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Bone Mineral Density and Risk Factors of Osteoporosis in Healthy Men and Women

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Ⅰ. Introduction

Recently, the proportion of elderly people is increasing compared to other age groups. This rapid aging of society raises interest not only in the mean life span, but also in healthy life expectancy (or Disability-Adjusted Life Expectancy, DALE). Osteoporosis, previously accepted as a natural part of the aging process, has now become accepted as a disease which reduces independence and lowers the quality of life.

As opposed to other diseases, osteoporosis does not initially present itself with subjective symptoms, and it may not cause severe problems. Nevertheless, the treatment of a fracture caused by osteoporosis is difficult, it can cause large financial loss, serious sequelae due to complications, and it may even be fatal (Lim, Kim, and Song 2000). In addition, it has

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been reported that the sensitivity of the association of bone density and fracture is several fold higher than the sensitivity of the association of serum cholesterol value and acute myocardial infarction (Kleerekoper and Blacker 1998). It has further been reported that the factors mediating an effect on bone density include age, sex, body size, ethnicity, years since menopause, and behavioral factors (Tanaka et al. 2001; Voort, Geusens, and Dinant 2001; Shin et al. 2004)

However, the most important point is that osteoporosis is a preventable disease. Bone density reaches its maximum in the 20s and 30s, making it very important to perform health promotion behavior so that bone mass can reach its maximum capacity in early adulthood. Whereas after mid adulthood, it becomes more important to minimize the decrease of bone mass and to find means to prevent osteoporosis. Therefore, behavior to prevent osteoporosis should be undertaken throughout the entire life cycle.

Particularly, among the variables mediating an effect on the health behaviors of individuals, disease knowledge has been reported to directly mediate an effect on health behaviors that are associated with the prevention as well as the control of diseases (Rosenstock 1974; Shin et al. 2005), and also reported knowledge as being the most important variable for the prevention of osteoporosis (Sedlak, Doheny, and Jones 2000). In addition, it was found that to decrease the bone loss by osteoporosis, the prevention of secondary complications in osteoporosis patients is important, as is prophylactic approaches to community residents.

Therefore, this study aimed to identify the prevalence of osteoporosis and confirm the priority for health promotion program on osteoporosis. The study focused specifically on (1) identifying the prevalence of osteoporosis in a community-dwelling population of Korean men and women, and (2) assessing factors pertinent to osteoporosis and the risk factors of osteoporosis.

Ⅱ. Methods

Sample

The study was performed in Ansan-city, in the southwestern part of Seoul, South Korea. We selected subjects from the Ansan Health Study sample, which has been described elsewhere (Hwang et al. 2003). In brief, the target sample in the Ansan Health Study represented approximately 1.4% (5,021) of 362,656 adults aged 18 years and more in the city register in 1998 and was randomly selected based on address codes from June 1999 to June 2000. Trained nursing students interviewed subjects to measure their osteoporosis knowledge using Kim, Horan, and Gendler (1991)'s Osteoporosis Knowledge Test (OKT).

After adjusting for insufficient data, our final sample size was 1,269 adults, aged 18-84 years, comprising of 527 men and 742 women. Written informed consent was obtained from all subjects, and an Ansan Health Study review committee approved the study.

Data collection

Basic demographic and clinical data were collected using a standardized questionnaire concerning age, gender, and smoking and drinking habits. For females, their age at menopause was obtained. Knowledge of osteoporosis was evaluated by OKT, developed by Kim et al. (1991). All interviews were conducted by well trained interviewers, and participants' body heights and weights were recorded.

BMD was measured for the anteroposterior lumbar spine (L2-L4) and femur by Dual Energy X-ray Absorptiometry (DEXA) using Lunar PIXI instruments. BMD of femur was expressed as the mean of the BMD values for the following subregions: trochanter, Ward's triangle, and femoral neck. Calibration was performed daily. The T-score was statistically transformed by the number of standard deviations from peak bone mass in normal individuals of the same gender. Osteoporosis was diagnosed by the WHO T-score criteria, if the T-score belonged to the range from 1 to 2.5, osteopenia was diagnosis, and if it marked

Table 1. Bone mineral density and T-score

Age	Number	Femur		Lumbar 2-4	
(years)	(n)	BMD†	T-score	BMD	T-score
Men	527	1.04±0.16	0.70±1.16	1.13±0.17	-0.42±1.41
18-29	39	1.13±0.14	1.45±1.05	1.21±0.12	0.25±1.06
30-39	93	1.08±0.14	1.07±1.04	1.19±0.13	0.04±1.11
40-49	134	1.07±0.14	0.95±1.02	1.14±0.16	-4.34±1.33
50-59	107	1.05±0.15	0.77±0.93	1.13±0.17	-0.43±1.41
60-69	104	0.97±0.16	0.27±1.16	1.08±0.18	-0.82±1.53
70 or over	50	0.87±0.15	-0.47±1.17	1.07±0.20	-0.88±1.73
Women	742	0.96±0.15	0.28±1.25	1.11±0.19	-0.01±1.65
18-29	63	1.00±0.12	0.58±1.04	1.17±0.12	0.43±1.08
30-39	241	1.02±0.12	0.71±0.98	1.21±0.14	0.79±1.18
40-49	195	1.03±0.12	0.81±1.01	1.18±0.14	0.56±1.24
50-59	93	0.94±0.15	0.08±1.24	1.03±0.18	-0.68±1.52
60-69	95	0.83±0.11	-0.82±0.92	0.92±0.17	-1.66±1.44
70 or over	55	0.75±0.09	-1.53±0.81	0.85±0.17	-2.16±1.45

† BMD: bone mineral density

Table 2. Prevalence of low bone mineral density

Age (years)	Number (n)	Femur			Lumbar 2-4		
		Normal	Osteopenia	Osteoporosis	Normal	Osteopenia	Osteoporosis
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Men	527	495 (93.9)	28 (5.3)	4 (0.8)	344 (65.3)	150 (28.5)	33 (6.3)
18-29	39	39 (100)	0 (0.0)	0 (0.0)	36 (92.3)	3 (7.7)	0 (0.0)
30-39	93	92 (98.9)	1 (1.1)	0 (0.0)	74 (79.6)	19 (20.4)	0 (0.0)
40-49	134	133 (99.3)	1 (0.7)	0 (0.0)	88 (65.7)	38 (28.4)	8 (6.0)
50-59	107	105 (98.1)	2 (1.9)	0 (0.0)	66 (61.9)	37 (34.6)	4 (3.7)
60-69	104	92 (88.5)	11 (10.6)	1 (1.0)	51 (49.0)	40 (38.5)	13 (12.5)
70-	50	34 (68.0)	13 (26.0)	3 (6.0)	29 (58.0)	13 (26.0)	8 (16.0)
Women	742	609 (82.1)	126 (17.0)	7 (0.9)	537 (72.4)	152 (20.5)	53 (7.1)
18-29	63	59 (93.7)	4 (6.3)	0 (0.0)	58 (92.1)	4 (6.3)	1 (1.6)
30-39	241	234 (97.1)	7 (2.9)	0 (0.0)	224 (92.9)	17 (7.1)	0 (0.0)
40-49	195	185 (94.9)	10 (5.1)	0 (0.0)	172 (88.2)	23 (11.8)	0 (0.0)
50-59	93	74 (79.6)	18 (19.4)	1 (1.1)	45 (48.4)	41 (44.1)	7 (7.5)
60-69	95	45 (47.4)	49 (51.6)	1 (1.1)	29 (30.5)	41 (43.2)	25 (26.3)
70-	55	12 (21.8)	38 (69.1)	5 (9.1)	9 (16.4)	26 (47.3)	20 (36.4)

below 2.5, osteoporosis was diagnosis.

Data Analysis

Collected data were analyzed by a computer using the SPSS 12.0 program. The mean and standard deviation of bone density and the values of osteoporosis was obtained, and factors pertinent to bone density were analyzed by a correlation test. The risk factors of osteoporosis were analyzed by multiple logistic regression, with the level of significance set to $p<0.05$.

Ⅲ. Results

The mean BMD values, grouped according to age and gender, are given in Table 1, along with the corresponding *T*-scores for the femur and lumbar spine. BMD of the femur was consistently higher in males than in females through all age groups. Females exhibited higher BMD lumbar spine values than males in the age groups of 30-39 and 40-49 years.

Prevalence of osteoporosis

Table 2 presents the analyzed results of the age- and gender- specific data, as well as the prevalence of osteoporosis and osteopenia, based on the T score of the lumbar vertebral bone density and the femoral bone density.

Table 3. Relationship between BMD and correlates to osteoporosis

	Male (n=527)		Female (n=742)	
	Femur BMD (g/cm^2)	Lumbar 2-4 (g/cm^2)	Femur BMD (g/cm^2)	Lumbar 2-4 (g/cm^2)
Age (years)	-.390**	-.249**	-.519**	-.578**
	.000	.000	.000	.000
BMI (kg/cm^2)	.052	.041	.077	.020
	.232	.352	.036	.578
Osteoporosis knowledge	.134**	.091*	.282**	.259**
	.002	.037	.000	.000
YSM (years)			-.536**	-.392**
			.000	.000

*p<.05; **p<.01; BMD: bone mineral density; BMI: body mass index; YSM: years since menopause

Table 4. Risk factors of Osteoporosis

	Male		Female	
	Femur	Lumbar 2-4	Femur	Lumbar 2-4
	Age adjusted OR (95% CI)	Age adjusted OR (95% CI)	Age adjusted OR (95% CI)	Age adjusted OR (95% CI)
Age (years)	1.115 (1.072-1.159)	1.034 (1.020-1.048)	1.099 (1.028-1.174)	1.064(1.005-1.126)
	.000*	.000*	.006*	.032*
BMI (kg/cm2)	0.810 (0.696-0.942)	0.864 (0.806-0.928)	0.884 (0.817-0.957)	0.897 (0.820-0.981)
	.006*	.000*	.002*	.017*
Osteoporosis knowledge	0.990 (0.886-1.106)	0.991 (0.941-1.043)	0.821 (0.743-0.907)	0.882 (0.817-0.951)
	.863	.730	.000*	.001*
YSM (years)			1.043 (0.981-1.110)	1.021 (0.962-1.083)
			.180	.492

*p<.05; BMI: body mass index; YSM: years since menopause

Correlation of BMD and risk factors of osteoporosis

Factors correlated to bone density were shown to be age, body mass index (BMI), osteoporosis knowledge, and years since menopause (YSM) (see Table 3).

Table 4 displays the odds ratios of selected risk factors for osteoporosis. Factors that were detected to be common risk factors in both femur and lumbar sites of males and females were age and BMI, as already reported (Hannan, Felson, and Dawson-Hughes 2000;

Orwoll, Bavan, and Phipps 2000; Verenna et al. 1999; Tenenhouse et al. 2000). Especially in the female cases, osteoporosis knowledge was observed to be significantly inversely correlated with osteoporosis risk in the femur and lumbar.

Ⅳ. Discussion

BMD and prevalence of osteoporosis

The BMD values of the femur and L2-L4 spine measured in the present study were similar to those of previous studies (Cvijetic and Korsic 2004; Liu et al. 2004; Ardawi et al. 2005; Forsmo et al. 2005). The level was similar to that reported by Forsmo et al. (2005) who measured the forearm BMD in Norwegians and found that BMD decreased rapidly in females in their 50s and 60s. This result reconfirmed that compared to men, middle aged women experiencing menopause are a group more vulnerable to osteoporosis.

In our study, the overall incidence of osteoporosis based on the femur and the lumbar spine was 0.8% and 6.3% for males, and 0.9% and 7.1% for females, respectively. These results were lower than those reported by Shin et al.(2004) who examined 1420 women and 732 men aged 40 years and older in rural Korea, they found an osteoporosis prevalence of 8.4% and 27.3% at the calcaneus, and 4.2% and 18.8% at the distal radius, for males and females, respectively. These results were considered to be related to subject age. An absolute comparison is not possible because our study's population included adults over 20 years old with normal bone density. and the area of the BMD measurement in the two studies was different. Nevertheless, the overall prevalence of osteoporosis was considered to be low because young adults were included in the study subjects. In addition, in comparison with the study reported by Shin and Kang (2000), our study was performed in urban areas with subjects thought to have higher education levels, living standards, nutritional condition and rate of practicing health promotion behaviors, in comparison to the rural subjects. Nonetheless, for accurate determination of the influencing factors, comparison studies that measure bone density in an identical region are required.

Several important characteristics were observed in an analysis of osteoporosis according to age. First, the incidence of a lumbar fracture in women in their 60s and 70s was more than 2-fold higher than that in men of the same age. Second, during the young adult period when bone volume reaches its maximum, 7.7% of males and 6.3% of females already have osteopenia, and 1.6% of women have osteoporosis. This may be considered to be due to the influence of social cultural factors such as an

excessively decreasing body weight and maintaining unbalanced diets in order to obtain the thin figure that Koreans recently favor. With regards to nursing, it was found that education on the importance of maintaining the maximum bone volume and prevention measures of osteoporosis for young adults are required.

Risk factors of osteoporosis

In order to characterize the risk factors of osteoporosis, multiple logistic regression on age, BMI, years since menopause, and osteoporosis knowledge was performed. The results showed that BMI was negatively correlated with age in both females and males. The result that age and BMI were associated with bone density is in agreement with the result of previous studies (Shin et al., 2004; Liu et al., 2004). Furthermore, we found that osteoporosis knowledge level was negatively correlated with osteoporosis risk in women. This is because osteoporosis knowledge prevents the disease and mediates an effect on health-related behaviors. Levin reported that knowledge is the best strategy for self care and prophylactic behaviors (Levin 1986), which became the basis to stress the importance of the effective education of osteoporosis.

For women, the number of years passed since menopause was also found to be a risk factor, due to its being associated with bone density. The risk of osteoporosis increased with lengthening postmenopausal period, but it was not significant statistically.

Consequently, not only the well-known factors of age and BMI, but also osteoporosis knowledge level, are predictors for osteoporosis risk. This relationship has important implications for nursing strategies in order to approach a program of osteoporosis prevention. Knowledge of osteoporosis will facilitate the adoption of preventive measures against potentially remediable risk factors such as smoking, nutritional deficiencies and a sedentary life style (Tanaka et al. 2001). Such measures are vital because osteoporosis is a disease that can be prevented by life style modifications. However, most prevention programs are confined to urban areas and most are intended for middle aged women in Korea. Therefore, our study results emphasize the necessity of tailoring osteoporosis treatment programs specifically aimed at the more vulnerable groups. In addition, interventions targeting the main risk factors can have beneficial effects on reducing morbidity and mortality. The cause of change relevant to osteoporosis in the study was the knowledge about osteoporosis. The more the increase of osteoporosis knowledge is, the less the decrease of bone loss by osteoporosis is, which provided the reasons to emphasize the importance of efficient education toward

osteoporosis. Accordingly, based on the results above, considering the modifiable risk factors in osteoporosis of age, sex, and tears since menopause, it is possible to sort out vulnerable groups, and the data can be utilized as the sources for the application of health promotion and health education programs for the groups.

V. Conclusion

The results of this study emphasize the consideration of various lifestyle independent risk factors such as age, sex and years since menopause in selecting groups from vulnerable classes in osteoporosis prevention programs. It is also strongly advised that the appropriate nursing strategies for education, screening and promotion of health behavior among such vulnerable groups are developed. Among the modifiable risk factors, nurses can play a key role through educational intervention, targeting the increase of osteoporosis knowledge and its practice, the decrease of additional bone loss, and the reduction of the morbidity and mortality caused by osteoporosis. However, as the study was practiced in a limited area, it is advised that a nationwide long-term study is needed to have the basis to identify the cause of change to influence efficient health education and health promotion strategy regarding osteoporosis.

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ABSTRACT

Aims. The aims of this study were to identify the prevalence of osteoporosis and confirm the priority for health promotion program on the osteoporosis. Methods. 1,269 adults aged 18-84 years participated in this study from the Ansan Health Study sample. A questionnaire was used to evaluate the risk factors, and a Dual Energy X-ray Absorptiometry was used to measure the bone mineral density in the anteroposterior lumbar spine and femur. Collected data were analyzed using the SPSS 12.0 program. Results. BMD was decreased rapidly in females in their 50s and 60s and the overall incidence of osteoporosis based on the femur and the lumbar spine was 0.8% and 6.3% for males and 0.9% and 7.1% for females. Osteoporosis knowledge was significantly correlated with BMD. Conclusions. The results of this study can be applied to provide effective and practical implementation guidelines for osteoporosis prevention program

Key Words: Osteoporosis; Osteoporosis knowledge; Bone mineral density

〈국문초록〉

건강한 성인 남녀의 골밀도와 골다공증 위험요인

목적. 본 연구의 목적은 골다공증의 유병률을 확인하고 건강증진 프로그램의 우선적 대상을 확인하고자 실시되었다. 방법. 연구대상자는 Ansan Health Study센터를 방문한 18-84세의 성인 남녀 1,269명이었다. 위험요인을 평가하기 위한 질문지를 이용하였고 DEXA(Dual Energy X-ray Absorptiometry)를 이용하여 2-4번 요추와 대퇴의 골밀도를 측정하였다. 수집된 자료는 SPSS12.0프로그램을 이용하여 분석하였다. 결과. 골밀도는 50대와 60대 여성에게서 급격히 감소하였으며, 골다공증 유병률은 대퇴와 요추를 기준으로 남성은 각각 0.8%, 6.3%, 여성은 0.9%와 7.1%로 나타났다. 골다공증 지식 정도는 골밀도와 유의한 순상관관계가 있는 것으로 나타났다. 결론. 본 연구의 결과는 골다공증 예방 프로그램을 위한 효과적이고 실제적인 중재전략을 위한 기초자료를 제공하였다.

주제어: 골다공증, 골다공증 지식, 골밀도