Turkish Journal of Endocrinology and Metabolism, (2002) 3 : 125-129 **ORIGINAL ARTICLE**

Association Between Calcaneous Mineral Density By Ultrasound and Various Other Parameters

Ramazan Sarı **Gökhan Yazıcıoğlu** **Mustafa Kemal Balcı**

Akdeniz University, Faculty of Medicine, Department of Internal Medicine, Division of Endocrinology and Metabolism, Antalya

Quantitative ultrasound of bone is cheaper and easier than other bone mineral density measurement techniques. Because of that, it is useful for population screening. We determined calcaneous bone mineral density with a SAHARA clinical bone sonometer in 182 subjects [155 females (85.1%), 27 males (14.9%)] who had attended a community education program. Body fat percentage was evaluated by bio-electrical impedance analysis (OMRON BF 302) and dominant handgrip strength was measured with a JAMAR handgrip dynamometer. Body mass index, duration of menopause, family history of osteoporosis and/or spontaneous fracture, weekly consumpt ion of milk and milky products, duration of weekly exercise and drug history for calcium, steroids, and thyroxine were registered.

Body fat percentage was 33.6 ± 7.3%, body fat weight was 23.7 ± 7.5 kg, handgrip strength was 29.5 ± 7.9 kg. Cheese consumption was <100 gr/week in 11.5%, between 100-150 gr/week in 69.8%, and >150 gr/week in 18.7%. The average t score was -0.95 [95% confidence interval (–1.10; -0.79)] and z score was -0.60 [95% confidence interval (–0.75; -0.44)]. Osteoporosis was detected in 5.4% (10/182) (t score <–2.5) and osteopenia was seen in 50% (91/182) (-2.5 <t score < -1.0). The mean age of the osteoporotic group (60.9 ± 6.5 years) was found to be higher than that of both the osteopenic (48.9 ± 9.8 years) and normal group (48.8 ± 9.6 years) (p<0.001). When osteoporotic, osteopenic and normal groups were compared with each other, there was no statistically significant difference between body mass index, duration of menopause, family history of osteoporosis and/or spontaneous fracture, handgrip strength or weekly consumption of milk and milky products. Fifty-six per cent of females (87/155) were in the postmenopausal period (mean menopausal period: 9.3 ± 7.5 years). There was no difference between t score, z score, body mass index, body fat weight or handgrip strength between post- and premenopausal females (p>0.005). We detected a negative correlation between t score and age (r=-0.28, p=0.005). There was no other correlation between t and z scores and body mass index, duration of menopause, family history of osteoporosis and/or spontaneous fracture, handgrip strength or weekly consumption of milk and milky products. When factors affecting calcaneous bone mineral density were researched, the age of subjects was found to have a negative effect on t score (t=-2.414, p=0.034), however, weekly consumption of cheese was found to have a positive effect on t score (t=4.299, p=0.001).

There was no direct effect of body fat percentage and weight or handgrip strength on calcaneous bone mineral density. However, age and consumption of cheese were found to affe ct calcaneous bone mineral density.

Key words: Osteoporosis, risk factors, handgrip strength, quantitative ultrasound

Correspondence address:

Mustafa Kemal Balcı
Akdeniz University, Faculty of Medicine,
Department of Internal Medicine,
Division of Endocrinology and Metabolism, 07070, Antalya.
Phone: (242) 227 4343/35340
Fax: (242) 2274490
E-mail: mbalci@isbank.net.tr

Introduction

Osteoporosis has a great impact on the population due to its economic and health implications. Age, sex, nutrition, physical exercise, hormonal and genetic factors can influence both the maturing and loss of bone mass. The means by which these factors accelerate bone loss are poorly understood (1-3).

Quantitative ultrasound of bone is a relatively new technique that appears to assess 'bone quality' in addition to bone mineral density, it is easy, cheap and suitable for public screening (4-6). There is no study in the literature about osteoporosis methods in our region. Preventive measures including patient education can reduce fractures related to osteoporosis. Turkish women have inadequate knowledge of osteoporosis (7). Therefore we prepared a community education program about osteoporosis. We also determined the association between calcaneous bone mineral density by ultrasound and body fat percentage, body mass index (BMI), dominant handgrip strength, duration of menopause, duration of weekly exercise, and weekly consumption of milk and milky products in this population.

Materials and Methods

Calcaneous bone mineral density was evaluated with a SAHARA clinical bone sonometer in 182 apparently healthy subjects (who had attended a community education program about osteoporosis), during a pilot screening study [155 females, 27 males; mean age 49.6 ± 9.9 years (range 16-81)]. Broadband Ultrasound Attenuation (BUA), t score and z score were calculated. Body fat percentages were evaluated by bio-electrical impedance analysis (OMRON BF 302) and dominant handgrip strength was measured with a JAMAR handgrip dynamometer. BMI was calculated from the formula = body weight (kg) / height (m^2). Duration of menopause, sun exposure, family history of osteoporosis and/or spontaneous fracture, weekly consumption of milk and milky products, duration of weekly exercise and drug history for calcium, steroids, and thyroxine, hormone replacement therapy and all drugs were registered.

Statistical Analysis

All results are expressed as mean ± SD. Mann-Whitney U, Chi-Square tests and linear regression analysis were used for statistical analysis. Spearman's nonparametric correlation test was performed for correlation tests. $P < 0.05$ was considered significant.

Results

Demographic parameters, milk and milk products consumption of females and males are shown in Tables 1, 2, and 3. A family history of osteoporosis was present in 43 (23.6%) patients. A regular drug history was observed in 12 (6.5%) patients [corticosteroid in 3 (1.6%), thyroid hormone in 9 (4.9%)], and 124 patients (68.1%) were not using any drugs. Calcium supplementation treatment had been commenced priorly in 40 patients (21.9%). There were no patients who had taken hormone replacement therapy.

Table 1. Demographic parameters in females and males

	N (%)	Osteoporosis (n)	Age (years)	BMI (kg/m^2)	Body fat Percentage (%)	Body fat weight (kg)	Handgrip strength (kg)
Females	155 (85.1)	7	50.1 ± 9.0	28.9 ± 4.9	35.0 ± 8.3	25.0 ± 4.9	28.0 ± 9.1
Males	27 (14.9)	3	46.7 ± 10.4	27.0 ± 5.6	32.9 ± 6.7	22.9 ± 7.8	30.9 ± 10.5
Total	182 (100)	10	49.6 ± 9.9	27.7 ± 4.4	33.6 ± 7.3	23.7 ± 7.5	29.5 ± 7.9

Table 2. Milk and milk products consumption in females and males

	Yogurt consumption (kg/week) (%)			Milk consumption (L/week) (%)			Cheese consumption (gr/week) (%)			Sun exposure (%)	Physical exercise (%)
	>1.5	1-1.5	<1	>1.5	1-1.5	<1	>150	100-150	<100		
Females	3.9	31.9	62.8	7.5	20.4	72.5	19.7	70.8	12.0	45.4	27.8
Males	3.2	32.4	66.0	7.0	20.1	72.0	17.5	68.0	11.0	49.1	30.8
Total	3.7	31.4	64.9	7.2	20.3	72.5	18.7	69.8	11.5	46.7	28.8

The average t score was -0.95 [95% confidence interval (–1.10; -0.79)] and z score was -0.60 [95% confidence interval (–0.75; -0.44)]. Osteoporosis was detected in 5.4% (7 females and 3 males) (t score <–2.5) and osteopenia was seen in 50% (-2.5 <t score < -1.0). The mean age of the osteoporotic group was found to be higher than that of both the osteopenic and normal group (p<0.001). When osteoporotic, osteopenic, and normal groups were compared with each other, there was no statistically significant difference between other parameters. Out of 155 women, 87 (56.1%) were in the postmenopausal period (mean menopausal period: 9.3 ± 7.5 years) and 68 (43.9%) were in the premenopausal period (Table 4). There was no difference between t score, z score, body mass index, body fat weight or handgrip strength between post- and premenopausal females (p>0.005). We detected a negative correlation between t score and age (r=-0.28, p=0.005). There was no other statistically significant correlation between t and z scores and other parameters (body fat percentage, BMI, dominant handgrip strength, duration of menopause, duration of weekly exercise, and weekly consumption of milk and milky products) (Table 5). When factors affecting calcaneous bone mineral density were researched, the age of subjects was found to have a negative effect on t score (t=-2.414, p=0.034),

Table 3. Demographic parameters of osteoporotic, osteopenic and normal subjects

	N (%)	Age (years)	BMI (kg/m^2)	Body fat percentage (%)	Body fat weight (kg)	Handgrip strength (kg)
Osteoporotic group	10 (5.4)	60.9 ± 6.5	27.2 ± 5.6	32.8 ± 9.4	23.3 ± 9.0	29.4 ± 7.9
Osteopenic group	91 (50)	48.9 ± 9.8	27.7 ± 4.4	33.5 ± 7.2	23.3 ± 7.4	28.5 ± 7.6
Normal	81 (44.6)	48.8 ± 9.6	28.0 ± 4.5	33.7 ± 7.1	24.1 ± 7.6	30.2 ± 8.1

Table 4. Comparison of pre- and postmenopausal women

	Postmenopausal females	Premenopausal females	P value
N	87	68	
Age (years)	53.7 ± 7.4	43.3 ± 6.4	0.025
T score	-1.05 ± 1.0	-0.67 ± 0.9	NS*
Z score	-0.61 ± 1.0	-0.46 ± 0.4	NS*
BMI (kg/m^2)	29.5 ± 4.5	27.9 ± 3.9	NS*
Body fat percentage (%)	37.4 ± 5.4	32.4 ± 5.3	NS*
Body fat weight (kg)	26.9 ± 7.2	23.0 ± 6.2	NS*
Handgrip strength (kg)	25.6 ± 5.9	29.9 ± 5.3	NS*

*NS: Not statistically significant.

Table 5. Correlation between t and z scores and other parameters

	T score		Z score	
Age (Years)	r=-0.28	p=0.005	r=-0.12	p=0.11
BMI (kg/m^2)	r=0.10	p=0.19	r=0.16	p=0.17
Body fat percentage (%)	r=0.12	p=0.10	r=0.22	p=0.15
Handgrip strength (kg)	r=0.15	p=0.25	r=0.25	p=0.12
Duration of menopause (years)	r=0.11	p=0.2	r=0.21	p=0.8
Weekly exercise (hours)	r=0.19	p=0.6	r=0.35	p=0.9
Weekly consumption of milk (gr)	r=0.125	p=0.9	r=0.25	p=0.75
Weekly consumption of yogurt (gr)	r=0.15	p=0.86	r=0.20	p=0.95
Weekly consumption of cheese (gr)	r=0.24	p=0.07	r=0.125	p=0.07

however, weekly consumption of cheese was found to have a positive effect on t score (t=4.299, p=0.001) (Table 6).

Table 6. The factors affecting calcaneous t score

	T score	
Age (years)	t= -2.414	p= 0.034
BMI (kg/m^2)	t= -0.128	p= 0.9
Weekly consumption of milk (gr)	t= -0.831	p= 0.424
Weekly consumption of yogurt (gr)	t= -1.148	p= 0.275
Weekly consumption of cheese (gr)	t= 4.299	p= 0.001
Body fat percentage (%)	t= -0.945	p= 0.345
Handgrip strength (kg)	t= 0.950	p= 0.634
Duration of menopause (years)	t= 0.414	p= 0.13
Weekly exercise (hours)	t= 1.14	p= 0.534

Discussion

Quantitative ultrasound bone measurement is a relatively new technique for the diagnosis of osteoporosis which is cheaper and easier to use than the more established method of bone densitometry by x-ray absorptiometry (DEXA). For the identification of subjects under the risk of osteoporosis defined by the World Health Organization criteria for axial bone mineral densitometry, the performance of bone mineral density by DEXA and quantitative ultrasound calcaneal parameters were statistically comparable. Recent data suggests that calcaneous quantitative ultrasound can be effectively used for screening osteoporosis (4-6).

Females are more prone to osteoporosis. In the post-menopausal period, bone loss was especially observed in the first five years which is directly proportional to (increasing) age (1-3). Murillo Uribe et al. (3) reported that significant negative correlation was found between age, time since menopause and T score. However, Wunsche et al. (6) reported no correlation between the ultrasound bone parameters and age, height, and weight. We have observed a negative correlation between t scores and age which is consistent with the literature. In addition, we did not observe any correlation between t scores and body weight, height, BMI, body fat percentage, and body fat weight. On the other hand, Qin et al. (8) reported weak or no association between bone mineral density with anthropometric parameters and years since menopause. We did not observe a statistically significant difference according to t scores and z scores between pre- and postmenopausal women.

A family history of osteoporosis and/or bone fracture increases the risk of osteoporosis which is thought to be due to genetic causes (1,2). In our study population, we did not observe a statistically significant difference according to t scores between patients having a positive or negative family history. However, this may be due to the small number of patients with a positive family history of osteoporosis and/or bone fracture.

Drugs including corticosteroids, thyroid hormones, anticonvulsants, heparin, lithium, cytotoxic chemotherapeutics may lead to bone loss by several mechanisms (1,2). We did not evaluate the effect of drugson calcaneous bone mineral density, because of the small number of patients on drug treatment in our study.

Insufficient dietary calcium supplementation leads to increased bone turnover. For that reason, lower calcium intake may facilitate the development of osteoporosis. However, conflicting results were obtained from the literature. Moreover, the effects of dietary calcium supplementation during the childhood period on peak bone mass have also not been clearly determined. Insufficient dietary calcium supplementation and decreased vitamin D activation from the skin may lead to decreased absorption of calcium (1-3). In this study, we could not detect a correlation between t scores and milk and yogurt consumption and sun exposure. However, consumption of cheese was found to affect calcaneous bone mineral density.

Inmobilization is an important cause of bone loss and regular physical exercise is thought to have positive effects on bone mass (1,2). In the past decade, there have been numerous publications reporting a significant and direct relationship between handgrip strength and bone mineral density (9-11). Several cross-sectional studies have reported a positive correlation between muscle strength and local bone mineral density (9,11). However, a small number of studies have evaluated the possible role of confounding variables, including bone mineral density and muscle strength (8,10). Qin et al (8) reported weak or no association between bone mineral density and handgrip strength. In our study, we also did not detect a relation between handgrip strength and calcaneous bone mineral density. Radius bone mineral

density must be determined for the relationship between handgrip strength and bone mineral density.

Preventive measures including patient education can reduce hip fractures related to osteoporosis. Turkish women have inadequate knowledge of osteoporosis (7). Osteoporosis and/or osteopenia were detected in more than half of our study population. There should be periodically education programmes and information resources should be easily accessible for these patients.

In conclusion, there was no direct effect of body fat percentage and weight, BMI, or handgrip strength on calcaneous bone mineral density. However, age and consumption of cheese were found to affect calcaneous bone mineral density.

References

1. Riggs BL. Osteoporosis. Endocrinology 2nd edition (Ed: DeGroot LJ). Philadelphia, W.B. Saunders Company, 1989, 1191-1199.
2. Shoback D, Marcus R, Bikle D, Strewler G. Osteoporosis. Basic & Clinical Endocrinology 6th edition (Ed: Greenspan FS, Gardner DG). San Francisco, McGraw-Hill Company, 2001, 310-320.
3. Murillo Uribe A, Carranza Lira S, Martinez Trejo N, Takane V, Santos Gonzalez J. Determination of the sensitivity and specificity of an osteoporosis risk factor questionnaire. *Ginecol Obstet Mex* **68:** 408-15, 2000.
4. Phillipov G, Holsman M, Phillips PJ. The clinical role of quantitative ultrasound in assessing fracture risk and bone status. *Med J Aust* **173:** 208-11, 2000.
5. Roux C, Dougados M. Quantitative ultrasound in post-menopausal osteoporosis. *Curr Opin Rheumatol* **12:** 336-45, 2000.
6. Wunsche K, Wunsche B, Fahnrich H, Mentzel HJ, Vogt S Abendroth K, Kaiser WA. Ultrasound bone densitometry of the os calcis in children and adolescents. *Calcif Tissue Int* **67:** 349-55, 2000.
7. Ungan M, Tumer M. Turkish women's knowledge of osteoporosis. *Fam Pract* **2:** 199-203,2001.
8. Qin L, Au SK, Chan KM, Lau MC, Woo J, Dambacher MA, Leung PC. Peripheral volumetric bone mineral density in pre- and postmenopausal Chinese women in Hong Kong. *Calcif Tissue Int* **67:** 29-36, 2000.
9. Di Monaco M, Di Monaco R, Manca M, Cavanna A. Handgrip strength is an independent predictor of distal radius bone mineral density in postmenopausal women. *Clin Rheumatol* **19:** 473-6, 2000.
10. Foley KT, Owings TM, Pavol MJ, Grabiner MD. Maximum grip strength is not related to bone mineral density of the proximal femur in older adults. *Calcif Tissue Int* **64:** 291-4,1999.
11. Elliot JR, Hanger HC, Gilchrist NL, Frampton C, Turner JG, Sainsbury R, Gillespie WJ. A comparison of elderly patients with proximal femoral fractures and a normal elderly population: a case control study. *N Z Med J* **105:** 420-2,1992.