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Low fat ratio is better risk factor than low body mass index for low bone mineral density

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Abstract
Osteoporosis is a health problem that limits quality life and may cause morbidity and mortality, unless prevented or actively treated. The objective of the study was to determine the effects of risk factors on bone mineral density. We evaluated 353 women who had undergone bone mineral density measurements for any reason in our hospital. Since a Z score less than -1 for the lumbar (L1-4) was considered to be an increased risk factor for fracture, subjects were divided into two groups according to lumbar Z scores of bone mineral density (BMD). Having evaluated the potential risk factors for osteoporosis in literature, we designed a questionnaire including 25 items in the following four sections: anthropometric variables, social history, reproductive history and past medical history. Logistic regression analysis used to identify the possible risk factors for low BMD. Multivariate logistic regression analysis revealed that low BMD was associated with low fat% ratio (odds ratio 3.2, [95% CI 1.93 to 5.3] p=0.0001), drinking tea (odds ratio 3.32, [95% CI, 1.19 to 4.57] p <0.001), low body mass index (odds ratio 2.13, [95% CI, 1.29 to 3.7] p=0.001), more than ten years of previous working in building (odds ratio 2.11, [95% CI, 1.11 to 2.89] p=0.001), early ages at menopause (odds ratio 1.85, [95% CI, 1.07 to 3.19] p =0.026) and ages (odds ratio 1.53, [95% CI, 1.06 to 1.76] p =0.0012). Our findings indicated that low fat ratio was better risk factor than low body mass index for low bone mineral density.

Keywords: Osteoporosis, risk factor, bone mineral density, Z score, workspace

Introduction

Osteoporosis is an age-related skeletal condition resulting in micro-architectural deterioration and loss of bone mass and density [1]. It is common comorbidity of all major rheumatic diseases, and manifests itself both systemically and locally. Systemic bone loss manifests because of several factors, primarily inflammation, immobility, and commonly used medical treatment for rheumatic diseases [2].

The prevalence of patients with osteoporosis is rising worldwide with increasing of mean age in developing countries. Unless prevented or actively treated, osteoporotic fractures are a major health problem that limits quality life and may cause morbidity and mortality. Epidemiologic studies suggested that over 70% of all fractures would have been in the developing countries by the year 2050 [3]. Risk factors of osteoporosis in Western populations have been relatively well documented but it has not been well studied in developing countries, like our country. It has been shown that the age over 50 years, age at menopause, years in menopause and low body mass index (BMI) are risk factors for osteoporosis [3-5].

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Osteoporosis affects 1 out of 3 women after the menopause and 1 out of 8 men over 50 [6]. However, the effects of various diseases, medications and nutritional factors on osteoporosis were not confirmed as a risk factor for osteoporosis in large serial studies.

The objective of the study was to determine the effects of risk factors on bone mineral density in Turkish women.

Materials and methods

We evaluated 353 women who had required condition and underwent bone mineral density measurements for any reason in our hospital. Since, a Z score less than -1 for the lumbar (L1-4) was considered to be increased risk factor for fracture [7-10], subjects were divided in to two groups according to lumbar Z scores of bone mineral density (BMD). Group I was consisted of 118 women (mean age 55.6±4.01 year, age range 33-84 years) with lumbar Z scores lower than -1. Group II was consisted of 235 women (mean age 54.5±3.24 year, age range 29-82 years) with lumbar Z scores equal or higher than -1.

None of the patients had any forearm fracture history, bone and joint diseases and serious intercurrent diseases, and none of them used glucocorticoids, vitamin D or calcium supplements. Informed consent was obtained from all subjects and the study was conducted in accordance with

the Helsinki Declaration and approved by the ethical committee of the Inonu University Faculty of Medicine.

Definition of risk factors and patient selection:
After evaluation of potential risk factors for osteoporosis in literature, we designed questionnaire including 25 items in the following four sections: anthropometric variables, social history, reproductive history and past medical history. Qualified nursing staff measured anthropometric variables (height, weight, circle of the waist and hip). Body mass index (BMI) was calculated as weight (kg)/height (m^2). According to the American Heart Association, BMI > 30 was accepted obesity and BMI < 25 was considered as non-obesity [11]. Abdominal and hip circumferences were used to calculate waist-to-hip ratio in all patients. Fat % ratio was measured by bioimpedance on a leg-to-leg analyzer (Tanita TBF-215; Tanita Corporation, Tokyo, Japan).

Social history included living space, marital status, overall appearance costume, smoking habits, coffee and tea consumption were noted for each women.

According to daily clothes, women were divided into two sub groups as covered or uncovered. Uncovered group consisted of women whose daily clothes uncover her head, face, neck, arm, hands and legs. Covered group consisted of women whose daily clothes cover her head, neck, arm and legs. None of the covered group were covered their face. Some of women in covered group were wearing garment that covering a woman from head to foot.

According to workspace, women were divided into 2 subgroups as working in open field and working in building. Housewife in rural area was accepted as working in open field. Housewife in urban area was accepted as working in building. Our city was taken excess emigration from rural areas between 10 to 15 years ago. For this reason, Workspace was evaluated in the two seasons as last ten years and before.

Reproductive history included both obstetric and menstrual history. Age at the first childbirth, total lactation period (month), child number and surgical menopause history were obtained from obstetric history. Menstrual history included age at menarche and at menopause. Medical history involved ascertainment of previous history and duration of systemic hypertension, diabetes mellitus, coronary artery diseases, dyslipidemia (hyperlipidemia or hypercholesterolemia), and thyroid disorders.

Married, non-obese (BMI less than 25), covered dress, cigarette smoking (1≥ packet/daily), tea drinking (3≥ glass/day), coffee drinking (1≥ cup/day), low menarche age (less than 13 years), low childbirth age (less than 20 years), early ages at menopause (less than 45 years), long total lactation period (more than 19 months), increased hip to waist ratio (0.8≥), low fat ratio (less than 35), working in building (last ten years and before), surgical menopause history, and disease history were assessed as risk factors for osteoporosis.

Bone Mineral Density Measurement:
The BMD measurements of the lumbar (L1-4) were made by dual energy X-ray absorptiometry (DXA) (Hologic QDR 4500W, Waltham, MA, USA). For the present study, Z scores of the lumbar BMD data were used. BMD measurement eligibility criteria, calibration techniques, and quality control measures have been described previously [9]. The original World Health Organization (WHO) criteria to define osteoporosis and osteopenia used mean BMD values for white females [12]. The CVs of lumbar spine bone density measurement was found as 18.623%.

Statistical Analysis:
Statistical analysis was performed with SPSS for Windows version 13.0. Age values were expressed as mean±standard deviation (SD). Chi square and Fisher's exacts tests for categorical variables are used as appropriate. Each variable that yielded a results $p \leq 0.20$ was further analyzed in a multivariate logistic regression analysis [13]. $p<0.05$ was considered to be statistically significant.

Results

Table 1. illustrated the distribution of the risk factors by low bone mineral density for Turkish women.

Table 2. Multivariate logistic regression analysis revealed that low BMD was associated with low fat% ratio (odds ratio 3.2, [95% CI 1.93 to 5.3] p=0.0001), drinking tea (odds ratio 3.32, [95% CI, 1.19 to 4.57] p <0.001), low body mass index (odds ratio 2.13, [95% CI, 1.29 to 3.7] p=0.001), more than ten years of previous working in building (odds ratio 2.11, [95% CI, 1.11 to 2.89] p=0.001), early ages at menopause (odds ratio 1.85, [95% CI, 1.07 to 3.19] p =0.026) and age (odds ratio 1.53, [95% CI, 1.06 to 1.76] p =0.0012). Low fat ratio was found better risk factor than low body mass index.

Covered dress, cigarette smoking, drinking coffee, low menarche age, age at the first childbirths, child number, total lactation period, hip to waist ratio, working in building at the last ten years, normotension, diabetes mellitus, coronary artery disease and surgical menopause history were not found as a risk factor (p>0.05).

Table 1. Distribution of Characteristics of Subjects with low Z scores and normal Z Scores.

	Group I	Group II	
	Low BMD	with Normal Z Scores	
	(n=118)	(n=235)	p value
Age (years)	55.6±4.01	54.5±3.24	0.02
Marital Status			
(1) Married	100 (84.7%)	189(80.4%)	0.33
(0) Unmarried	18 (15.2%)	46(19.5%)	
BMI			
(1) Normal or low	79(66.9%)	107(45.5%)	0.0001
(0) High	39(33.1%)	128(54.5%)	
Dress			
(1) Covered	90(76.2%)	182(77.4%)	0.804
(0) Uncovered	28(23.8%)	53(22.6%)	
Cigarette Smoking			
(1) Yes	12(10.2%)	34(14.4%)	0.257
(0) No	106(89.8%)	201(85.5%)	
Drinking Coffee			
(1)Yes	5(4.2%)	10(4.2%)	0.993
(0) No	113(95.7%)	225(95.7%)	
Drinking Tea			
(1) 3 ≥ glass/day	91(77.1%)	109(46.4%)	0.00001
(0) <3 glass/day	27(22.8%)	126(23.6%)	
Age at menarche			
(1) < 13	110 (93.2%)	203(86.4%)	0.055
(0) 13 ≥	8 (6.8%)	32 (13.6%)	
Age at the first childbirths			
(1) < 20	62(52.5%)	109 (46.4%)	0.270
(0) 20 ≥	56 (47.4 %)	126 (53.4%)	
Early age at menopause			
(1) < 45	82(69.5%)	95(40.4%)	0.00001
(0) 45 ≥	36(30.5%)	140(59.6)%)	
Child number			
(1) 3 ≥	66(55.9%)	128 (54.4%)	0.794
(0) < 3	52 (44.1%)	107 (45.6%)	
Total lactation period (month)			
(1) 20 ≥	61(51.7%)	119(50.6%)	0.851
(0) < 20	57(48.3%)	116(49.4%)	
Hip to waist ratio			
(1) 0.8 ≥	104 (88.1%)	215 (91.5%)	0.414
(0) < 0.8	14 (11.9%)	20 (8.5%)	
Fat% ratio			
(1) < 35	62 (52.5%)	58 (24.6%)	<0.00001
(0) 35 ≥	56 (47.4 %)	177 (77.4%)	
Previous working (more than 10 years)			
(1) In building	70 (59.3 %)	101 (42.9%)	0.0037
(0) open field	48 (40.6%)	134 (57.1%)	
Previous working (last ten years)			
(1) In building	103(87.2%)	207(88.0%)	0.829
(0) open field	15 (12.8%)	28 (12.0%)	
Hypertension			
(1) No	76 (64.4%)	133 (56.4%)	0.158
(0) Yes	42 (35.6%)	102 (43.4%)	
Surgical Menopause History			
(1) Yes	21 (17.8%)	33 (14.0 %)	0.355
(0) No	97 (82.2%)	202 (86.0%)	
Diabetes Mellitus			
(1) Yes	1 (0.8%)	8 (3.4 %)	0.138
(0) No	117 (99.3 %)	227 (96.6%)	
Coronary Artery Diseases			
(1) Yes	15 (12.7 %)	18 (7.6%)	0.178
(0) No	103 (87.3%)	217 (92.4%)	
Dyslipidemia			
(1) Yes	12 (10.2%)	25 (10.6%)	0.960
(0) No	106 (89.8%)	210(89.4%)	
Antidiabetic Medication			
(1) Yes	10 (8.5%)	26 (11.1%)	0.567
(0) No	108 (91.5%)	209 (88.9%)	
Thyroid Treatment			
(1) Yes	6 (5.1%)	25 (10.6%)	0.123
(0) No	112 (94.9%)	210(89.4 %)	

1, Risk factor
0, Not a risk factor

Table 2. Multivariate Logistic Regression Predictors of Subjects with Osteoporosis

Variables	OR	95% CI	p Value
Fat % ratio	3.20	1.93 – 5.30	0.0001
Drinking tea	3.32	1.19 – 4.57	0.001
Low BMI	2.13	1.29 – 3.70	0.001
Previous working (more than 10 years)	2.11	1,11 – 2.89	0.001
Early ages at menopause	1.85	1.07 – 3.19	0.026
Age (Years)	1.53	1.06 – 1.76	0.0012

Discussion

The present study was focused on the risk factors in patients who had low BMD using logistic regression algorithms. Our data showed that low BMD is significantly associated with low body mass index, drinking tea, age at menopause, low fat ratio, and working in building earlier than ten years. Drinking tea was found to be the strongest risk factor for low BMD (odds ratio 8.52, [95% CI, 3.84 to 19.47] p <0.0001). Low fat ratio was better risk factor than low body mass index.

Kato et al reported that women in the highest quintile of calorie adjusted daily dietary fat intake had a 23% greater risk of all fractures in the New York Women's Health Study cohort of 6250 postmenopausal women [14]. McTiernan et al were studied on effect of a low-fat and increased fruit/ vegetables ingestion in 500 women. They reported that BMD of hip was reduced in a low-fat and increased fruit/vegetables ingestion group. In this group, the risk of multiple falls was reduced but the risk of osteoporotic fracture was not changed [15]. Our results was not different the work of McTiernan's.

Although more than ten years of previous working in building is found to be significant risk factor for low BMD, it was interesting that overall appearance costume, age of menarche, age of the first given birth, number of child, total lactation period were not significantly related to low BMD.

Actually, there is a widely accepted convention to report BMD results in terms of T scores but our women cases had wide age interval (29 to 84 years). Since the Z score is less affected from age variation, we used Z score for evaluation.

Previous literature reported that there was a significant association between bone density and age, body weight, height, body mass index, age at the menopause and duration of menopause [16-24]. Our results are parallel to the literature.

In a multi-centric study, it was reported that high consumption of tea is protective factor for osteoporosis. Similarly, Hegarty et al. were studied BMD in 1134 tea drinkers (90.3%) and 122 non-tea drinkers (9.7%) and found that mean BMD values in tea drinkers was significantly greater (approximately 5%) compared with non-tea drinkers [25]. In IPPOT study, habitual tea drinking was reported to be a statistically significant risk factor for osteoporosis in Turkish women [26). Contrary to these reports, Kanis et al reported that tea consumption was associated with a decrease in the risk of hip fracture [27]. Furukawa et al studied in Japanese female with systemic lupus erythematosus and reported that daily use of tea was marginally associated with a decreased risk of vertebral fractures [28]. In our study, we found that tea consumption is risk factor for bone loss.

Frost's mechanostat theory suggested that tension in bone lead to increase in bone mineral density [29,30]. Similarly, Korpelainen at al reported that hypertension is not a risk factor for osteoporosis [31]. Normotension was studied as a risk factor but was not found as a risk factor for low BMD.

Diabetes mellitus [32], dyslipidemia [3], cigarette smoking [4,16,17,33-40], coffee drinking [31,41-43], reported as risk factor in some studies but we did not found. To our knowledge, the relation between low BMD and coronary artery diseases were not found [44]. In our study, coronary artery disease was not found as risk factor for low BMD.

Mariconda et al reported that number of pregnancies (p=0.018) was associated with a higher value of BMD by the multivariate analysis [22]. Shilbayeh reported that number of children (live births) and frequency of lactations associated with bone loss at femoral neck [3). Saadi et al reported that participants with osteopenia were more likely to have a later onset of menarche (p = 0.011) [45]. Alekel et al. reported that menarche decrease BMD in women from Pakistan and India [46]. However, we did not observe relations between menarche and low BMD.

In our study, Odd ratio was found more than one for married women, age at the first given birth, child number, total lactation period, normotension, surgical menopause history and coronary artery disease however 95% confidence intervals were included lower than 1. We thought that these could be risk factors in larger series.

Study limitation: Calcium intake, diet and exercise habits were not evaluated in our study.

Conclusion

Our results showed that low fat ratio was better risk factor than low body mass index and severe bone loss is associated with non-obesity, drinking tea, early ages at menopause, low fat ratio and working inside the building.

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