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ORIGINAL ARTICLE

Dietary Patterns and Osteoporosis Risk in Postmenopausal Korean Women

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Abstract

Objectives: The prevalence of osteoporosis and related fractures has increased rapidly in Korean women. Proper nutrition intake is associated with the prevention of osteoporosis. We analyzed the association between dietary patterns and the risk of osteoporosis during a 4-year follow-up in postmenopausal Korean women.

Methods: Postmenopausal women (n = 1,725) who participated in the Korean Genome and Epidemiology Study were enrolled. Food intake was assessed using a validated semiquantitative food frequency questionnaire, and a quantitative ultrasound device was used to measure the speed of sound at the radius and tibia.

Results: Three major dietary patterns were identified using factor analysis based on baseline intake data: traditional (high intake of rice, kimchi, and vegetables), dairy (high intake of milk, dairy products, and green tea), and western (high intake of sugar, fat, and bread). Multivariate Cox proportional hazards models were used to estimate relative risk for osteoporosis. An inverse association was detected between the dairy dietary pattern and the osteoporosis incidence [relative risk (RR): 0.63, 95% confidence interval (CI): 0.42—0.93, p-trend = 0.055 in radius; RR: 0.56, 95% CI: 0.35—0.90, p-trend = 0.048 in tibia]. Individuals in the highest quintile for the traditional dietary pattern (p-trend = 0.009 in tibia) and western dietary pattern (p-trend = 0.043 in radius) demonstrated a higher risk of osteoporosis incidence than those in the lowest quintile.

Conclusion: These results suggested that high consumption of milk, dairy products, and green tea may reduce the risk of osteoporosis in postmenopausal Korean women.

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1. Introduction

Osteoporosis is a skeletal disorder characterized by compromised bone strength that predisposes the affected individual to an increased risk of fracture [1]. South Korea has already entered the phase of an aging society, and the prevalence of osteoporosis and related fractures is expected to increase rapidly. According to the 2010 Korean National Health and Nutrition Examination Survey (KHANES), the prevalence of osteoporosis was 34.9% in females and 7.8% in males older than 50 years [2]. Nutrients such as calcium, phosphorus, protein, and vitamin D have a relationship with bone mass [3,4]. Proper nutrient intake has a crucial role in both prevention and treatment of osteoporosis [5]. The association of individual nutrient intake with disease outcomes can be difficult to detect, because nutrients are not consumed independently and they also act synergistically with one another in the body [6,7]. To overcome the limitations of studying individual nutrient intake, dietary pattern analysis has emerged as a method of assessing total food consumption [8]. Examining dietary patterns rather than isolated nutrients or foods offers an advantage of studying the effect of the whole diet [9].

Many studies that have used factor or principal component analysis have empirically derived a “healthy” or “prudent” food pattern that is high in fruits, vegetables, fish, low-fat foods, fiber, legumes, etc. These food patterns are inversely associated with the risk for metabolic syndrome [10] and cancer [11−13]. Several studies have investigated the association of dietary patterns with bone mineral density (BMD), fracture, and osteoporosis [14−19]. However, the relation of these patterns and osteoporosis is not well understood in Korean women.

Thus, the aim of the current study was to examine, using prospective cohort study data, whether dietary patterns are related to risk of osteoporosis in postmenopausal Korean women.

2. Materials and Methods

2.1. Participants

The Korean Genome and Epidemiology Study (KoGES) is a longitudinal cohort study that began in 2001 with the aim to study genetic and environmental risk factors for chronic diseases. Korea Centers for Disease Control and Prevention constructed a cohort and performed follow-up studies. As a part of KoGES, the community-based cohort recruited participants from a rural area (Ansung) and an urban area (Ansan). The baseline survey was conducted from May 2001 to February 2003 and comprised 10,038 participants aged 40−69 years. Among those participants, 1725 postmenopausal women completed the food frequency questionnaire at baseline, and the speed of sound (SOS, m/s) at their radius and tibia was measured at baseline, 2-year, and 4-year follow-ups. A total of 261 participants were excluded for the following reasons: reported daily energy intake being lower or higher than 2 standard deviations (SDs) (<347.0 kcal, $n = 3$ or >3204.6 kcal, $n = 63$) from the mean value; early menopause prior to 40 years of age ($n = 145$); on insulin therapy ($n = 9$); on hormone therapy ($n = 19$); or on thyroid drug use ($n = 22$). Finally, we used 1464 participants’ data in the final analysis. Informed consent was obtained from all study participants. The study protocol was approved by the Korea Centers for Disease Control and Prevention Institutional Review Board.

2.2. Measurement of covariates

Data on general characteristics, socioeconomic status, and lifestyle were collected using an interviewer-administered questionnaire. Data on baseline age, age at menarche, age at menopause, marital status (married or other), educational level (graduate elementary school, middle or high school, or college graduate), income status (under $1000, $1000−2000, $2000−3,000, or more than $3000 per month), passive smoking status (yes or no), and exercise (yes or no) were collected.

2.3. Anthropometry and SOS measurement

Height and weight were measured to the nearest 0.1 kg and 0.1 cm, respectively, by trained staff using a scale and a wall-mounted extensometer. Body mass index (BMI) was calculated as the weight in kilograms (kg)/height in square meters (m^2). The quantitative ultrasound measurement was used to measure the SOS (Omnisense 7000s, Sunlight Medical Ltd, Petah Tivka, Israel). Measurement sites were at mid-tibia and radius shafts of the nondominant arm and leg. Measurements were performed three times, and the average of the three measurements was used as the final value. Based on the WHO criteria [20], the osteoporosis incident case was that who had normal T-score at baseline and subsequently diagnosed with osteoporosis at primary or secondary follow-up.

2.4. Dietary assessment and food grouping

Usual dietary intake was assessed using a 103-food-item, semiquantitative food frequency questionnaire (SQFFQ) developed for KoGES. The development procedure of SQFFQ was described in detail elsewhere [21]. Briefly, based on the dietary intake data from the KHANES in 1998, the frequency of servings was classified into nine categories (never or seldom, once a month, 2−3 times a month, 1−2 times a week, 3−4 times a week, 5−6 times a week, once a day, twice a day, and 3 times or more a day). The portion size of each food item was classified into three categories: small, medium, and large. For the food items with different seasonal availability, we requested the participants to mark for how long they ate the food among the following four categories: 3, 6, 9, or 12 months. This SQFFQ has been validated using 12-day diet record data of 124 participants [22]. Nutrient intakes were calculated for each participant using the seventh-edition Food Composition Tables of the Korean Nutrition Society [23].

2.5. Statistical analyses

Descriptive statistics such as mean and SD were used to summarize continuous variables; frequencies were expressed as percentages. Chi-square tests were used for examining the relationship between categorical variables. Dietary patterns were derived using factor analysis (principal component) based on the 18 food groups from SQFFQ using PROC FACTOR. To reduce the complexity of the data, 103 food items were categorized into 18 groups. In general, the food grouping was based on food and nutrient composition similarity (Table 1). The factors were rotated via an orthogonal transformation (the varimax rotation) to obtain a simpler structure with greater interpretability. To determine the number of factors, we considered eigenvalues (>1) and inspection of scree plots. We decided to retain three major factors for further analyses. 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. Participants were divided into quintiles by score of each factor, and their general characteristics were compared with first quintile and fifth quintiles. Relative risks (RRs) and 95% confidence intervals (CIs) associated with dietary patterns were estimated using the multivariate Cox proportional hazards regression model. To test for trends, we entered the factor scores into the model as continuous terms. A significant difference was defined as $p < 0.05$. All statistical analyses were performed using SAS 9.1 (SAS institute Inc., Cary, NC, USA).

3. Results

Factor loadings and variances of each dietary pattern are shown in Table 2. Positive loading indicates that the dietary variable is positively associated with the factor and negative loading indicates an inverse association with the factor. Dietary pattern factor 1, labeled as the traditional dietary pattern, included high factor loadings

Table 1. Food grouping used in dietary pattern analysis[a]

Food or food group	Food items included
Rice and rice cake	Cooked well-milled rice, cooked rice with barley, cooked rice with other cereals, parched cereal powder, rice cakes (plain rod shape), other rice cakes
Noodles	Ramen, noodles with soup, chajangmyon, buckwheat vermicelli/buckwheat noodle, dumpling
Bread	Loaf bread, bread with small red beans, other breads, pizza/fast food, cereals
Sugar and fat	Cakes, snacks, candy/chocolate, butter/margarine, coffee, sugar, coffee cream
Potatoes	Potatoes, sweet potatoes, starch vermicelli, starch jelly
Legumes and nuts	Soybean, tofu, stew with soybean pastes, soybean milk, nuts
Kimchi	Kimchi, Korean cabbage, kakduki/small radish kimchi, kimchi with liquid, other kimchi (green onion/kodulbbagi/mustard leaves)
Vegetables	Green pepper, red pepper leaves, spinach, lettuce, perilla leaf, leek/water dropwort, green-yellow vegetables, radish/salted radish Doraji/deoduck (kinds of white root), onion, cabbages, cucumber, bean sprouts, carrot, pumpkin gruel/pumpkin juice, young pumpkin, vegetable juice, bracken/sweet potato stalk, pickles
Mushrooms	Oyster mushroom, other mushrooms
Fruits	Persimmon, dried persimmon, tangerine, muskmelon/melon, banana, pear, apple/apple juice, orange/orange juice, watermelon, peach/plum, strawberry, grape/grape juice, tomato/tomato juice
Meat	Dog meat, chicken/chicken leg/chicken wing, pan-roast pork, pork belly, braised pork, ham/sausage, pan-roast beef ribs, thick beef soup/hard-boiled beef ribs, edible viscera
Eggs	Eggs
Fish and seafood	Sushi, hair tail, eel, yellow croaker, Alaska pollack, mackerel/Pacific saury/Spanish mackerel, dried anchovy, cuttlefish/octopus, tuna, canned, fish paste/crab flavored, crab, clam (small ark shell/little neck clam/clam meat), oyster, shrimp, salt-fermented fish
Seaweeds	Laver, kelp/sea mustard
Milk	Milk
Dairy products	Yoghurt, ice cream, cheese
Coffee and carbonated drink	Coffee, carbonated drinks
Green tea and other drinks	Green tea, sikhae, citron tea

[a] *Food lists were from the Semiquantitative Food Frequency questionnaire.*

Table 2. Factor loadings matrix for the three dietary patterns identified from the Food Frequency questionnaire[a]

	Factor 1 Traditional	Factor 2 Dairy	Factor 3 Western
Rice and rice cake	0.21	−0.47	—
Noodles	—	—	0.56
Bread	—	0.26	0.61
Sugar and fat	—	—	0.60
Potatoes	0.42	—	0.29
Legumes and nuts	0.47	—	—
Kimchi	0.52	−0.30	—
Vegetables	0.71	—	—
Mushrooms	0.32	0.43	—
Fruits	0.51	—	—
Meat	0.43	—	0.35
Eggs	0.40	—	0.29
Fish and seafood	0.56	0.32	0.30
Seaweeds	0.55	0.34	—
Milk	—	0.55	—
Dairy products	—	0.50	
Coffee and carbonated beverages	—	—	0.39
Green tea and other drinks	0.22	0.53	—
Percentage of variance (%)	19.3	8.0	6.6

[a]*Food groups with absolute values <0.20 are not shown for simplicity.*

in rice, kimchi, vegetables, and fruits. The dairy dietary pattern (factor 2) had high factor loadings in milk, dairy products, and green tea. The western dietary pattern (factor 3) was characterized by high factor loadings in noodles, breads, sugar, and fat.

General characteristics of the participants at baseline study are presented in Table 3 according to quintiles of each food pattern. Mean (±SD) values for continuous variables and proportional distributions for categorical variables are presented. In the dairy dietary pattern, the participants in the highest quintile were younger ($p < 0.0001$), had more urban residents ($p < 0.0001$), were in lower socioeconomic status ($p < 0.0001$), exercised more ($p < 0.0001$), had fewer passive smokers ($p = 0.0002$), were taller ($p < 0.0001$), and showed higher SOS values at radius and tibia ($p < 0.0001$) and lower osteoporosis prevalence at radius ($p = 0.031$) and tibia ($p = 0.0002$), compared to those in the lowest quintile. The highest-quintile participants in traditional and western dietary patterns were younger, were more educated, and had higher income than lowest-quintile participants. However, the prevalence of osteoporosis was not different between the highest- and lowest-quintile groups in both dietary patterns.

Incident cases of osteoporosis were 324 (73/1000 person-years) at the radius and 390 (110/1000 person-years) at the tibia. There was an inverse association between dairy dietary pattern and osteoporosis risk (Table 4**)**. Compared with the reference group (*Q*1), the RR for the fifth quintile was 0.63 (95% CI 0.42−0.93, *p* for trend = 0.055) at radius, after adjusting for age, residual area, exercise, and passive smoking, and 0.56 (95% CI 0.35−0.90, *p* for trend = 0.048) at tibia. However, traditional and western dietary patterns increased the risk of osteoporosis incidence. In the traditional dietary pattern, RR for the fifth quintile versus the first quintile was 1.82 at tibia (95% CI 1.12−2.96, *p* for trend = 0.009). In the western dietary pattern, the RR for fifth quintile versus the reference group (*Q*1) was 1.46 at radius (95% CI 1.02−2.10, *p* for trend = 0.043).

4. Discussion

The KoGES is a series of large-population prospective cohort studies conducted from 2001. Among them we used the data of a 4-year follow-up study of community-based cohorts. We identified three distinct dietary patterns among 1464 postmenopausal Korean women and found associations between dietary patterns and risk of osteoporosis. The risk for osteoporosis at radius and tibia decreased in the highest dairy dietary pattern group, whereas it increased in the highest traditional and western dietary pattern groups.

Okubo et al [15] examined the association between BMD and dietary patterns derived from factor analysis in premenopausal Japanese farmwomen aged 40−55 years. The healthy dietary pattern (high intake of green and dark yellow vegetables, mushrooms, fish and shellfish, fruits, and processed fish) positively correlated with BMD, and the western dietary pattern (high intake of fats and oils, meat, and processed meat) tended to be inversely associated with BMD.

In the 4-year follow-up study of 877 Japanese elderly, it was found that a meat pattern decreased the risk of fall-related fracture (HR = 0.36, 95% CI = 0.13−0.94) after adjusting for confounding variables and a vegetable pattern significantly increased the fracture risk (HR = 2.67, 95% CI = 1.03−6.90) [17]. In Scottish postmenopausal women, the “healthy” dietary pattern (high intake of fruits, vegetables, rice, pasta, white meat, oily fish, and dairy products) was associated with decreased bone resorption ($r = 0.081, p < 0.001$). However, the processed foods and snack food patterns were associated with a lower BMD (femoral neck: $r = -0.056$ and $r = -0.044$, respectively; $p < 0.001$) [19].

The dietary pattern in middle-aged Greek women, characterized by high consumption of fish and olive oil and low intake of red meat, was positively associated with lumbar spine BMD [16]. In our previous study, the “healthy and light eating” pattern—higher intake of fruits, vegetables, fish, milk, dairy products, and low-calorie foods—showed a higher SOS and a lower risk for osteoporosis/osteopenia than other dietary patterns [24].

Table 3. Baseline general characteristics by quintile (*Q*) of factor scores for 1464 postmenopausal Korean women[a]

	Traditional			Dairy			Western		
	*Q*1	*Q*5	*p*	*Q*1	*Q*5	*p*	*Q*1	*Q*5	*p*
Mean age (SD), y	59.4 (6.8)	58.2 (6.6)	0.0247	60.3 (6.0)	56.7 (6.8)	<0.0001	60.0 (6.4)	56.9 (6.7)	<0.0001
Mean age of menarche (SD), y	16.4 (1.7)	16.4 (1.9)	0.9540	16.5 (1.7)	16.1 (1.7)	0.0025	16.2 (1.9)	16.3 (2.0)	0.8215
Mean age of menopause (SD), y	48.7 (4.4)	49.0 (3.9)	0.4226	48.8 (4.2)	48.7 (4.1)	0.7269	48.8 (4.2)	48.6 (4.1)	0.7195
Area, *n* (%)			0.8237			<0.0001			0.0001
Rural	228 (49.7)	231 (50.3)		277 (66.3)	141 (33.7)		238 (54.7)	197 (45.3)	
Urban	64 (50.8)	62 (49.2)		15 (9.0)	152 (91.0)		55 (36.7)	95 (63.3)	
Marital status, *n* (%)			0.0450			0.0909			0.1184
Married	226 (48.0)	245 (52.0)		224 (48.1)	242 (51.9)		230 (48.5)	244 (51.5)	
Others (single, widowed)	65 (58.6)	46 (41.4)		67 (56.8)	51 (43.2)		63 (56.8)	48 (43.2)	
Education, *n* (%)			0.0137			<0.0001			<0.0001
Elementary school degree	205 (53.3)	180 (46.7)		231 (65.4)	122 (34.6)		207 (58.6)	146 (41.4)	
Middle or high school degree	76 (43.4)	99 (56.6)		56 (27.9)	145 (72.1)		77 (37.8)	127 (62.3)	
College degree or above	4 (25.0)	12 (75.0)		2 (7.4)	25 (92.6)		7 (31.8)	15 (68.2)	
Income, *n* (%)			0.0303			<0.0001			<0.0001
<$1000	188 (54.8)	155 (45.2)		210 (64.6)	115 (35.4)		202 (59.9)	135 (40.1)	
$1000−2000	62 (45.6)	74 (54.4)		52 (37.7)	86 (62.3)		50 (37.9)	82 (62.1)	
$2000−3000	26 (47.3)	29 (52.7)		14 (22.6)	48 (77.4)		14 (28.6)	35 (71.4)	
>$3000	12 (32.4)	25 (67.6)		8 (18.2)	36 (81.8)		17 (33.3)	34 (66.7)	
Exercise, *n* (%)			0.0124			<0.0001			0.2289
No	242 (52.6)	218 (47.4)		259 (59.3)	178 (40.7)		232 (51.4)	219 (48.6)	
Yes	50 (40.0)	75 (60.0)		33 (22.3)	115 (77.7)		61 (45.5)	73 (54.5)	
Passive smoking, *n* (%)			0.0798			0.0002			0.6932
No	177 (54.5)	148 (45.5)		143 (42.6)	193 (57.4)		170 (50.3)	168 (49.7)	
Yes	103 (46.8)	117 (53.2)		124 (59.1)	86 (41.0)		101 (48.6)	107 (51.4)	
Height, mean (SD), cm	151.5 (5.2)	152.7 (5.4)	0.0047	151.5 (5.2)	154.3 (5.1)	<0.0001	152.3 (5.8)	152.7 (5.3)	0.4299
Weight, mean (SD), kg	56.4 (8.3)	58.4 (8.2)	0.0026	57.9 (8.4)	59.3 (8.8)	0.0335	58.1 (8.6)	58.1 (8.1)	0.9468
BMI, mean (SD), m^2/kg	24.5 (3.3)	25.0 (3.0)	0.0710	25.2 (3.2)	24.9 (3.1)	0.3456	25.0 (3.2)	24.9 (3.0)	0.5759
Radius SOS, mean (SD), m/s	4,143.5 (180.0)	4,138.8 (183.8)	0.7532	4,092.1 (177.5)	4,169.2 (180.1)	<0.0001	4,135.2 (187.1)	4,141.8 (175.4)	0.6609
Tibia SOS, mean (SD), m/s	3,780.8 (168.7)	3,805.2 (158.9)	0.0722	3,770.2 (155.0)	3,848.3 (156.5)	<0.0001	3,796.9 (160.0)	3,813.5 (162.2)	0.2134
Prevalence at radius, *n* (%)			0.5767			0.0305			0.3196
Normal	267 (50.3)	264 (49.7)		253 (48.4)	270 (51.6)		263 (49.4)	269 (50.6)	
Osteoporosis	25 (46.3)	29 (53.7)		39 (62.9)	23 (37.1)		30 (56.6)	23 (43.4)	
Prevalence at tibia, *n* (%)			0.0958			0.0002			0.0855
Normal	198 (47.7)	217 (52.3)		193 (45.2)	234 (54.8)		201 (47.9)	219 (52.1)	
Osteoporosis	94 (55.3)	76 (44.7)		99 (62.7)	59 (37.3)		92 (55.8)	73 (44.2)	

[a] *The factors were standardized continuous variables, and each participant received a score for each factor.* N = *292 in Q1, and* N = *293 in Q5.*

BMI = body mass index; SD = standard deviation; SOS = speed of sound.

Table 4. Relative risk for osteoporosis during the 4-year follow-up by quintile (*Q*) of the three major dietary patterns[a,b]

	*Q*1		*Q*3		*Q*5		
	Case *n* (%)		Case *n* (%)	RR (95% CI)	Case *n* (%)	RR (95% CI)	*p* for trend
Traditional							
Radius	56 (21.0)	Ref	71 (26.8)	1.37 (0.95−1.99)	69 (26.1)	1.46 (1.00−2.13)[c]	0.0674
Tibia	67 (33.8)	Ref	75 (34.9)	1.32 (0.81−2.16)	91 (41.9)	1.82 (1.12−2.96)[c]	0.0095
Dairy							
Radius	85 (33.6)	Ref	56 (21.4)	0.59 (0.41−0.84)[d]	53 (19.6)	0.63 (0.42−0.93)[d]	0.0554
Tibia	83 (43.0)	Ref	70 (34.3)	0.62 (0.40−0.96)[c]	70 (29.9)	0.56 (0.35−0.90)[d]	0.0483
Western							
Radius	64 (24.3)	Ref	76 (25.2)	1.18 (0.83−1.67)	68 (25.3)	1.46 (1.02−2.10)[c]	0.0428
Tibia	60 (30.0)	Ref	93 (39.4)	1.30 (0.82−2.05)	81 (37.0)	1.46 (0.91−2.33)	0.0628

[a]*Participants in* Q1, Q3, *and* Q5 *were not diagnosed with osteoporosis at the baseline;* [b]*Model adjusted for age, residual area, exercise, and passive smoking;* [c]*Significantly different from* Q1*:* $p < 0.05$*;* [d]*Significantly different from* Q1*:* $p < 0.01$.

Dairy food is rich in calcium, and it is generally accepted that this food group increases peak bone mass. Higher dairy product consumption was associated with greater hip BMD, and calcium supplementation protected bone loss in a longitudinal study of Caucasians [25]. In the Women's Health Initiative study, femoral neck BMD and high intake of calcium were positively correlated [26], and calcium- and vitamin D-supplemented individuals had less change in total body BMD and lower risk of hip fracture [4,27]. However, 67.9% of elderly Korean women over 65 years of age consume less calcium than the recommended daily allowance (RDA) [28]. The median calcium intake of our study participants was only 443.6 mg, which is 55% of the 800 mg RDA for elderly Korean women. Therefore, postmenopausal Korean women should try to increase their intake of calcium-rich foods to prevent osteoporosis.

In our study, participants with a dairy dietary pattern also tended to drink more green tea. High consumption of green tea had a protective effect on BMD in Japanese elderly women [29]. Although the underlying mechanism of the effect of green tea on BMD is not clear, flavonoids in green tea are thought to increase BMD. Antioxidants may play an important role in the prevention of oxidative stress-related osteoclastogenesis and bone resorption [30].

Even though food compositions in previous studies were different and direct comparison is difficult to determine the effect of dietary pattern on BMD, the healthy dietary pattern showed beneficial effects for BMD and the western (modified) dietary pattern showed negative effects in these studies. These results consistently demonstrate that women with a high western dietary pattern may have lower bone mass density than those without it [15,17,19]. Energy-dense, nutrient-poor dietary patterns were significantly inversely associated with total body bone mineral content [31].

Tucker et al [14] reported that elderly women with a candy dietary pattern were found to have lower BMD at radius, greater bone loss at the femoral neck, and more hip fractures with a high dietary ratio of animal to vegetable protein intake [32]. Groups that are high in meat intake and low in fruit and vegetable intakes have a negative effect on bone health through increased calcium excretion and bone resorption.

We measured bone characteristics using a quantitative ultrasound method. It measures the SOS value rather than the bone mass density, and therefore the result cannot be directly compared with other reports employing dual-energy X-ray absorptiometry (DEXA). However, Taiwanese people showed a significant linear correlation coefficient ($r = 0.93$) between SOS from ultrasound and BMD from DEXA at a tibia shaft [33]. Therefore, the SOS value can also be used for the bone risk assessment. The follow-up time of 4 years is rather short. Longer follow-up might clear the association between dietary patterns and the incidence of osteoporosis.

In conclusion, the dairy dietary pattern (consisting of high intake of milk, dairy products, and green tea) decreased the risk for osteoporosis and the traditional (high in rice, kimchi, and vegetables) and western (high intake of sugar, fat, and bread) dietary patterns were associated with greater risk for osteoporosis in postmenopausal Korean women. Our results suggest that high intake of milk, dairy products, and green tea is helpful for preventing osteoporosis in postmenopausal Korean women.

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