Relationship of sociodemographic and anthropometric characteristics, and nutrient and food intakes with osteoarthritis prevalence in elderly subjects with controlled dyslipidaemia: a cross-sectional study

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ABSTRACT

Background and Objectives: Several studies have suggested that abnormal levels of serum cholesterol may be a major risk factor for osteoarthritis. However, no studies have been conducted to prevent osteoarthritis under controlled conditions of serum cholesterol. This study aimed to examine the relationship of sociodemographic and anthropometric characteristics, and nutrient and food intakes with osteoarthritis prevalence in Korean elderly subjects with controlled dyslipidaemia. **Methods and Study Design:** This study included 314 subjects aged ≥65 years who were diagnosed and treated for dyslipidaemia (data from the Seventh Korea National Health and Nutrition Examination Survey, 2016). Among them, 108 were also diagnosed with osteoarthritis. Sociodemographic, health, and nutritional data were analysed. **Results:** Osteoarthritis prevalence was higher in females, higher-educated subjects, unmarried subjects, non-smokers, and subjects with high body mass index (p<0.05). After adjusting for the multiple variables, the non-osteoarthritis group had significantly higher vitamin C intake (132±11.0 vs 93.1±11.1 mg/day), fish intake (172±30.0 vs 79.0±12.9 g/day), and seaweed intake (93.7±19.3 vs 38.3±13.4 mg/day) than the osteoarthritis group. Furthermore, the lowest vitamin C, fish, seaweed intake group (quartile 1) each had 3.20, 2.76, 9.93 times higher risk of osteoarthritis than the highest vitamin C, fish, seaweed intake group (quartile 4) (p<0.05). **Conclusions:** Among Korean elderly subjects with controlled dyslipidaemia, those with osteoarthritis had lower vitamin C, fish, seaweed intakes than those without osteoarthritis. Although our results do not prove that low vitamin C, fish, seaweed intakes cause osteoarthritis, such relationship is worth exploring for preventive perspective.

Key Words: dyslipidaemia, osteoarthritis, vitamin C, fish, seaweed

INTRODUCTION

Dyslipidaemia implies an increase in serum cholesterol (total or low-density lipoprotein [LDL]) and triglyceride levels and a decrease in serum high-density lipoprotein [HDL] cholesterol level.[1] Cholesterol in serum is silently accumulated in vascular wall with calcium and cellular debris or in various tissues of human organs under the abnormal level of the cholesterol.[2] Although the dyslipidaemia does not present any particular symptoms, it has been found to be a major risk factor of various diseases including cardiovascular disease, Alzheimer's disease, and chronic kidney disease.[3-5] In addition, some studies have been reporting that the abnormal value of serum cholesterol could be also a significant cause of osteoarthritis (OA).

Two studies suggested that human synovial fluid with normal joint conditions contains low accumulation of cholesterol compared to plasma levels, however, the synovial fluid of patients with inflammatory joint conditions contains higher concentrations of cholesterol compared with synovial fluid of normal individuals.[6-7] And a study reported that it is likely that serum cholesterol draws the oxidation and deposition of lipids in tissues, which results in damage to cartilage similar to atherosclerosis.[8] Atherosclerotic lesion, which causes osteoarthritis, is significantly attributed to the imbalance between cholesterol influx and efflux regulation within the tissue.[9] However, despite much research into the relationship between cholesterol and osteoarthritis to date, there has been no study with preventive perspective on the development of osteoarthritis under controlled conditions of serum cholesterol.

The treatment of dyslipidaemia involves lipid-lowering medications and improvement in lifestyle habits, including diet, exercise, and abstinence from smoking.[10] Statins are first-line drugs for treating dyslipidaemia; they lower cholesterol levels by inhibiting the activity of HMG-CoA reductase, which is involved in cholesterol synthesis in the liver.[11] Additionally, PCSK9 inhibitors reduce LDL in the blood by inducing LDL receptor degradation, and Ezetimibe acts on NPC1L1 protein in small villi to inhibit absorption of cholesterol in food and bile.[12] The control rate of Korean people who take prescribed medication for dyslipidemia is more than 80% according to the 2010-2012 Korea National Health and Nutrition Examination Survey.[13]

On the other hand, Osteoarthritis (OA) refers to the wear and eventual loss of protective cartilage over the ends of bones. Since the disease worsens with aging, it is also called degenerative arthritis. Clinically, the narrowing of the articular space and the formation of osteophytes on radiographs characterise radiographic OA, whereas the experience of pain in the joints is defined as symptomatic OA.[14] Radiographic OA is considered potential symptomatic OA that can cause symptoms at any time, although the symptoms may not be observed at present. Doctor diagnose OA by collectively assessing radiographs and current symptoms.[15]

To treat OA symptoms in patients who are not indicated for surgery, a conservative approach is used, which may involve oral administration of a non-steroidal anti-inflammatory drug (e.g., acetaminophen) or local intra-articular administration of corticosteroids or hyaluronic acid.[16-18] Chronic OA patients experience restrictions in daily living due to knee pain, even with medication, which can also cause adverse effects such as gastrointestinal dysfunction.[19] Therefore, OA patients experiencing drug-related adverse effects need non-medical treatment and improvement in lifestyle habits that allow pain control.[20] In this context,

there have been reports that nutrient intake from specific foods is effective in the prevention and treatment of OA.[21-24] Therefore, it is worth investigating the difference in the living environment between arthritis patients and normal people under controlled conditions of dyslipidemia.

In this study, we used data from the Seventh Korea National Health and Nutrition Examination Survey in 2016 (KNHANES VII-1) to examine the relationship of sociodemographic and anthropometric characteristics, lipid indices, and nutrient and food intakes with OA prevalence in Korean elderly subjects with controlled dyslipidaemia, in an effort to understand the factors that increase OA incidence in these individuals.

MATERIALS AND METHODS

Data source and study subjects

This study used data from the KNHANES VII-1, a national cross-sectional survey conducted by the Korean Ministry of Health and Welfare. The KNHANES VII-1 evaluated subjects using a stratified and multistage probability model designed to represent individuals aged >1 year who were living in Korea. Through distinct surveys, the KNHANES VII-1 collected three types of data: sociodemographic, health, and nutritional data.[25] Health data included alcohol and tobacco use, disease, education, economic status, physical activity, and healthcare organization patronage. Alcohol and tobacco use were examined through self-administered questionnaires, and disease, education, economic status, and healthcare organization patronage were examined by interviews. The nutritional survey was conducted by interview, using the 24-hour recall method to obtain food intake information on the day before the survey. To evaluate nutrient intake, the 2015 Dietary Reference Intakes for Koreans[26] (Ministry of Health and Welfare, 2015) was applied. The health examination survey consisted of direct measurements of parts of the body (anthropometry), blood pressure, pulse, blood lipids, urine, vision, and grip strength. For the blood work, HDL cholesterol was measured, and the values were converted to derive true values, using an equation based on the Lipid Standardization Program by the U.S. Centers for Disease Control and Prevention. More detailed explanations for each survey can be found at http://knhanes.cdc.go.kr.

The KNHANES VII-1 included 10,806 subjects, of whom 8250 participated in at least one of the three data collection methods (i.e., health interview, health examination survey, and nutritional survey), which resulted in a total participation rate of 75.4%. In this study, subjects were excluded if they did not have dyslipidaemia or had missing data regarding dyslipidaemia

and OA. Subjects were also excluded if they were <65 years old or had a daily calorie intake of <500 or >5000 kcal. The final sample size was 314 subjects.

This study was approved by the Institutional Review Board of the Korea Institute of Oriental Medicine (I-1807/005-003).

Diagnosis of dyslipidaemia and osteoarthritis

Subjects with dyslipidaemia were selected as those who responded 'Yes' to the both questions 'Have you been diagnosed with dyslipidaemia by a doctor at a hospital?' and 'Have you treated dyslipidaemia by medications prescribed by a doctor?' in the health interview survey. The 314 subjects aged ≥65 years were diagnosed with dyslipidaemia and treated by doctors in the health examination survey of the KNHANES-VII-1. The dyslipidaemia was diagnosed in individuals who satisfied at least one of the following criteria: 1) LDL ≥130 mg/dL, 2) HDL <40 mg/dL, 3) total cholesterol ≥200 mg/dL, or 4) triglycerides ≥200 mg/dL.[25] Subjects with OA were defined as those who responded 'Yes' to the question 'Have you been diagnosed with osteoarthritis by a doctor at a hospital?' in the health interview survey. Subjects who responded 'No' were considered to not have OA, and subjects who responded 'Not applicable' were excluded from the study. In sum, 108 subjects were diagnosed with OA, and 206 subjects responded 'No' or 'Not applicable'.

Data analysis

To analyse the KNHANES-VII-1 data, we used presets of stratified random sampling (kstrata), population sampling (psu), and weighted samples (wt_itvex), and performed complex sample analyses in SPSS 23.0 software (IBM, Somers, USA). Descriptive statistics for the health interview, health examination, and nutritional surveys were generated, in which frequencies and percentages were calculated for categorical variables and means and standard deviations were calculated for continuous variables. To determine whether differences in sociodemographic, health, and nutrient intake indices existed between subjects diagnosed with dyslipidaemia and those diagnosed with OA, we used the chi-square test for categorical variables and linear regression modelling for continuous variables. To investigate risk factors for OA based on nutrient and food intakes in elderly subjects with dyslipidaemia, we used logistic regression to obtain odds ratios and 95% confidence intervals (CIs). This involved division of the variables of vitamin C, sodium, vegetable, fruit, fish, and seaweed intakes into quartiles. To derive Model 1, data were adjusted for sex and energy intake, and for Model 2,

data were adjusted for sex, energy intake, marital status, education, smoking status, and obesity. Statistical significance was set at $p<0.05$.

RESULTS

The sociodemographic characteristics of subjects aged ≥65 years who were diagnosed with dyslipidaemia with and without OA are shown in Table 1. In subjects with dyslipidaemia, there was a significant difference in OA prevalence between females and males, whereby 43.6% of females had OA compared with 13.5% of males with OA ($p<0.001$). A higher educational level was significantly associated with a lower prevalence of OA; specifically, subjects who completed a high school education or higher showed a significantly lower prevalence of OA than those whose highest academic achievement was middle school or lower ($p=0.038$). Meanwhile, married subjects had a significantly lower prevalence of OA (30.8%) than unmarried subjects (42.9%; $p=0.003$). OA prevalence was 27.3% in current smokers and 59.2% in non-smokers ($p=0.045$). Moreover, OA prevalence was 41.2% in subjects with obesity, which was significantly lower than 28.7% in subjects with a normal body weight ($p=0.046$). We found no significant differences in income level, alcohol consumption, aerobic exercise, hypertension, diabetes, or anaemia between subjects with and without OA ($p>0.05$).

Results of the anthropometric and blood measurements in elderly subjects with dyslipidaemia with and without OA are shown in Table 2. Compared with subjects with OA, subjects without OA were significantly taller ($p<0.001$) and had significantly lower body mass index (BMI) ($p=0.014$). There were no statistically significant differences in blood pressure or lipid measurement between the two groups.

The nutrient intake of subjects with dyslipidaemia with and without OA is shown in Table 3. Before adjusting the data for different variables, iron, potassium, thiamine, and niacin intakes were significantly lower in subjects with OA than in those without OA; however, after adjustment, the differences were not statistically significant. After adjustment for sex, education, marital status, smoking status, and BMI, subjects without OA had higher vitamin C intake than subjects with OA (132±11.0 vs 93.1±11.1 mg/day; $p=0.028$) and higher sodium intake than in those with OA (3295±187 vs 2407±158 mg/day; $p=0.033$).

The food intake by food group in subjects with dyslipidaemia with and without OA is shown in Table 4. Before adjustment for confounding variables, subjects without OA had higher fish intake (172±30.0 vs 79±12.9 g/day; $p=0.005$) and higher seaweed intake (93.7±19.3 vs 38.3±13.4 g/day; $p=0.024$) than subjects with OA. After adjustment for sex,

education, marital status, smoking status, and BMI, subjects without OA had significantly higher fish intake and seaweed intake than those with OA (p = 0.036, 0.042). Additionally, although subjects with OA had lower overall food intake, they showed trends for higher intakes of beans, eggs, and milk; however, before and after adjustment, the differences were not statistically significant.

Results of the logistic regression modelling, which was used to analyse OA risk by nutrient and food intakes in elderly subjects with dyslipidaemia, are presented in Table 5. As represented in Table 1, since the gender ratios of the two groups are significantly different, Model 1, adjusted for gender and energy intake, and Model 2, adjusted for all of the variables that were significantly different in sociodemographic variables, are suggested together. The quartile cut-off intake values for important variables are as follows: vitamin C, 31.2, 76.0, and 160 mg/day; sodium, 1587, 2543, and 3876mg/day; fish, 9.71, 33.3, and 129 g/day; and seaweed, 2.44, 8.65, and 43.8 g/day. Among nutrients, the lowest quartile (Q1) for vitamin C intake demonstrated 2.91 times higher risk of OA than the highest quartile (Q4) for vitamin C intake group, before adjustment for confounding variables (p=0.007, 95% CI: 1.34-6.32). Compared with Q4 for vitamin C intake, Q1 showed 3.29 times higher risk of OA after adjustment for sex and energy intake (p=0.004, 95% CI: 1.46-7.40) and 3.20 times higher risk of OA after adjustment for multiple variables (p=0.009, 95% CI: 1.34-7.65). For sodium intake, Q1 had 2.34 times higher risk of OA than Q4, before adjustment for confounding variables (p=0.041, 95% CI: 1.04-5.29); however, there was no significant difference between the groups after adjustment. For fish intake, compared with Q4, the Q1, Q2, and Q3 had 2.49 times higher risk (p=0.026, 95% CI: 1.12-5.15), 2.32 times higher risk (p=0.067, 95% CI: 0.94-5.72), and 2.90 times higher risk (p=0.015, 95% CI: 1.23-6.80) of OA, before adjustment, respectively. After adjustment for sex and energy intake, Q1, Q2, and Q3 for fish intake had 2.68 times higher risk (p=0.023, 95% CI: 1.15-6.24), 2.79 times higher risk (p=0.035, 95% CI: 1.08-7.24), and 3.86 higher risk (p=0.005, 95% CI: 1.53-9.75) of OA, respectively; after adjustment for multiple variables, Q1, Q2, and Q3 for fish intake had 2.76 times higher risk (p=0.023, 95% CI: 1.15-6.62), 2.56 times higher risk (p=0.071, 95% CI: 0.92-7.12), and 4.27 times higher risk (p=0.003, 95% CI: 1.68-10.8) of OA, respectively. For seaweed intake, compared with Q4, only a significant difference was found with Q3, before adjustment for confounding variables (p=0.023, 95% CI: 1.24-17.5); however, after adjustment for sex and energy intake, Q1 had 4.35 times higher risk of OA (p=0.041, 95% CI: 1.06-17.8) while Q3 had 5.10 times higher risk of OA (p=0.016, 95% CI: 1.37-18.9), and both results were significant. After adjustment for multiple variables, Q1 for seaweed intake

had 9.93 times higher risk of OA (p=0.010, 95% CI: 1.75-56.4) whereas Q3 had 6.95 higher risk of OA (p=0.008, 95% CI: 1.69-28.7).

DISCUSSION

This study used the KNHANES VII-1 data to examine the relationship of sociodemographic, health, and nutritional variables with the prevalence of OA in Korean subjects with dyslipidaemia, with a focus on whether these factors are associated with an increase in OA morbidity in the subjects. The ultimate goal of the study was to promote discussion about measures to prevent and treat OA.

In terms of sociodemographic characteristics, our results suggest that elderly subjects with dyslipidaemia were prone to OA based on differences in sex, education, marital status, smoking status, and obesity. Although this study was cross-sectional (i.e., across age groups), the results were consistent with those of a Framingham study of a randomly selected population of elderly patients aged ≥65 years,[27] which found that OA risk was 1.8 times higher in females than in males (95% CI: 1.1-3.1), 1.6 times higher in individuals with high obesity than in those with low obesity (95% CI: 1.2-2.2), and 0.4 times lower in smokers than in non-smokers (95% CI: 0.2-0.8). In addition, and consistent with our results, a systematic review on OA risk factors in the elderly found that the risk was 2.63 times higher in individuals with high obesity than in those with low obesity (95% CI: 2.28-3.05) and 1.84 times higher in females than in males (95% CI: 1.32-2.55) and that smoking had a moderate positive effect on OA prevalence.[28]

We also observed a significant difference in height between subjects with OA and those without OA, but given that the proportion of females was higher in the OA group, it is difficult to conclude whether this difference in height is a meaningful result. BMI was significantly higher in subjects with OA than in subjects without OA, which is consistent with the fact that obesity causes a heavy load on joints[29] and with the results of several studies on the topic.[30-32]

We observed significantly higher vitamin C intake in elderly subjects without OA than in those with OA. According to the new 1999 revised guidelines of the Korean Food and Nutrition Board, the recommended dietary allowance for vitamin C is 120 mg/day;[33] therefore, the vitamin C intake of elderly subjects without OA met the recommended amount. In addition, the quartile with the lowest vitamin C intake (Q1) had a substantially higher risk of OA, before adjustment for confounding variables, than the quartile with the highest vitamin C intake (Q4), and had an even higher risk after adjustment for multiple variables. Moreover,

the vitamin C intake for Q1 was fivefold lower than that for Q4, which is consistent with the fact that there is a large variation in the intake of vitamins depending on the level of income and education in studies of Korean people.[34] Vitamin C has a powerful antioxidant effect on the human body, and with greater intake and increased level in the blood, vitamin C is effective at preventing inflammatory disease.[35,36] At a vitamin C intake of 100-200 mg/day, an increase in intake causes a rapid increase in plasma vitamin C concentration, as illustrated along a sigmoid curve; plasma vitamin C is saturated at an intake of 400-500 mg/day.[37,38] This suggests that compared with the group without OA, the group with OA would have had five times the vitamin C plasma concentration, which would most likely result in a greater antioxidant effect and prevention of inflammatory disease. Thus, in the elderly subjects treating dyslipidaemia in our study, an increase in plasma vitamin C concentration in the group with the highest vitamin C intake is considered to have been a factor that reduced OA risk in that group.

Regarding the analysis of intake by food group, fish intake was lower in the group with OA than in the group without OA, before and after adjustment for confounding variables. This has been attributed to the large amounts of unsaturated fatty acids found in fish and their positive effect on calcium metabolism. Unsaturated fatty acid deficiency results in the loss of calcium bone tissue and ultimately leads to bone demineralization,[39] which can increase the chances of an elderly to develop OA.[40] Moreover, research has shown that the unsaturated fatty acids in fish are effective at preventing OA via their effects on lipid concentration in the bone marrow.[41] When we categorized fish intake into quartiles and compared OA risk, relative to the highest fish intake group (Q4), the groups with lower fish intake—Q3, Q2, and Q1—had a higher OA risk, before and after adjustment for confounding variables. Additionally, The Korean fish intake varies between 6-7 times more depending on income and education level, which is consistent with the results of our study.[42] However, in-depth research on the effects of fish intake on circulating unsaturated fatty acid concentration in the blood and related prevention of inflammatory disease has yet to be carried out.

In our study, seaweed intake was significantly higher in subjects without OA than in subjects with OA, before adjustment for confounding variables, and this difference was significant after adjustment. OA risk was significantly lower in Q4 for seaweed intake than in Q1 and Q3 after multiple adjustment. In a clinical trial in Australia, osteoarthritis test scores were significantly lower in osteoarthritis patients who took seaweed extract.[43] Moreover, the arthritis test score was reduced by 18% in the group taking 100 mg of seaweed extract per day and by 52% in the group taking 1000 mg per day, which is similar to the result of our study in

that the efficacy for osteoarthritis is proportional to dose. The seaweed intake amount is also largely different between Q1 and Q4, which may be also presumed to be socioeconomic differences.

This study has some limitations. First, because it was a cross-sectional study, the significant results do not prove causation in terms of susceptibility to OA. Second, data on the subjects' regular food and nutrient intakes were collected by surveying for 2 weekdays and 1 weekend day using the 24-hour recall method. Because surveying only consisted of 3 days, the data are not perfectly representative of the subjects' actual daily food and nutrient intakes; in other words, there was some degree of error in our measures. Lastly, although nutrient intake was quantified using the 2015 Dietary Reference Intakes for Koreans (Ministry of Health and Welfare, 2015),[26] the generated values may vary with actual values.

The strength of this study is that we restricted the study to elderly subjects who were under controlled dyslipidaemia. Despite the relationship between serum cholesterol and OA, there has been limited research on the risks of OA with controlled serum cholesterol. Our study was conducted based on the proposition that individuals with dyslipidaemia, but without OA, may be able to overcome the negative effects of dyslipidaemia based on their lifestyle habits. Therefore, in addition to the analysis of these diseases in relation to food and nutrient intakes, we examined other risk factors including sex, educational level, marital status, social economic status and BMI.

We also adjusted the data for sociodemographic and anthropometric factors that showed significant effects. Even though the significant results in this study do not prove the causative variables of OA in elderly subjects with controlled dyslipidaemia, the differences we have discovered can be worth exploring in further studies.

Conclusion

In this study, we used data from the KNHANES-VII-1 to examine the relationship of sociodemographic, health, and nutritional variables with the prevalence of OA in Korean elderly subjects with controlled dyslipidaemia, with a focus on factors that may affect the OA. We founded that among elderly subjects with controlled dyslipidaemia, those with OA had lower vitamin C, fish, and seaweed intake than those without OA. In the OA risk analysis, after adjustment for multiple variables, the quartile with the lowest vitamin C, fish, seaweed intake each had 3.20, 2.76, 9.93 times higher risk of OA than the quartile with the highest vitamin C, fish, seaweed intake. Future studies are required to further investigate these specific differences in nutrient and food intakes with preventive perspective.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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Table 1. Sociodemographic and health-related characteristics of subjects (n=314)

	Elderly with dyslipidaemia				Total (n)	χ^2	*p*-value
	Without osteoarthritis	%	With osteoarthritis	%			
Sex							
Male	83	86.5	13	13.5	96	25.4	<0.001
Female	123	56.4	95	43.6	218		
Household income							
Very low	39	65.0	21	35.0	60	5.00	0.278
Low	47	58.8	33	41.3	80		
Moderate	51	65.4	27	34.6	78		
High	64	70.3	27	29.7	91		
Education							
Elementary school	100	60.2	66	39.8	166	11.6	0.038
Middle school	35	55.6	28	44.4	63		
High school	33	78.6	9	21.4	42		
Undergraduate	29	85.3	5	14.7	34		
Marital status							
Married	148	69.2	66	30.8	214	12.6	0.003
Single	56	57.1	42	42.9	98		
Alcohol consumption							
Yes	51	57.3	38	42.7	89	0.884	0.378
No	151	68.6	69	31.4	220		
Smoking status							
Current	16	72.7	6	27.3	22	8.33	0.045
Past	57	81.4	13	18.6	70		
Never	129	59.4	88	40.6	217		
Physical activity							
Yes	121	62.4	73	37.6	194	0.699	0.493
No	73	67.6	35	32.4	108		
Hypertension							
Normal	27	81.8	6	18.2	33	4.15	0.231
Prehypertension	32	60.4	21	39.6	53		
Hypertension	147	64.5	81	35.5	228		
Subjective Obesity							
Yes	122	71.3	49	28.7	171	5.18	0.046
No	84	58.7	59	41.3	143		
Normal	76	66.1	39	33.9	115	2.71	0.314
Diabetes mellitus							
Impaired fasting glucose	45	59.2	31	40.8	76		
Diabetes	77	69.4	34	30.6	111		
Anaemia							
Yes	182	65.9	94	34.1	276	0.559	0.503
No	23	63.9	13	36.1	36		

Table 2. Anthropometric and health-related characteristics of subjects (n=314)

	Elderly with dyslipidaemia				
	Without osteoarthritis (mean±SD)	95% CI	With osteoarthritis (mean±SD)	95% CI	*p*-value
Age (years)	71.0±0.4	70.3-71.8	71.4±0.4	70.6-72.3	0.467
Height (cm)	159±0.7	157-160	155±0.7	153-156	<0.001
Weight (kg)	61.8±0.7	60.4-63.1	61±0.9	59.3-62.7	0.511
Waist circumference (cm)	86.6±0.6	85.5-87.8	87.3±0.8	85.8-88.8	0.480
Body mass index (kg/m2)	24.5±0.2	24.1-24.9	25.4±0.3	24.9-26.0	0.014
Systolic blood pressure (mmHg)	127±1.3	125-130	129±1.6	126-132	0.405
Diastolic blood pressure (mmHg)	72.4±0.8	70.8-73.9	71.9±0.9	70.1-73.7	0.707
Total cholesterol	174±2.5	169-179	171±3.5	164-178	0.536
HDL-cholesterol converted by formula	48.2±1.1	46.0-50.4	49.2±1.0	47.3-51.2	0.487
Triglycerides	151±7.7	136-166	143±6.8	130-157	0.446
LDL-cholesterol tested directly	103±3.7	95.7-111	96.6±6.9	82.6-111	0.423

CI: confidence interval; HDL: high-density lipoprotein; LDL: low-density lipoprotein; SD: standard deviation.

Table 3. Daily nutrient intake of subjects (n = 314)

	Dyslipidemia				*p*-value	
	Non-osteoarthritis (Mean±SD)	95% CI	Osteoarthritis (Mean±SD)	95% CI	Unadjusted	Adjusted†
Food intake (g)	1407±53.8	1300-1514	1154±63.1	1029-1279	0.002	0.028
Vitamin C (mg)	132±11.0	111-154	93.1±11.1	71.1-115	0.014	0.028
Sodium (mg)	3295±187	2925-3665	2407±158	2093-2720	<0.001	0.033
Water intake (g)	1015±47.6	922-1110	801±57.3	687-914	0.003	0.034
Saturated fatty acid (g)	7.1±0.4	6.2-7.9	7.3±1	5.3-9.2	0.845	0.093
Fat (g)	26.9±1.7	23.7-30.2	26±2.6	20.9-31.2	0.763	0.135
Polyunsaturated fatty acid (g)	7.6±0.5	6.6-8.6	7.1±0.6	5.9-8.3	0.524	0.168
Protein (g)	53.6±2	49.6-57.5	50±2.1	45.9-54.1	0.185	0.188
n-3 fatty acid (g)	1.4±0.1	1.2-1.7	1.3±0.1	1.1-1.6	0.449	0.210
n-6 fatty acid (g)	6.2±0.4	5.4-7	5.8±0.5	4.7-6.8	0.545	0.240
Monounsturated fatty acid (g)	8±0.6	6.9-9.1	7.6±0.9	5.7-9.5	0.717	0.244
Calcium (mg)	408±16.6	375-441	388±27.1	334-442	0.511	0.283
Vitamin A (μgRE)	569±39.2	491-646	570±62.5	447-694	0.985	0.301
Niacin (mg)	12.7±0.5	11.7-13.6	11±0.5	10.1-12	0.017	0.320
Cholesterol (mg)	154±13	128-179	150±20.2	110-190	0.872	0.356
Rivoflavin (mg)	1.1±0	1-1.2	1±0.1	0.8-1.3	0.882	0.377
Thiamin (mg)	1.7±0.1	1.6-1.8	1.5±0.1	1.4-1.6	0.013	0.380
Carotene (μg)	3008±222	2568-3448	2990±371	2257-3724	0.968	0.420
Vitamin A (μgRAE)	314±20.8	273-355	302±31.8	239-365	0.755	0.427
Dietary fiber (g)	23.9±0.9	22-25.7	22.7±1.4	20-25.5	0.501	0.428
Potassium (mg)	2873±125	2624-3121	2541±139	2266-2816	0.07	0.520
Carbohydrate (g)	289±7.4	274-304	262±10.6	241-283	0.043	0.534
Iron (mg)	16.5±0.8	15.0-18.1	14.0±0.9	12.3-15.8	0.037	0.585
Energy intake (Kcal)	1655±43.1	1570-1741	1492±57.6	1378-1606	0.023	0.877
Retinol (μg)	63.1±6.2	50.8-75.4	52.7±8.7	35.5-69.9	0.294	0.978

CI: confidence interval; SD: standard deviation; RE: retinol equivalents; RAE: retinol activity equivalents.
†Adjusted for sex, education, marriage, smoking, body mass index, and energy intake.

Table 4. Daily food group intake of subjects (n=314)

Food group[†]	Dyslipidemia				*p*-value	
	Non-osteoarthritis (Mean±SD)	95% CI	Osteoarthritis (Mean±SD)	95% CI	Unadjusted	Adjusted[‡]
Fish (g)	172±30	113-232	79±12.9	53.4-105	0.005	0.036
Seaweeds (g)	93.7±19.3	55.2-132	38.3±13.4	11.7-65.0	0.024	0.042
Milk (g)	167±13.5	140-194	236±50.7	134-338	0.154	0.082
Potatoes (g)	98.4±16	66.4-130	74.2±16.2	41.8-107	0.287	0.134
Beans (g)	37.6±5.2	27.4-47.8	47.6±7.9	32-63.2	0.293	0.166
Eggs (g)	42.4±3.4	35.7-49.2	49.5±8.3	32.8-66.1	0.418	0.328
Fruits (g)	340±26	288-391	281±31.6	218-343	0.158	0.396
Oil (g)	6.2±0.5	5.1-7.2	4.9±0.6	3.8-6.0	0.103	0.411
Meat (g)	92.7±15.1	62.7-123	85±14.1	56.9-113	0.719	0.534
Nuts (g)	9.5±2.3	4.9-14.1	5.6±1.3	2.9-8.2	0.163	0.555
Vegetables (g)	341±18.3	305-377	300±26.4	248-353	0.185	0.567
Cereals (g)	269±8.6	252-287	242± 12.8	217-268	0.075	0.658
Sugar (g)	11.4±1.4	8.6-14.2	11.2±1.8	7.5-14.8	0.918	0.703
Mushrooms (g)	19.6±6.3	6.8-32.4	9.5±2.3	4.8-14.2	0.158	0.711

[†]Intake of food and their products.
[‡]Adjusted sex, education, social economic status, marriage, smoking, body mass index, and energy.

Table 5. Risk analysis of osteoarthritis (n=314)

Daily Intake amount	Unadjusted			Adjusted model 1[†]			Adjusted model 2[‡]		
	OR	95% CI Lower-Upper	Sig.	OR	95% CI Lower-Upper	Sig.	OR	95% CI Lower-Upper	Sig.
Vitamin C									
Q1[‡](less than 31.2)	2.91	1.34-6.32	0.007	3.29	1.46-7.40	0.004	3.20	1.34-7.65	0.009
Q2 (31.2-76.0)	1.79	0.79-4.06	0.165	1.95	0.84-4.57	0.121	1.76	0.70-4.45	0.227
Q3 (76.0-160)	1.78	0.79-4.03	0.164	1.70	0.73-3.97	0.219	1.67	0.70-3.96	0.243
Q4 (more than 160)	1.00			1.00			1.00		
Sodium									
Q1 (less than 1587)	2.34	1.04-5.29	0.041	1.45	0.54-3.89	0.456	1.79	0.64-4.99	0.265
Q2 (1587-2543)	2.10	0.87-5.06	0.098	1.51	0.59-3.87	0.392	1.67	0.65-4.28	0.285
Q3 (2543-3876)	1.69	0.73-3.94	0.219	1.41	0.59-3.37	0.433	1.85	0.77-4.41	0.164
Q4 (more than 3876)	1.00			1.00			1.00		
Fish									
Q1 (less than 9.71)	2.49	1.12-5.51	0.026	2.68	1.15-6.24	0.023	2.76	1.15-6.62	0.023
Q2 (9.71-33.3)	2.32	0.94-5.73	0.067	2.79	1.08-7.24	0.035	2.56	0.92-7.12	0.071
Q3 (33.3-129)	2.90	1.23-6.80	0.015	3.86	1.53-9.75	0.005	4.27	1.68-10.8	0.003
Q4 (more than 129)	1.00			1.00			1.00		
Seaweeds									
Q1 (less than 2.44)	3.63	0.90-14.5	0.069	4.35	1.06-17.8	0.041	9.93	1.75-56.4	0.010
Q2 (2.44-8.65)	2.43	0.58-10.3	0.222	3.58	0.79-16.1	0.096	3.77	0.84-17.0	0.083
Q3 (8.65-43.8)	4.66	1.24-17.5	0.023	5.10	1.37-18.9	0.016	6.95	1.69-28.7	0.008
Q4 (more than 43.8)	1.00			1.00			1.00		

OR: Odds ratio; Q: Quartile.
[†]Adjusted model 1: Adjusted sex, energy.
[‡]Adjusted model 2: Adjusted sex, education, social economic status, marriage, smoking, body mass index, and energy.