any association to hip bone density. Western pattern results in metabolic acidosis associated with increase of bone turnover due to rises in cortisol secretion (44). Systematically increased acid load that due to high animal protein content of western diets, In contrast to our study Jehle S, et al (45) found neutralization of the western diet will promote bone mineral density in postmenopausal women. We have not found any association between western diet and BMD among Iranian postmenopausal women. We hypothesize women with western dietary pattern perform a small percentage (9%) of whole dietary patterns and this diet is unusual in Iranian elderly women so there is no relationship between unhealthy dietary pattern and BMD in any sites in our investigation. In the other hand, women at this rang of age, get different multi-mineral supplements usually; it can be explained this kind of relationship between western dietary pattern and BMD. Recent studies indicated a significant correlation between nutrients intake and bone density in different regions (46-48) and some studies did not find this relationship (42, 49). Although there is little information about relationships between dietary intake and bone discordance, several theories may help to explain our findings, it should be noted that bone tissue was divided into two categories, trabecular (like vertebrae lumbar) and cortical bone (same as hip). 80% of bone density, metabolism are about cortical bone (50) while trabecular bone metabolism is faster (51). Both kinds of bone need different dietary component same as mineral, vitamin and micro-macro nutrient. Our statistical analyses had indicated that, there was no association between dietary pattern and bone discordance. As we found there was any relationship between different dietary pattern and both regions. So it is usual to find no relationship between bone discordance and dietary pattern due to definition of bone discordance that related to difference between a T score of hip and lumbar bone density in an individual.

There is like every cross-sectional study, has a number of limitations for example, the small number of participants compared with others and the other one is all of our participants were obese maybe that was better if we divided two groups: obese and non-obese. The power of our study is the first one to examine the relation between bone discordance and dietary pattern as a risk factor of bone discordance. We both looked Z score and T score while other studies have evaluated only T score.

Conclusion

We do not suggest that this article resolves the puzzle of the bone discordance cause; instead we suspect; we only found a few more parts of a complex mechanism and the problem. This study found that the bone discordance was not related to dietary pattern among postmenopausal Iranian women. While unhealthy and a Mediterranean dietary pattern had inversely associated with lumbar bone density and hip BMD orderly.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. Moayyeri A, Soltani A, Tabari NK, Sadatsafavi M, Hossein-neghad A, Larijani B. Discordance in diagnosis of osteoporosis using spine and hip bone densitometry. BMC endocrine disorders. 2005;5(1):3.
2. Mounach A, Abayi DM, Ghazi M, Ghozlani I, Nouijai A, Achemlal L, et al., editors. Discordance between hip and spine bone mineral density measurement using DXA: prevalence and risk factors. Seminars in arthritis and rheumatism; 2009: Elsevier.
3. Faulkner KG, von Stetten E, Miller P. Discordance in patient classification using T-scores. Journal of Clinical Densitometry. 1999;2(3):343-50.
4. El Maghraoui A, Abayi DM, Rkain H, Mounach A. Discordance in diagnosis of osteoporosis using spine and hip bone densitometry. Journal of Clinical Densitometry. 2007;10(2):153-6.
5. Mounach A, Abayi DM, Ghazi M, Ghozlani I, Nouijai A, Achemlal L, et al., editors. Discordance between hip and spine bone mineral density measurement using DXA: prevalence and risk factors. Seminars in arthritis and rheumatism; 2009: Elsevier.
6. Tuchendler D, Bolanowski M. The influence of thyroid dysfunction on bone metabolism. Thyroid research. 2014;7(1):12.
7. Williams GR. Actions of thyroid hormones in bone. Endokrynol Pol. 2009;60(5):380-8.
8. Dennison EM, Compston JE, Flahive J, Siris ES, Gehlbach SH, Adachi JD, et al. Effect of co-morbidities on fracture risk: findings from the Global Longitudinal Study of Osteoporosis in Women (GLOW). Bone. 2012;50(6):1288-93.
9. Farhat GN, Cauley JA. The link between osteoporosis and cardiovascular disease. Clinical cases in mineral and bone metabolism. 2008;5(1):19-34.
10. Zhang Y, Min S. Analysis of clinical factors correlating with osteoporosis in patients with type 2 diabetes mellitus. Nan fang yi ke da xue xue bao= Journal of Southern Medical University. 2016;36(11):1546.
11. Zhou L, Song J, Yang S, Meng S, Lv X, Yue J, et al. Bone mass loss is associated with systolic blood pressure in postmenopausal women with type 2 diabetes in Tibet: a retrospective cross-sectional study. Osteoporosis International. 2017:1-6.
12. Vuolo L, Barrea L, Savanelli M, Savastano S, Rubino M, Scarano E, et al. Nutrition and Osteoporosis: Preliminary data of Campania Region of European PERsonalised ICT Supported Service for Independent Living and Active Ageing. Translational medicine@ UniSa. 2015;13:13.
13. Hirota T, Hirota K. [Bone and Nutrition. Nutritional management of osteoporosis]. Clinical calcium. 2014;25(7):1049-55.
14. Offord E, Karagounis L, Vidal K, Fielding R, Meydani S, Penninger J. Nutrition and the biology of human ageing: Bone health & osteoporosis/sarcopenia/immune deficiency. The journal of nutrition, health & aging. 2013;17(8):712-6.
15. Dai Z, Butler LM, van Dam RM, Ang L-W, Yuan J-M, Koh W-P. Adherence to a vegetable-fruit-soy dietary pattern or the Alternative Healthy Eating Index is associated with lower hip fracture risk among Singapore Chinese. The Journal of nutrition. 2014;144(4):511-8.
16. Zeng F-f, Wu B-h, Fan F, Xie H-l, Xue W-q, Zhu H-l, et al. Dietary patterns and the risk of hip fractures in elderly Chinese: a matched case-control study. The Journal of Clinical Endocrinology & Metabolism. 2013;98(6):2347-55.
17. Park S-J, Joo S-E, Min H, Park JK, Kim Y, Kim SS, et al. Dietary patterns and osteoporosis risk in postmenopausal Korean women. Osong Public Health and Research Perspectives. 2012;3(4):199-205.
18. Munger RG, Cerhan JR, Chiu BC. Prospective study of dietary protein intake and risk of hip fracture in postmenopausal women. The American journal of clinical nutrition. 1999;69(1):147-52.
19. Tucker KL, Chen H, Hannan MT, Cupples LA, Wilson PW, Felson D, et al. Bone mineral density and dietary patterns in older adults: the Framingham Osteoporosis Study. The American journal of clinical nutrition. 2002;76(1):245-52.
20. Samieri C, Coupez VG, Lorrain S, Letenneur L, Alles B, Feart C, et al. Nutrient patterns and risk of fracture in older subjects: results from the Three-City Study. Osteoporosis International. 2013;24(4):1295-305.
21. Chen G-d, Dong X-w, Zhu Y-Y, Tian H-y, He J, Chen Y-m. Adherence to the Mediterranean diet is associated with a higher BMD in middle-aged and elderly Chinese. Scientific reports. 2016;6.
22. Mirzaei K, Hossein-nezhad A, Keshavarz SA, Koohdani F, Saboor-Yaraghi AA, Hosseini S, et al. Crosstalk between circulating peroxisome proliferator-activated receptor gamma, adipokines and metabolic syndrome in obese subjects. Diabetology & metabolic syndrome. 2013;5(1):1.
23. Mirzaei K, Hossein-nezhad A, Aslani S, Emamgholipour S, Karimi M, Keshavarz S. Energy expenditure regulation via macrophage migration inhibitory factor in obesity and in vitro anti-macrophage migration inhibitory factor effect of Alpinia officinarum hance extraction. Endocrine Practice. 2011;18(1):39-48.
24. Mirmiran P, Esfahani FH, Mehrabi Y, Hedayati M, Azizi F. Reliability and relative validity of an FFQ for nutrients in the Tehran Lipid and Glucose

Study. Public health nutrition. 2010;13(05):654-62.

25. Azar M, Sarkisian E. Food composition table of Iran: National Nutrition and Food Research Institute. Shaheed Beheshti University, Tehran. 1980.
26. Mirmiran P, Hosseini-Esfahani F, Jessri M, Mahan LK, Shiva N, Azizi F. Does dietary intake by Tehranian adults align with the 2005 dietary guidelines for Americans? Observations from the Tehran lipid and glucose study. Journal of Health, Population and Nutrition. 2011:39-52.
27. de França N, Camargo M, Lazaretti-Castro M, Peters B, Martini L. Dietary patterns and bone mineral density in Brazilian postmenopausal women with osteoporosis: a cross-sectional study. European journal of clinical nutrition. 2015.
28. Mahdaviroshan M, Ebrahimimameghani M. Assessments of dietary pattern and nutritional intake in osteoporotic patients in Tabriz. Journal of Paramedical Sciences. 2014;5(3).
29. http://www.stattutorials.com/SPSS/TUTORIAL-SPSS-Interrater-Reliability-Kappa.htm.
30. Derakhshan S, Shahsavari S. Discordance in diagnosis of osteoporosis using spine and femur bone densitometry: prevalence and related factors. Iranian Journal of Nuclear Medicine. 2012;20(2):14-9.
31. Moayyeri A, Soltani A, Tabari NK, Sadatsafavi M, Hossein-neghad A, Larijani B. Discordance in diagnosis of osteoporosis using spine and hip bone densitometry. BMC endocrine disorders. 2005;5(1):1.
32. Fairweather-Tait SJ, Skinner J, Guile GR, Cassidy A, Spector TD, MacGregor AJ. Diet and bone mineral density study in postmenopausal women from the TwinsUK registry shows a negative association with a traditional English dietary pattern and a positive association with wine. The American journal of clinical nutrition. 2011;94(5):1371-5.
33. Vokes TJ, Gillen DL, Lovett J, Favus MJ. Comparison of T-scores from different skeletal sites in differentiating postmenopausal women with and without prevalent vertebral fractures. Journal of Clinical Densitometry. 2005;8(2):206-15.
34. Pedone C, Napoli N, Pozzilli P, Lauretani F, Bandinelli S, Ferrucci L, et al. Quality of diet and potential renal acid load as risk factors for reduced bone density in elderly women. Bone. 2010;46(4):1063-7.
35. Hardcastle A, Aucott L, Fraser W, Reid D, Macdonald H. Dietary patterns, bone resorption and bone mineral density in early post-menopausal Scottish women. European journal of clinical nutrition. 2011;65(3):378-85.
36. Langsetmo L, Poliquin S, Hanley DA, Prior JC, Barr S, Anastassiades T, et al. Dietary patterns in Canadian men and women ages 25 and older: relationship to demographics, body mass index, and bone mineral density. BMC musculoskeletal disorders. 2010;11(1):1.
37. Lin P-H, Ginty F, Appel LJ, Aickin M, Bohannon A, Garnero P, et al. The DASH diet and sodium reduction improve markers of bone turnover and calcium metabolism in adults. The Journal of nutrition. 2003;133(10):3130-6.
38. Okubo H, Sasaki S, Horiguchi H, Oguma E, Miyamoto K, Hosoi Y, et al. Dietary patterns associated with bone mineral density in premenopausal Japanese farmwomen. The American journal of clinical nutrition. 2006;83(5):1185-92.
39. van den Hooven EH, Ambrosini GL, Huang R-C, Mountain J, Straker L, Walsh JP, et al. Identification of a dietary pattern prospectively associated with bone mass in Australian young adults. The American journal of clinical nutrition. 2015;102(5):1035-43.
40. Shin S, Sung J, Joung H. A fruit, milk and whole grain dietary pattern is positively associated with bone mineral density in Korean healthy adults. European journal of clinical nutrition. 2015;69(4):442-8.
41. Tucker KL, Hannan MT, Kiel DP. The acid-base hypothesis: diet and bone in the Framingham Osteoporosis Study. European journal of nutrition. 2001;40(5):231-7.
42. New SA, Robins SP, Campbell MK, Martin JC, Garton MJ, Bolton-Smith C, et al. Dietary influences on bone mass and bone metabolism: further evidence of a positive link between fruit and vegetable consumption and bone health? The American journal of clinical nutrition. 2000;71(1):142-51.
43. Rafferty K, Davies KM, Heaney RP. Potassium intake and the calcium economy. Journal of the American College of Nutrition. 2005;24(2):99-106.
44. Maurer M, Riesen W, Muser J, Hulter HN, Krapf R. Neutralization of Western diet inhibits bone resorption independently of K intake and reduces cortisol secretion in humans. American Journal of Physiology-Renal Physiology. 2003;284(1):F32-F40.
45. Jehle S, Zanetti A, Muser J, Hulter HN, Krapf R. Partial neutralization of the acidogenic Western diet with potassium citrate increases bone mass in postmenopausal women with osteopenia. Journal of the American Society of Nephrology. 2006;17(11):3213-22.
46. Krieger NS, Sessler NE, Bushinsky DA. Acidosis inhibits osteoblastic and stimulates osteoclastic activity in vitro. American Journal of Physiology-Renal Physiology. 1992;262(3):F442-F8.
47. Karamati M, Yousefian-Sanni M, Shariati-Bafghi S-E, Rashidkhani B. Major Nutrient Patterns and Bone Mineral Density among Postmenopausal Iranian Women. Calcified tissue international.

2014;94(6):648-58.
48. Wachman A, Bernstein D. Diet and osteoporosis. The Lancet. 1968;291(7549):958-9.
49. New SA, Bolton-Smith C, Grubb DA, Reid DM. Nutritional influences on bone mineral density: a cross-sectional study in premenopausal women. The American journal of clinical nutrition. 1997;65(6):1831-9.
50. Eriksen E, Axelrod D, Melsen F. Bone histomorphometry Raven Press. New York. 1994.
51. Clarke B. Normal bone anatomy and physiology. Clinical journal of the American Society of Nephrology. 2008;3(Supplement 3):S131-S9.