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A Study of Korean Elderly on the Preference of Food according to Body Composition

Chorong Oh[1], Min-Sun Kim[2] and Jae-Kyung No[3,¶]

[1]Dept. of Nutrition and Health Care, Kyungsung University, Busan 608-736, Korea
[2]Dept. of Pharmacy, College of Pharmacy, Sunchon National University, Sunchon 540-742, Korea
[3]Dept. of Nutrition and Health Care. Kyungsung University, Busan 608-736, Korea

ABSTRACT: Present study classified body composition to 4 groups categorized as sarcopenic obesity (SO), sarcopenic nonobesity (SNO), nonsarcopenic obesity (NSO), and nonsarcopenic nonobesity (NSNO) and then was performed to investigate that body composition associated with food consumption frequency as well as MS in individual aged 60 years or older. Body mass index and an appendicular skeletal muscle mass (ASM) divided by weight (Wt) of < 1 standard deviation (SD) below the sex-specific mean for young adults were used to define obesity and sarcopenia. A total of 1,433 subjects (658 male and 775 females) 60 years or older from the fifth Korea National Health and Nutritional Examination Survey 2010 participated in this study. One of the interesting findings was that the association of the prevalence of MS with body composition was higher in women than man. Other finding was that there were different food frequency and food preference according to 4 different groups between men and women. In addition, men are much more influenced by food than women. In conclusion, body composition changes were more related with food frequency in elderly men (60 years or older) than women. Women had a higher prevalence of MS than men, suggesting early nutritional intervention in elderly women may help them prevent body composition changes.

Keywords: Elderly, Body Composition, Obesity, Nutrient, Human

Abbreviations: KNHANES; Korean National Health and Nutrition Examinations Survey, SO; Sarcopenic Obesity, SNO; sarcopenic nonobesity, NSO; nonsarcopenic obesity, NSNO; nonsarcopenic nonobesity, BMI; Body Mass Index

INTRODUCTION

Significant changing distributions of body composition with age, like a progressive loss of muscle mass and an increase of fat mass were occurred (Baumgartner *et al*., 1998). Many previous studies supported that age related body composition change (SO; sarcopenic obesity, SNO; sarcopenic nonobesity, NSO; non-sarcopenic obesity; NSNO; nonsarcopenic nonobesity) resulted in chronic disease (Li & Heber, 2012), even though, so far there is a lack of understanding of the healthy body composition criteria and it didn't also well known to define and to prevent. Among the variety causes, multiple influences of nutrient imbalance is associated with, ultimately, the age-related chronic diseases caused by body composition change and constantly increasing chronic inflammation (Chung, Kim, Kim, Choi, & Yu, 2002). According to increased chronic inflammation, cytokines from adipose tissue induced muscle loss and muscle strength weakness, simultaneously, lead to increased fat.

For that reason, recently nutritional research has considered to reduce body composition changes through inhibiting inflammation-related factors. There are many dietary factors contributing to chronic disease among adults, specially fruits and vegetables as an anti-inflammatory nutrients rich in vitamin A, B, C, E and K, and affluent minerals, phytochemical, and other food groups also has various nutrients factors. WHO (World Health Organization) emphasis diet rich in fresh and varied fruit and vegetable intake as well as a minimum daily food consumption goal as part of a healthy diet in many countries in order to protect against chronic diseases to their general population. In Korea, there is guidelines that the Dietary Reference Intakes for Koreans (KDRIs) recommend 3 servings of grains, 5 servings of vegetables, 4 servings of meats and beans, 2 servings of dairy and milk products, 2 servings of fruits and 4 servings of fat and sweets per day the to promote optimum health in Koreans adults (Paik, 2008).

To know the consumption pattern and preference of food along with appropriate quantity are so important. Recently MS (Metabolic syndrome) which is defined as having abnormality with three or more of the following five criteria: 1) waist cir-

§ Corresponding Author: Jae-Kyung No, Ph.D., Dept. of Nutrition and Health Care, Kyungsung University, 309, Suyeong-ro, Nam-gu, Busan 608-736, Korea, Tel. +82-51-663-4651, Fax. +82-611-2447, E-mail: jkno3@ks.ac.kr
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cumference, 2) hypertriglyceridemia, 3) HDL cholesterol, 4) blood pressure, 5) fasting plasma glucose is emerging as major public health problems in Korea and dietary intervention on MS provides greatest opportunity to intervene in earlier stages before the onset of chronic diseases (Ford, 2005). Dietary patterns, such as Mediterranean diet and Dietary Approaches to Stop Hypertension (DASH) have showed the reduction effect on the risk of MS (Kastorini *et al*., 2011). Because those dietary patterns have high fruits and vegetables intake among food compositions. Although the relations of diet and MS were investigated in many studies, study on the relation with body composition and food frequency by gender was few. A beneficial effect of various food groups on MS may be expected by maintains of body composition in the elderly. But the mechanisms of nutritional components in all food groups are quite complex, not well understood yet, because it works acting in concert. In the elderly, food preference changes due to reduced appetite, altered taste and smell sensation, slower gastric function and altered hormonal responses so the study of food consumption frequency are needed. Furthermore the study of food consumption frequency by FFQ will be a useful data for creating various dishes with adequate nutrition and educational data for the elderly as well.

Accordingly, this study examined MS and the role of nutrients in preserving muscle mass and decreasing visceral fat by food frequency questionnaire (FFQ) according to sarcopenic obesity (SO), sarcopenic nonobesity (SNO), nonsarcopenic obesity (NSO), and nonsarcopenic nonobesity (NSNO) by gender among a representative elderly population, aged 60 years or older, who participated in the survey by the Korea National Health and Nutrition Examination Survey V (NHANES V). Finally, this study will provide interventional data for successful aging of the aging population.

METHODS

Study Sample

This study was based on data obtained from the KNHANES 2010, a nationally representative survey conducted by the Korean Ministry of Health and Welfare. The survey's target population included non-institutionalized Korean civilians. Sampling units consisted of households selected through a stratified, multistage, probability-sampling design based on geographic area, sex, and age group using household registries (Kim, Y. & Lee, 2012). KNHANES 2010 consisted of four components: a health interview survey, a health behaviors survey, a health examination survey, and a nutrition survey. These surveys were completed by 8,473 (77.5% of the total target population of 10,938) participants in 2010 (Y. Kim & Lee, 2012). A total of 1,433 individuals (658 men, 775 women) 60 years or older who participated in the health examination and nutrition surveys were included in this study. We excluded those who had not performed DXA, did not have data on oral daily nutrition intake, and had not undergone blood tests. This study was performed as next study of "the study of the relationship of sarcopenic obesity and nutritional risk factor in Korean" (Oh, C, 2014) so most of methods were same.

Definition of Appendicular Skeletal Muscle Mass and Obesity for Group Classification

Appendicular skeletal muscle mass (ASM, kg) was defined as the sum of lean soft tissue mass in the arms and legs following the method of Heymsfield *et al.,* (Heymsfield *et al*., 1990). We calculated ASM as a percentage of body weight (Wt), modifying methods published by Janssen *et al.* (Janssen, Heymsfield, & Ross, 2002) and Lim *et al.* (Lim *et al*., 2010), respectively. Sarcopenia was defined as an ASM divided by Wt (ASM/Wt) that was less than 1 standard deviation (SD) below the mean of a reference sample of 1,746 healthy adults age 20~39 years (748 men, 998 women) from the fifth KNHANES database. The cutoff value (32.4 ± 2.8 for men, 25.7 ± 2.3 for women) for sarcopenia was 44% for men and 52% for women. Obesity classification was determined according to the BMI criteria established by the Obesity Task Force (IOTF), World Health Organization (WHO) and the Korean Society for the Study of Obesity (KSSO) (Oh, 2011). Subjects were further classified into four groups based on the combination of sarcopenia and obesity definitions above: sarcopenic obese (SO), sarcopenic nonobese (SNO), nonsarcopenic obese (NSO), and nonsarcopenic nonobese (NSNO).

Definition of Metabolic Syndrome

We employed the original criteria for metabolic syndrome proposed by the National Cholesterol Education Program (NCEP) Adult Treatment Panel III. However, we used ethnicity-specific WC values, as proposed by the International Diabetes Federation (IDF) (Song & Joung, 2012). Obesity was assessed based on the BMI cut-offs proposed by the World Health Organization (WHO). Metabolic syndrome were defined as having three or more of the following five criteria: Abdominal obesity was defined as waist circumference >90 cm in males and >80 cm in females; hypertriglyceridemia as triglycerides ≥150 mg/dL; low HDL cholesterol as <40 mg/dL in males and <50 mg/dL in females; hypertension as blood pressure ≥130/85 mmHg; and hyperglycemia as fasting plasma glucose ≥110 mg/dL (Song & Joung, 2012).

Dietary Information

Dietary information was obtained from food frequency questionnaires (FFQ) in KNHANES data sets. Depending on the food group classification of the National Health and Nutrition Examination Survey Guide, food groups divided to 5 groups such as cereals, legumes/potatoes, meat/eggs, fish/shellfishes, fruits, vegetables, seaweeds. The frequency of food intake were scored to based that 'once a week' is one point and 'almost not eat' was considered as zero point.

Statistical Analyses

All statistical analyses were conducted using SPSS version 20.0 (SPSS, IBM, NY, USA). The level of significance was set at $p<0.1$ The generalized linear model was used to compare anthropometric measurements, biochemical tests, and nutrient intakes among the four groups. Data are presented as means ± SE. All models were adjusted for age, sex.

RESULTS

Body composition changes can be a marker of aging and related with chronic diseases. In aging process, there are typically

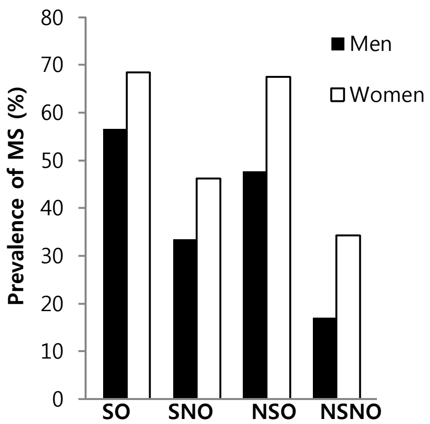

Fig. 1. Comparisons of prevalence of MS among SO, SNO, NSO, and NSNO groups (male N=685, female N=775). MS; metabolic syndrome, SO; sarcopenic obesity, SNO; sarcopenic nonobesity, NSO; nonsarcopenic obesity, NSNO; nonsarcopenic nonobesity. All models were adjusted for age, sex.

changes with significant body composition like a muscle mass loss and an increased fat mass. Fig. 1 showed the prevalence of MS according to 4 different body composition groups by gender. The prevalence of MS was higher in the obese group than non-obese group. There are significantly different between body composition and MS and especially in sarcopenic obesity group, it trend to high in both gender. The MS prevalence in women was higher than man.

Table 1-a and Table 1-b showed the food frequency and food preference according to 4 different groups. There were significantly different in food groups. For men, there were significant different with frequency of food group such as rice (p=0.099) in cereals group, pork (p=0.020), egg(p=0.045) in meat/eggs group, yogurt(p=0.066) in milk/diary-products, persimmon (p=0.099), water melon (p=0.001), melon (p=0.034), grape (p=0.056), banana (p=0.015) in fruit group, radish leave (p=0.045), tomato (p=0.080), mushroom (p=0.055) in vegetables group. For women, there were significant different with frequency of food group such as soybean curd (p=0.000) in legumes/potatoes group, pollack (p=0.029) in fish group, melon (p=0.001), strawberry (p=0.000), orange (p=0.007) in fruit group, carrot (p=0.047) in vegetables group. This indicated that food consumption frequency by food groups among 4 different body compositions was more related with men than women in the elderly.

It is important to recognize malnutrition problem early among the elderly so we investigated nutrient intake status through comparing with the daily intake of protein, calcium, and vitamin C and RDA and showed in Fig. 2. For men, there were significant differences in protein, calcium, except vitamin C, on the other hand, for women, there were no significantly different in all.

DISCUSSION

Body composition changes that result in lots of chronic diseases are noticeable in the elderly and could be a warning marker. It is related with many other internal and external influences such as malnutrition, the reduced function of absorption, and metabolism of food induce inflammation and insulin resistance (Candow *et al*., 2012). In the elderly, especially, food preference changes due to reduced appetite, altered taste and smell sensation, slower gastric functions and altered dramatically hormonal responses, so the study of food consumption frequency are necessary and meaningful. Therefore, present study classified body composition to 4 groups and then was performed to investigate that body composition associated with food consumption frequency as well as MS in individual aged 60 years or older. One of the interesting findings in this study was that the association of the prevalence of MS with body composition was higher in women than man. Previous our research by Oh (Oh C, 2014) showed that SO, in particular, was closely associated with insulin resistance and inflammation-related factors in both men and women, however, vitamin D and HDL were in abnormal ranges, respectively, in all of the women groups. Other research supported that there are gender differences in

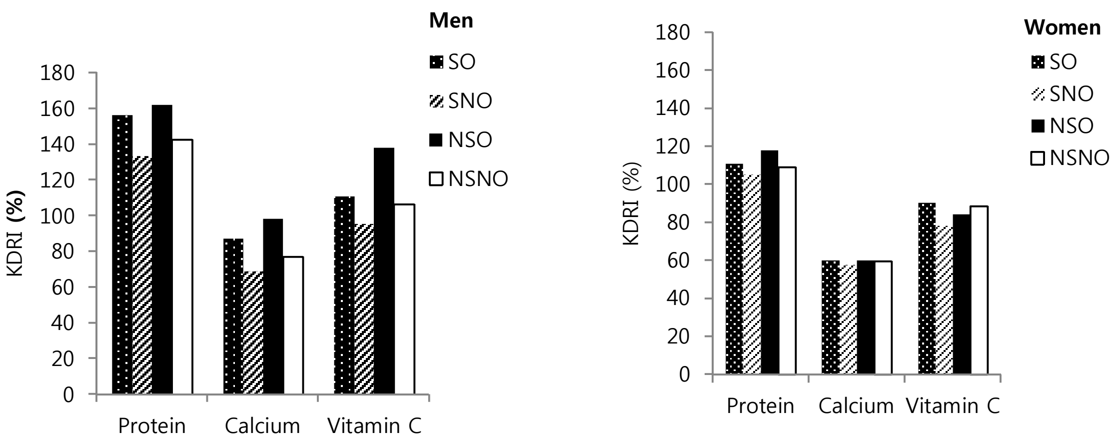

Fig. 2. Assessment of nutrient intakes and nutrient intake as % KDRI among SO, SNO, NSO, and NSNO (male N=685, female N=775). There were significant difference protein KDRI (%), calcium KDRI (%) according to body composition in men (p=0.041, 0.002). SO; sarcopenic obesity, SNO; sarcopenic nonobesity, NSO; nonsarcopenic obesity, NSNO; nonsarcopenic nonobesity, KDRI; Korean dietary reference intakes. All models were adjusted for age, sex.

Table 1-a. Food consumption frequency among SO, SNO, NSO, and NSNO (N=628, men)

N		SO	SNO	NSO	NSNO	p^a
		129 (19.9)[b]	161 (22.5)	69 (11.1)	299 (46.5)	
Cereals	Rice	19.49±0.39[c]	19.27±0.30	19.55±0.41	20.02±0.16	0.099
	Barley	12.58±0.85	12.29±0.90	11.86±1.26	12.59±0.67	0.944
	Ramyeon	0.53±0.07	0.62±0.07	0.72±0.14	0.63±0.05	0.540
	Noodle	0.60±0.10	0.57±0.06	0.63±0.10	0.57±0.05	0.932
	Bread	0.63±0.13	0.52±0.06	0.60±0.14	0.62±0.07	0.722
	Rice cake	0.46±0.11	0.49±0.06	0.43±0.09	0.42±0.06	0.844
	Snack	0.66±0.30	0.55±0.11	0.51±0.13	0.51±0.09	0.957
Legumes · potatoes	Soybean curd	1.66±0.23	1.36±0.12	1.81±0.30	1.23±0.10	0.142
	Legumes	9.59±0.91	9.62±0.90	9.33±1.29	8.76±0.70	0.855
	Soy milk	0.52±0.11	0.35±0.09	1.50±0.83	0.47±0.07	0.405
	Potato	0.76±0.10	0.84±0.13	1.05±0.22	0.63±0.06	0.100
	Sweet potato	0.47±0.06	0.59±0.08	0.52±0.09	0.49±0.05	0.599
Meat · eggs	Beef	0.76±0.12	0.64±0.08	0.71±0.11	0.57±0.05	0.241
	Chicken	0.52±0.08	0.37±0.04	0.44±0.07	0.35±0.02	0.146
	Pork	1.22±0.14	0.79±0.06	1.05±0.20	0.96±0.07	0.020
	Egg	1.83±0.25	1.99±0.19	2.10±0.30	1.55±0.11	0.045
Milk · dairyproducts	Milk	1.41±0.28	1.70±0.27	1.28±0.22	1.62±0.21	0.580
	Yoghurt	0.80±0.17	0.46±0.11	0.82±0.27	0.38±0.08	0.066
	Ice-cream	0.34±0.06	0.22±0.04	0.45±0.15	0.25±0.03	0.349
Fish · shellfishe	Chub mackerel	0.72±0.09	0.64±0.07	0.96±0.21	0.67±0.05	0.505
	Tuna	0.34±0.08	0.20±0.03	0.44±0.174	0.19±0.03	0.187
	Yellow corvina	0.53±0.08	0.59±0.09	0.60±0.12	0.53±0.07	0.913
	Pollack	0.61±0.08	0.41±0.04	0.44±0.06	0.45±0.041	0.170
	Anchovy	2.55±0.37	2.37±0.27	3.99±1.09	2.22±0.21	0.403
	Fish paste	0.22±0.03	0.28±0.05	0.26±0.07	0.28±0.05	0.628
	Cuttlefish	0.30±0.05	0.26±0.03	0.31±0.06	0.26±0.02	0.764
	Shellfishes	0.43±0.10	0.29±0.05	0.37±0.08	0.27±0.04	0.329
	Fermented fish	0.82±0.14	0.66±0.09	1.00±0.26	0.98±0.17	0.275
Fruits	Citrus fruit	0.81±0.10	0.61±0.05	0.96±0.22	0.69±0.07	0.183
	Persimmon	0.65±0.08	0.45±0.04	0.63±0.12	0.63±0.10	0.099
	Pear	0.54±0.11	0.37±0.05	0.44±0.08	0.35±0.06	0.101
	Water melon	0.58±0.08	0.34±0.03	0.64±0.06	0.42±0.03	0.001
	Melon, yellow	0.47±0.08	0.38±0.04	0.56±0.08	0.34±0.02	0.034
	Strawberry	0.41±0.04	0.36±0.04	0.50±0.15	0.45±0.12	0.650
	Grape	0.67±0.14	0.36±0.02	0.61±0.15	0.39±0.03	0.056
	Peach	0.37±0.07	0.25±0.03	0.38±0.06	0.27±0.02	0.116
	Apple	1.40±0.15	1.25±0.14	1.15±0.19	1.12±0.12	0.561
	Banana	0.68±0.13	0.59±0.08	0.59±0.15	0.37±0.05	0.015
	Orange	0.89±0.42	0.28±0.05	0.59±0.22	0.30±0.22	0.275

Table 1-a. Continued

N		SO	SNO	NSO	NSNO	p[a]
		129 (19.9)[b]	161 (22.5)	69 (11.1)	299 (46.5)	
Seaweeds	Sea mustard	0.78±0.09	0.71±0.05	1.04±0.17	0.77±0.08	0.316
	Laver	2.25±0.21	2.02±0.15	2.35±0.39	2.18±0.21	0.710
Vegetables	Korean cabbage	16.48±0.79	14.33±0.73	15.24±1.15	15.84±0.48	0.182
	Radish root	5.89±0.72	5.11±0.48	4.41±0.75	4.60±0.36	0.427
	Radish leaves	1.56±0.17	2.02±0.25	2.77±0.83	2.09±0.17	0.045
	Soybean sprout	1.05±0.10	1.10±0.09	1.00±0.12	1.03±0.06	0.943
	Spinach	0.52±0.06	0.53±0.04	0.51±0.11	0.55±0.05	0.973
	Cucumber	1.08±0.12	0.99±0.09	0.98±0.17	0.95±0.09	0.778
	Hot pepper	1.74±0.26	1.37±0.15	1.68±0.36	1.36±0.13	0.471
	Carrot	0.42±0.10	0.35±0.08	0.28±0.13	0.28±0.08	0.750
	Squash	0.42±0.10	0.35±0.08	0.25±0.41	0.69±0.05	0.750
	Cabbage	0.51±0.08	0.64±0.10	0.39±0.07	0.43±0.07	0.264
	Tomato	1. 09±0.23	0.75±0.09	0.73±0.11	0.58±0.07	0.080
	Mushroom	1.40±0.18	0.87±0.09	1.35±0.24	0.88±0.08	0.055

[a] Differences were tested using generalized linear model. [b] Categorical variables are given as numbers and percentages. [C] Numerical variables are given as means±SE. SO; sarcopenic obesity, SNO; sarcopenic nonobesity, NSO; nonsarcopenic obesity, NSNO; nonsarcopenic nonobesity. All models were adjusted for age, sex. $p>0.1$.

body composition changes and it is occurred in women dramatically by hormonal factors (Wells, 2007).

Other finding was that there were different food frequency and food preference according to 4 different groups between men and women. In addition, men are much more influenced by food than women. Among 53 variety food items, there were significant difference in eleven food items in men and six in women. Previous study supported that no relationship between nutrient intake and body composition was shown in older women, although their body composition changes were associated with inflammatory markers (Oh C, 2014). In this study, there were significantly different food frequency trend in protein rich food such as pork and egg in men, whereas, fish like a pollack and plant protein like soybean curd in women. Other study reported that protein intake at the RDA level (0.8/kg/day) resulted in the loss of muscle in the elderly (Vezzoli, Soldati, & Gambaro, 2009). In addition, in previous study (C Oh, 2014), intake of protein was enough compared with RDA, but it was insufficient for the elderly compared by new emerging recommendation 1.0~1.2/kg/day (Volpi *et al*., 2013). Some study emphasized on both total and animal protein intake because plant proteins which tend to be deficient in one or more essential amino acids and a source of high-biological-value protein than animal protein (Volkert, 2011). The Korean diet is tradetionally high in plant foods like soybean and soy foods (Kim SR, 1999) so Korean elderly do not need to avoid intake of animal protein. The lack of nutrients such as vitamin B_6, vitamin B_{12}, folic acid in major animal protein diet accumulates homocystein and leads to inflammation (Kruman *et al*., 2002).

There were significant different food frequency trend in fruits and vegetables groups such as water melon, melon, grape, banana, radish leaves, tomato, mushroom in men, whereas, melon, strawberry, orange, carrot in women. Diet rich in fruit and vegetable has low calories, fat and sodium and were good sources of micronutrients such as vitamins and mineral, antioxidants, and other phytochemical components which had a protective effect on chronic diseases (Van Duyn & Pivonka, 2000). Some studies indicated that eating meal rich in fruit and/or vegetables was closely correlated with serum biomarkers like vitamin A, vitamin C and folate (M, 2010) and influences DNA methylation controlled by gene expression on/off switch to treat chronic disease (Szarc vel Szic, Ndlovu, Haegeman, & Vanden Berghe, 2010). Using both DNA methylation and histone methylation processes, converting homocysteine to methionine is so important for mitigation for inflammation, as epigenetic view, by sufficient intake of vitamin B group. There were significantly different food frequency trend in cereal and milk products only in men, not in women. Increasing intake of calcium and vitamin D rich food like dairy products is important for not only bone health but also body composition through muscle synthesis because increase serum IGF-1 influenced by milk based protein is known to the most important mediator of muscle growth and repair possibly by utilizing Akt-mTOR-p70S6K (p70 ribosomal protein S6 kinase) signaling and then stimulate osteoblast proliferation, differentiation, and bone matrix formation (Philippou, Maridaki, Halapas, & Koutsilieris, 2007).

Also, the muscle-bone linkage stimulated by exercise and enhancing the skeletal accrual of calcium with the vitamin D must be important (Anderson, 2000). Kim *et al.,* (Kim MK *et al*., 2011) reported vitamin D levels correlated negatively with appendicular fat mass and positively protects skeletal muscle mass from insulin resistance. Low vitamin D level may influence atrophy of skeletal muscle and infiltration of fat impairs muscular performance in older individuals. The estimated average vitamin

Table 1-b. Food consumption frequency among SO, SNO, NSO, and NSNO (N=746, women)

N		SO	SNO	NSO	NSNO	p^a
		299 (38.6)[b]	164 (22.6)	71 (8.7)	241 (30.1)	
Cereals	Rice	18.96±0.30[c]	18.97±0.38	19.48±0.44	19.53±0.265	0.399
	Barley	13.76±0.57	13.42±0.98	12.98±1.65	12.18±0.68	0.329
	Ramyeon	0.30±0.04	0.25±0.04	0.27±0.05	0.31±0.03	0.724
	Noodle	0.53±0.06	0.58±0.13	0.55±0.19	0.44±0.05	0.351
	Bread	0.47±0.05	0.54±0.09	0.47±0.11	0.47±0.05	0.901
	Rice cake	0.55±0.05	0.56±0.11	0.43±0.06	0.54±0.05	0.508
	Snack	0.47±0.08	0.32±0.05	0.37±0.11	0.64±0.13	0.126
Legumes · potatoes	Soybean curd	1.20±0.12	1.34±0.16	0.75±0.10	1.28±0.12	0.000
	Legumes	10.31±0.69	10.77±0.85	10.23±1.67	10.09±0.68	0.931
	Soy milk	0.33±0.06	0.29±0.11	0.29±0.10	0.47±0.09	0.543
	Potato	0.74±0.08	0.60±0.07	0.79±0.12	0.64±0.05	0.338
	Sweet potato	0.68±0.07	0.57±0.07	0.62±0.09	0.55±0.05	0.466
Meat · eggs	Beef	0.44±0.04	0.47±0.06	0.32±0.05	0.46±0.06	0.106
	Chicken	0.27±0.03	0.36±0.07	0.21±0.03	0.30±0.02	0.103
	Pork	0.68±0.07	0.68±0.07	0.58±0.09	0.69±0.07	0.786
	Egg	1.43±0.13	1.51±0.19	1.34±0.16	1.58±0.15	0.737
Milk · diary products	Milk	1.63±0.19	1.81±0.24	1.61±0.26	1.84±0.23	0.856
	Yoghurt	0.76±0.14	0.49±0.11	0.40±0.13	0.73±0.12	0.119
	Ice-cream	0.24±0.03	0.19±0.03	0.22±0.04	0.21±0.03	0.688
Fish · shellfishe	Chub mackerel	0.55±0.05	0.64±0.07	0.61±0.15	0.56±0.06	0.734
	Tuna	0.19±0.03	0.23±0.05	0.14±0.04	0.26±0.04	0.159
	Yellow corvina	0.54±0.06	0.57±0.07	0.41±0.06	0.56±0.04	0.223
	Pollack	0.40±0.03	0.40±0.04	0.32±0.04	0.49±0.04	0.029
	Anchovy	1.90±0.19	2.40±0.53	1.54±0.34	2.11±0.22	0.416
	Fish paste	0.28±0.04	0.28±0.04	0.17±0.04	0.25±0.03	0.278
	Cuttlefish	0.29±0 .052	0.28±0 .048	0.18±0.06	0.23±0.03	0.473
	Shellfishes	0.27±0.03	0.48±0.14	0.35±0.08	0.35±0.04	0.219
	Fermented fish	0.51±0.07	0.50±0.10	0.48±0.16	0.75±0.12	0.331
Fruits	Citrus fruit	1.05±0.08	0.85±0.07	0.86±0.14	0.91±0.07	0.354
	Persimmon	0.81±0.07	0.73±0.07	0.85±0.14	0.74±0.05	0.668
	Pear	0.40±0.04	0.42±0.06	0.38±0.05	0.41±0.04	0.971
	Water melon	0.50±0.04	0.54±0.04	0.44±0.07	0.56±0.05	0.427
	Melon, yellow	0.53±0.05	0.45±0.04	0.28±0.04	0.38±0.04	0.001
	Strawberry	0.38±0.05	0.37±0.04	0.19±0.03	0.42±0.07	0.000
	Grape	0.55±0.05	0.54±0.06	0.47±0.09	0.60±0.07	0.636
	Peach	0.38±0.04	0.34±0.05	0.24±0.05	0.35±0.07	0.302
	Apple	1.35±0.12	1.43±0.16	1.21±0.27	1.39±0.16	0.903
	Banana	0.68±0.08	0.61±0.09	0.46±0.08	0.59±0.11	0.345
	Orange	0.43±0.08	0.45±0.18	0.17±0.04	0.42±0.10	0.007

Table 1-b. Continued

N		SO	SNO	NSO	NSNO	p[a]
		299 (38.6)[b]	164 (22.6)	71 (8.7)	241 (30.1)	
Seaweeds	Sea mustard	0.94±0.08	0.92±0.13	0.94±0.15	0.84±0.05	0.694
	Laver	2.48±0.22	2.88±0.26	2.36±0.35	2.39±0.19	0.485
Vegetables	Korean cabbage	14.97±0.61	15.16±0.65	14.03±1.06	14.95±0.57	0.849
	Radish leaves	1.99±0.21	2.37±0.27	2.33±0.29	1.96±0.19	0.469
	Radish root	3.95±0.40	4.51±0.61	3.82±0.57	4.5±0.34	0.812
	Soybean sprout	1.04±0.07	1.15±0.15	0.83±0.12	1.07±0.06	0.277
	Spinach	0.51±0.05	0.56±0.09	0.48±0.08	0.69±0.07	0.099
	Cucumber	1.01±0.09	1.23±0.17	1.10±0.21	1.09±0.10	0.703
	Hot pepper	1.19±0.14	1.40±0.23	1.48±0.39	1.20±0.11	0.677
	Carrot	0.29±0.05	0.14±0.03	0.20±0.08	0.26±0.05	0.047
	Squash	0.88±0.08	0.91±0.14	0.70±0.09	0.93±0.07	0.234
	Cabbage	0.49±0.10	0.56±0.13	0.74±0.21	0.41±0.06	0.361
	Tomato	0.74±0.10	0.83±0.14	0.90±0.14	0.80±0.08	0.790
	Mushroom	0.82±0.08	1.08±0.16	0.68±0.12	0.95±0.09	0.124

[a] Differences were tested using generalized linear model. [b] Categorical variables are given as numbers and percentages. [c] Numerical variables are given as means±SE. SO; sarcopenic obesity, SNO; sarcopenic nonobesity, NSO; nonsarcopenic obesity, NSNO; nonsarcopenic nonobesity. All models were adjusted for age, sex. $p>0.1$.

D requirement for older adults to reach a serum 25(OH)D level of 80 nmol/L (30 ng/mL) is 20 to 25 μg/day (800 to 1,000 IU/day) (Jorde & Grimnes, 2011), and individuals who are obese, osteoporosis, limited sun exposure, and malabsorption may need uptake to as much as 50 μg /day (2,000 IU/day) (McKenna & Freaney, 1998). Intake frequency of vitamin D in this study is that egg was less than once a month and milk and mackerel were about 2 times per month. To reach 800 to 1,000 IU/day, we recommend intake of egg, milk, and mackerel at least once a day with sun exposure. Specially, oily fish and milk products are good sources of protein, vitamin D, and calcium as well. Good sources of calcium in Korean were radish, anchovies, tofu, seaweed, and milk. Comparing with RDA (RDA 700 both gender), this study showed calcium-poor diets refer to intakes below about 60 % KDRI. Generally the recommended calcium intake is 1,000~1,500 mg/day (Seo *et al*., 2012). Altered calcium homeostasis was found to be associated with skeletal muscle weakness during the aging process. Calcium may combine with fatty acids in the intestine to inhibit the absorption of fat (Melanson, Donahoo, Dong, Ida, & Zemel, 2005), so low calcium intake may increase adiposity and fat infiltration in skeletal muscle and lead to increased triglyceride (Zemel, 2002).

Up to this date, many studies have reported associations between dietary patterns and MS (Song & Joung, 2012) but there was no study directly examined the effects of food frequency and preference and body composition changes on Korean elderly, even though there were several reports that the body composition changes in aging increased the risk of metabolic disorder (Song & Joung, 2012). But the mechanisms of nutrition compounds are quite complex so we need more study for underlying mechanism requires further study. The purposes of the study are to determine the relation between food frequency and different body compositions which has relation with metabolic syndrome by gender. And further, these data on the relationship between food frequency and body compositions may be helpful for the prevention for chronic diseases. One limitations of the current study was the use of food frequency questionnaires (FFQ) for estimating food consumption trend and 24 recalls for nutrients intake. Due to memory errors in older adults, over or under reporting may impact the accuracy of our data. Another possible limitation is that our criteria for body composition classification to 4 groups may be inaccurate because there are still different criteria and additionally, it may not accurately reflect muscle strength and function as well. However, this study used ASM/Wt as Lim *et al.,* (Lim *et al*., 2010) showed that sarcopenia defined by ASM/Wt is more closely associated with metabolic factors than sarcopenia defined by ASM/height (m^2) in Koreans. The strength of this study is that a few studies have examined the association between food frequency and body composition by gender in Korean elderly. And this study used representative national data, allowing us to infer its relation among Korean elderly.

In conclusion, body composition was associated with MS in both gender with 60 years or older. Body composition changes were more related with food frequency in elderly men (60 years or older) than women. Women who had a higher prevalence of MS than men, suggesting early nutritional intervention in elderly women may help them prevent body composition changes.

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