

Health-Related Characteristics that Affect the Prevalence of Osteoporosis in Elderly Women

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Purpose: We examined the relationship between the health-related issues of elderly women and bone density and identified specific factors that affect the prevalence of osteoporosis to provide basic data for developing a health care program on osteoporosis prevention. **Methods:** This study is a secondary data analysis of 118,903 66-yr-old women who received a health examination conducted by the National Health Insurance Corporation in 2008. Multiple logistic regression analysis was used to identify factors affecting the prevalence of osteoporosis. **Results:** The prevalence of osteoporosis was 46.8%, whereas the prevalence of osteopenia was 38.4% among elderly women in this study. Statistically significant differences were observed between the osteoporosis and non-osteoporosis group in terms of smoking ($p<.001$), exercise ($p<.001$), obesity ($p<.001$), waist circumference ($p<.001$), depression ($p<.001$), falling experience ($p<.05$), and the cognitive function risk ($p<.05$). Based on the multiple logistic regression results, the risk for osteoporosis was high in those who were underweight, smoked, or were depressed. In contrast, moderate or high level obesity showed a negative relationship with osteoporosis. **Conclusion:** The prevalence of osteopenia and osteoporosis was 85.2%. Therefore, there is a need to develop health care programs pertaining to osteoporosis intervention and prevention for elderly women. Because smoking, non-exercise, and obesity are main osteoporosis risk factors, it is highly recommended that some sound practical life programs and psychological support programs be considered for this population.

Key Words: Elderly women, Osteoporosis

INTRODUCTION

The prevalence of osteoporosis in the Korean female population is higher (15.52-41.35%; Jeon et al., 2008) than the prevalence in women from the USA, Canada, and Europe (2.0-20.5%; Maalou et al., 2000; Melton et al., 1995). Using the World Health Organization's (WHO) criteria, 28.7% of postmenopausal women had osteoporosis, 46.4% had osteopenia, and 24.9% had normal bone mineral density (BMD). The incidence of osteoporosis after menopause is closely related to the lack of ovarian hormones, particularly estrogen, caused by menopause (Drake & Khosla, 2008; Reid, 2008). As a person gets older, the bone resorption rate exceeds the bone formation rate; the bone's microstructure

gets weaker; and bone strength is reduced (National Osteoporosis Foundation, 2008). The loss of osseous tissue is accelerated by the inhibition of osteoblast stimulants (Gambert, Schltez, & Hamdy, 1995). Because the loss of bone mass is induced by both aging and menopause, women in menopausal period are vulnerable for bone disease, especially, osteoporosis (Park et al., 2009).

The average life span of Korean women was 82.4 yr in 2006, which is higher than the Organisation for Economic Co-operation and Development (OECD) member's average life span of 81.7 yr (OECD, 2008). Furthermore, Korea is expected to become a robust "Aging Society" in 2019 with over 14% of the population aging and a "Super Aging Society" in 2026 with over 20.8% of the population aging (Korean National Statistical Office, 2008).

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Therefore, it is expected that osteoporosis prevalence among older Korean women will increase (Chung, 2008). The death rate resulting from fractures caused by a fall injury is 2.8%, which is the same death rate resulting from breast cancer. This rate is four times higher than the death rate from endometrial cancer, which is 0.7% (Chung, 2008). According to the Health Insurance's Payment Data, the total medical expenses for hospitalization due to fractures in the ankle, hip, and thigh bone are 14.718 billion Korean Won (Yang, 2009). The factors affecting bone density level and the occurrence of osteoporosis are age, body mass index (BMI), smoking, drinking, physical activity, and exercise (Atalar et al., 2009). In contrast, non-smoking, moderate drinking, and regular exercise are factors contributing to good health (Ali, Shonk, & El-Sayed, 2009). The WHO (2003) estimated that about 6 million people will suffer from hip fractures caused by osteoporosis in 2050, and 20% of these will be fatal.

The relationship between obesity and osteoporosis varies depending on how obesity is defined. If obesity is based on the percentage of body fat, it may be a risk factor for osteoporosis. According to Kim (2010), body weight is positively related to BMD and serves as a protective factor for vertebral fractures, whereas the percentage of body fat and waist circumference are negatively related to BMD and serve as risk factors for vertebral fractures. Depression is another risk factor for osteoporosis. Major depressive disorder is an important cause of disability in the US and one of the leading causes of disability worldwide (Cizza et al., 2009). Determining whether the decreased bone mass in subjects with depression affects the increased fracture risk is crucial (Cizza et al., 2009). Women with cognitive disabilities are at high risk for osteoporosis and osteoporosis-related fractures, and osteoporosis is a major problem for all women with cognitive disabilities (Schrager, 2004).

Hence, the WHO recommended that guidelines for osteoporosis prevention, nursing, and all relevant policies should be developed. Recently, some studies have been conducted on the prevalence of osteoporosis and osteopenia in the Korean female population (Chung, 2008; Hwang, 2009; Jeon et al., 2008) and its relevant risk factors. Most of the studies were conducted in one region or in a small target size considered applicable to the general population. So, such studies are limited in representing the osteoporosis prevalence among the Korean female population.

Therefore, this study utilized the life-turning period check-up project data, which includes osteoporosis testing targeting 66-yr-old women at the national level. From the data, we determined the current osteoporosis prevalence in the Korean elderly women population and identified some influential factors for the occurrence of osteoporosis. The result of this study will be utilized as basic data to develop health-care programs for osteoporosis intervention and prevention.

1. Study purpose

This study aimed to examine the specific factors that affect the prevalence of osteoporosis by analyzing the differences in the prevalence of osteoporosis compared to health-related issues (health behaviors, obesity, falling, depression, and cognitive function) of elderly females.

METHODS

1. Study design

This study was a secondary analysis. In Korea, life transition period health examinations have conducted under the health examination policy for the elderly population (age, 66 yr old) since 2007. We used data collected by National Health Insurance Corporation (NHIC) to examine the impacts of health-related issues (health behavior, obesity, falling, depression, and cognitive function) on the prevalence of osteoporosis.

2. Study sample and data source

The study sample consisted of 119,438 sixty six year old females, who took the life transition period health examination conducted by the NHIC from January to December 2008. Among them, 535 were excluded due to insufficient data. Thus, the final study sample was 118,930 elderly women. In compliance with the NHIC information extraction policies, we requested personally non-identifiable data from the information management center. The data were internally screened by the NHIC. Private information on the subjects was carefully reviewed and transformed into a code, so the individuals could not be identified. Our study used this transformed data. Data sets from the national health check-up program were used that contained information regarding weight, height, BMI, waist circumference,

health behaviors (eating, smoking, drinking, and exercise), illnesses, geriatric depression, and cognitive function level.

3. Variable selection and definition

1) Measurement and diagnosis of osteoporosis

Dual energy X-ray absorptiometry, peripheral dual energy X-ray absorptiometry, quantitative computed tomography (QCT), peripheral QCT, and quantitative ultrasound were used to measure osteoporosis in compliance with the standard test guidelines for health examination institutes (NHIC, 2008). Individuals with T-scores ≤ -2.5 on bone densitometry were classified into an osteoporosis group; those with $-2.5 < \text{T-scores} \leq -1.0$ were placed into the osteopenia group, and those with a T-scores > -1 were categorized into a normal group (NHIC, 2008).

2) Health behavior

Health behaviors included smoking, drinking, and exercising. A smoker was defined as one who has smoked at least five packs of cigarettes in his whole life and is currently smoking; a drinker was defined as one who drinks at least once per week on average; an exerciser was defined as one who exercises at least three times for 30 minutes each per week (National Health Nutritional Investigation, 2008; NHIC, 2008).

3) Obesity

BMI (kg/m^2) was calculated using the height and weight measured during the health examination. The obesity category was classified into underweight ($< 18.5 \text{ kg}/\text{m}^2$), normal weight ($18.5\text{--}25 \text{ kg}/\text{m}^2$), mildly obese ($25\text{--}30 \text{ kg}/\text{m}^2$), or severely obese group ($\geq 30 \text{ kg}/\text{m}^2$) (NHIC, 2008).

4) Waist circumference

Waist circumference was used to assess abdominal obesity. Size between the lowest part of the ribs and the thinnest part of the iliac crest of the hip up to 0.1 cm was measured. When the waist circumference was greater than 85 cm, it was classified to abdominal obesity (Lee et al., 2007).

5) Falling experience

Elderly women with a falling experience were defined as those who responded "yes" to the question "Have you experienced a

fall over the last 6 months?" in the medical interview checklist from the life transition period health examination (NHIC, 2008).

6) Depression

We used the three-item Geriatric Depression Scale Short form by Gi (1996) to objectively measure geriatric depression. The score range is 0-3. Those with a score of 1-3 were classified into a depression risk group (NHIC, 2008). The reliability of this instrument, as measured by Cronbach's α was 0.742 for this study.

7) Cognitive function

We used the Korean Dementia Screening Questionnaire (KDSQ) cognition medical interview, which is a shortened form of the KDSQ developed by Yang and others (2002) into a five-item short-form questionnaire. This short-form questionnaire consists of three-point scales (0: no; 1: sometimes (slightly yes); 2: frequently (very much yes). The score ranges from 0 to 10 for this questionnaire; 0-3, normal; ≥ 4 indicates a risk group who needs further testing (NHIC, 2008). The reliability of this questionnaire, as measured by Cronbach's alpha, was 0.856.

4. Data analysis methods

The collected data were submitted to SPSS/WIN 15.0 for analyses (SPSS Inc., Chicago, IL, USA). The subject's health behavior, obesity, depression, cognitive function and osteoporosis-related characteristics are presented as percentile scores, frequencies, means and standard deviations. Characteristics across different diagnosis groups were analyzed with the χ^2 -test. A multiple logistic regression method was used to identify factors affecting the prevalence of osteoporosis.

RESULTS

1. Health-related issues

The health-related issues of the elderly female subjects are presented in Table 1. Among the health behaviors, 2.3% were smokers ($n=2,702$). Approximately 9% ($n=108,007$) drank at least once per week. Approximately 31% ($n=36,908$) exercised at least three times per week. With respect to obesity, 54.9% ($n=65,332$) were in the normal group with BMIs of $18.5\text{--}25 \text{ kg}/\text{m}^2$; 38.3% ($45,573$) were mildly obese (BMI, $25\text{--}30 \text{ kg}/\text{m}^2$);

Table 1. Health Behaviors

(N=118,903)

Contents		n	%	Mean (\pm SD)
Smoking	Smoker	2,702	2.3	
	Non-smoker	116,201	97.7	
Drinking	Drinker	10,896	9.2	
	Non-drinker	108,007	90.8	
Exercise	Exerciser	36,908	31.0	
	Non-exerciser	81,995	69.0	
Obesity	Normal ($18.5 \leq \text{BMI} < 25 \text{ kg/m}^2$)	65,332	54.9	24.65 (\pm 3.13)
	Underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$)	2,074	1.7	
	Mild obesity ($25 \leq \text{BMI} < 30 \text{ kg/m}^2$)	45,573	38.3	
	Severe obesity ($\text{BMI} \geq 30 \text{ kg/m}^2$)	5,924	5.0	
Waist circumference	< 85 cm	72,474	61.0	82.54 (\pm 9.18)
	≥ 85 cm	46,429	39.0	
Falling experience	Yes	14,974	12.6	
	No	103,929	87.4	
Depression	Normal	73,619	61.9	0.64 (\pm 0.97)
	Depression	45,284	38.1	
Cognitive function	Normal	85,765	72.1	2.11 (\pm 2.19)
	Risky	33,138	27.9	
Osteoporosis	Normal	17,521	14.7	
	Osteopenia	45,705	38.4	
	Osteoporosis	55,677	46.8	

5.0% ($n=5,924$) were severely obese ($\text{BMI} \geq 30 \text{ kg/m}^2$); and 1.7% ($n=2,074$) were underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$). Approximately 61% ($n=72,474$) were in the normal group with a waist circumference (the criteria for abdominal obesity) < 85 cm. Approximately 13% ($n=14,974$) experienced a fall over the last 6 months and 61.9% ($n=73,619$) were normal with 0 for the depression score. A total of 72.1% ($n=85,765$) were normal with a cognitive score ≤ 3 . Approximately 47% ($n=55,677$) had T-scores ≤ -2.5 on bone densitometry; 38.4% ($n=45,705$) had T-scores > -2.5 but ≤ -1 ; and 14.7% ($n=17,521$) had T-scores > -1 .

2. Health-related issues according to osteoporotic status

The differences in health-related issues across different diagnosis groups are presented in Table 2. Statistically significant differences were observed for smoking ($p < .001$), exercise ($p < .001$), obesity ($p < .001$), waist circumference ($p < .001$), depression ($p < .001$), falling experiences ($p < .05$), and cognitive function risk group ($p < .05$). The prevalence of osteoporosis in smokers was 54.5%, and it was 45% for exercisers. Approximately 69.0% of the underweight were diagnosed with osteoporosis, 49.1% of those with a waist size < 85 cm were diagnosed with osteoporosis, 48.0% of those who had experienced falling were diagnosed with osteoporosis, and 47.8% of those who were depressed and 47.6% of the cognitive function risk group were diagnosed

with osteoporosis.

3. Health-related factors affecting osteoporosis

Factors that affected osteoporosis are presented in Table 3 and include smoking, exercise, obesity, falling experience, depression, and cognitive function. The results showed that osteoporosis occurred more often among smokers (odds ratio [OR], 1.298; 95% confidence interval [CI], 1.201-1.402), the underweight (OR, 2.135; 95% CI, 1.942-2.346), those who had fallen (OR, 1.058; 95% CI, 1.022-1.095), and those who were depressed (OR, 1.055; 95% CI, 1.030-1.081) than among those without these characteristics. In contrast, subjects with mild (OR, 0.688; 95% CI, 0.669-0.708) or moderate obesity (OR, 0.549; 95% CI, 0.517-0.582) had fewer chances for osteoporosis than those with normal weight. Furthermore, exercisers (OR, 0.895; 95% CI, 0.873-0.917) had less chance of acquiring osteoporosis than non-exercisers. Taken together, drinking, waist measurement, and cognitive function level failed to influence the occurrence of osteoporosis.

DISCUSSION

We examined elderly female health-related issues and factors affecting their health. The prevalence of osteoporosis among the

Table 2. Differences in health-related characteristics according to osteoporotic status

(N=118,903)

Contents		Non-osteoporosis	Osteoporosis	Total	χ^2	p
Smoking	Smoker	1,230 (45.5)	1,472 (54.5)	2,702 (100)	65.028	.000
	Non-smoker	61,996 (53.4)	54,205 (46.6)	116,201 (100)		
Drinking	Drinker	5,805 (53.3)	5,091 (46.7)	55,677 (100)	0.050	.823
	Non-drinker	57,421 (53.2)	50,586 (46.8)	108,007 (100)		
Exercise	Exerciser	20,282 (55.0)	16,626 (45.0)	36,908 (100)	67.984	.000
	Nonexerciser	42,944 (52.4)	39,051 (47.6)	81,995 (100)		
Obesity	Normal	32,194 (49.3)	3,318 (50.7)	65,332 (100)	1569.683	.000
	Underweight	643 (31.0)	1,431 (69.0)	2,074 (100)		
	Mild obesity	26,620 (58.4)	18,953 (41.6)	45,573 (100)		
	Severe obesity	3,769 (63.6)	2,155 (36.4)	5,924 (100)		
Waist circumference	<85 cm	36,863 (50.9)	35,611 (49.1)	72,474 (100)	397.996	.000
	≥85 cm	26,363 (56.8)	20,066 (43.2)	46,429 (100)		
Falling experience	Yes	7,788 (52.0)	7,186 (48.0)	14,974 (100)	9.327	.002
	No	55,438 (53.3)	48,491 (46.7)	103,929 (100)		
Depression	Normal	39,608 (53.8)	34,011 (46.2)	73,619 (100)	30.510	.000
	Depression	23,618 (52.2)	21,666 (47.8)	45,284 (100)		
Cognitive function	Normal	45,857 (53.5)	39,907 (46.5)	85,764 (100)	10.739	.001
	Risky	17,368 (52.4)	15,770 (47.6)	33,138 (100)		

Table 3. Predictors of osteoporosis

(N=118,903)

	Compare group	Reference group	Osteoporosis (ref. not osteoporosis) Adj or (95% CI)		
			Exp (B)	Low	High
Smoking	Yes	No	1.298 [†]	1.201	1.402
Drinking	Yes	No	0.990	0.952	1.031
Exercise	Yes	No	0.895 [†]	0.873	0.917
Obesity	Underweight	Normal	2.135 [†]	1.942	2.346
	Mild obesity	Normal	0.688 [†]	0.669	0.708
	Severe obesity	Normal	0.549 [†]	0.517	0.582
Waist circumference	≥85 cm	<85 cm	1.007	0.979	1.036
Falling experience	Yes	No	1.058 [*]	1.022	1.095
Depression	Depression	Normal	1.055 [†]	1.030	1.081
Cognitive function	Abnormal	Normal	1.019	0.993	1.046
df			10		
-2 log l			162605.884		
Model chi-square			1747.813 [†]		
Case			118,903		

*= $p < .01$; [†]= $p < .001$.

subjects in this study was 46.8%, and the prevalence of osteoporosis was 38.4%. These figures are higher than 19.5% (Hwang, 2009) and 40.2% (Jeon et al., 2008) targeting 65-69-yr-old females, and the 22% and 39% of American 60-69-yr-old and 70-79-yr-old females (Melton, 1995), respectively. Our results represent the generalized characteristics of the elderly women population given in the study based on the life-turning period check-up project data. Given that the prevalence of osteoporosis in Korean elderly women is higher than that of western women, some programs need to be developed to help patients with osteoporosis and to prevent the disease in advance.

This study showed that the prevalence of osteoporosis was

higher among smokers, non-exercisers, the underweight, those who had falling experiences, those with depression, and those in a cognitive functions risk group. Smoking reduces calcium absorption in the intestines and facilitates the elimination of calcium through urine. We identified that smoking is a factor contributing to lower BMD. This result corresponded with the report of Need et al. (2002) who found that female smokers have lower bone mass at the time of menopause, and that the bone loss develops faster after menopause. To the affected person, regular exercise is important because it increases bone strength and muscular force and improves muscle function, joint flexibility, and balance. The results of this study suggest that if physical activities

begin early in life, maximum bone mass is maintained at a higher level, which slows down the bone density reduction later in life, and lowers the risk of osteoporosis (National Institutes of Health Consensus Development Panel, 2001). This suggestion corresponds with Kim (2006) study that a person who exercises has a 0.77 times lower risk of osteoporosis than those who do not exercise. However, many studies have shown opposite results for drinking in relation to bone density (Shuhei et al., 2000). Some have reported that moderate drinking (28.6-57.2 g/week) increases bone density, and helps bone density to be maintained at an appropriate level (Rapuri, Gallagher, Kinyamu, & Ryschon, 2000). However, our results showed that a drinker's risk of osteoporosis was generally low, but the result was not statistically significant. It seems that amount of liquor ingested is a more important factor than the frequency, so future studies on the amount of alcohol ingested that influences the prevalence of osteoporosis are in need.

The prevalence of osteoporosis is 2.135 times higher in the underweight population than in the normal weight population. Contrary to this observation, disease prevalence was reduced 0.688 times in mildly obese women, and 0.549 in severely obese women, which corresponded with previous studies (Kim, 2006; La Vecchia et al., 1991; Melton et al., 1995). This is because weight works as a mechanical load against the skeleton, and the mechanical load protects bone density. Adrenal androgens are converted into estrogen in the peripheral adipose tissue at a relatively higher rate in the obese individuals than thin individuals. In other words, obesity strongly protects bone density (Melton et al., 1995). According to Kim (2006), the risk of osteoporosis for women with BMI ≤ 25 kg/m² is 1 and 0.46 for those with BMI ≥ 25 kg/m², which was statistically significant. La Vecchia and others (1991) found that women who are normal weight and overweight (BMI ≥ 25) have a significantly lower risk of hip fracture by 0.5 and 0.4 times, respectively, than those who are underweight (BMI < 20). Therefore, obesity greatly influences the risk for osteoporosis. Some nursing interventions were required to improve bone strength, muscular force, and function in the underweight. Those who were depressed showed a 1.055 times higher prevalence rate for osteoporosis than those who were not ($p < .001$), which is consistent with Yirmiya and Bab's (2009) report that depression and bone density are positively correlat-

ed. Although some disagree with the opinion that depression is a risk factor for reducing bone density, our meta-analysis results showed that cases diagnosed with major depression were significantly more likely to develop osteoporosis (OR, 1.055). Because we analyzed depression using the standard for the depression risk score obtained from the life-turning period check-up, the OR appeared lower than that of subjects not diagnosed with major depression. Therefore, future studies should analyze the relationship between osteoporosis and major depression targeting subjects diagnosed with major depression. Kasper and others (2004) reported that smoking, drinking, falls, vision, female hormonal status, physical activity, history, and family history of bone fractures, gender, and age are risks for osteoporotic fractures. As described above, we identified factors that affected the prevalence of osteoporosis by analyzing health-related issues in elderly Korean females. As it was confirmed that non-smoking, regular exercise, and moderate drinking are important factors for preventing osteoporosis, some nursing intervention programs need to be developed to improve bone health in elderly females and prevent osteoporosis.

CONCLUSION

This study showed that smokers, non-exercisers, underweight, those with a falling experience, and those with depression were significantly correlated with the osteoporosis prevalence rate. These results suggest that an osteoporosis preventive program based on health issues is urgently needed. Life-long physical activity may protect women from fractures, and a multifactorial program with an emphasis on physical and social activities and nutritional supplementation within the primary care setting for elderly women is highly recommended.

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