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The association between daily calcium intake and sarcopenia in older, non-obese Korean adults: the fourth Korea national health and nutrition examination survey (KNHANES IV) 2009

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Abstract. Recent data suggest that variations in calcium intake may influence body weight and composition; however, the relationship between daily calcium intake and muscle mass has not been well established. The objective of this study was to assess the relationship between daily calcium intake and sarcopenia. We analyzed data for older adults (over 60 years) from the fourth Korea National Health and Nutrition Examination Survey (KNHANES) conducted in 2009. A total of 1339 Non-Obese (BMI between 18.5 and 25 kg/m²), older adults (592 men and 707 women) were enrolled. Dietary variables were assessed using a nutrition survey that used a 24-hour recall method. Daily calcium intake based on the consumption of each food item was calculated. Sarcopenia was defined as an appendicular skeletal muscle mass divided by body weight less than 2 SD below the sex-specific mean for young adults. We found that daily calcium intake was negatively correlated with total body fat percentage and positively correlated with appendicular skeletal mass ($p < 0.001$). Participants with sarcopenia appear to have significantly lower daily calcium intakes than participants without sarcopenia ($p < 0.001$). The unadjusted prevalence of sarcopenia according to daily calcium intake tertiles were 6.3%, 4.3%, and 2.7% in tertiles 1, 2, and 3, respectively. After adjustment for age, sex, BMI, total energy intake, and lifestyle factors, compared with those in the lowest tertile of daily calcium intake, participants in the highest tertile had an odds ratio for sarcopenia of 0.295 (95% confidence interval, 0.087-0.768; p for trend = 0.014). We found that daily calcium intake, corrected for total energy intake and serum 25(OH)D status, was significantly lower in subjects with sarcopenia than in those without. Our results suggest a strong inverse association between daily calcium intake and sarcopenia in non-obese, older Korean adults.

Key words: Daily calcium intake, Sarcopenia, Non-Obese older adult

A NUMBER of epidemiological studies have shown a strong inverse correlation between calcium intake and adiposity. Individuals with the lowest calcium intake tend to have the highest body weight [1-3]. Data from the National Nutrition Survey 1995 indicate that Australian men and women with higher calcium intakes have lower BMIs and waist circumferences, after controlling for various confounders. More recent clinical studies have documented that a diet high in

dairy calcium accelerates fat loss, particularly from the abdominal region, and that increasing calcium intake is a potential means of weight management [4-6]. In particular, high calcium intakes were found to decrease the rate of lipogenesis and enhance lipolysis in adipocytes [7, 8]. In contrast, there have been no studies of the relationship between muscle mass and daily calcium intake.

Numerous studies have shown age-related body composition changes in both men and women, notably that fat mass increases and muscle mass decreases with age [9, 10]. Sarcopenia is an evolving concept and the current definition includes both a loss of muscle strength and loss of muscle mass [11]. The etiology of sarcopenia is multifactorial. Factors that have been implicated in sarcopenia include a decreased

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physical activity level, declining androgen concentrations, chronic disease, inflammation, insulin resistance, and nutritional deficiencies (dietary protein and serum 25(OH)D) [12]. Importantly, cachexia and obesity may also contribute to sarcopenia. Hence, excluding these subpopulations (underweight, overweight, obese) might be of clinical importance for assessing the risk factors of sarcopenia.

The aim of our study was to investigate whether dietary calcium intake is associated with sarcopenia in non-obese, older Korean adults.

Subjects and Methods

Study population

This cross-sectional study was based on data acquired by the Fourth Korea National Health and Nutrition Examination Survey (KNHANES IV) conducted in 2009. The KNHANES surveys have been conducted periodically since 1998 to assess the health and nutritional status of the non-institutionalized civilian population of Korea [13]. KNHANES IV was a cross-sectional and nationally-representative survey conducted by the Division of Chronic Disease Surveillance, Korea Centers for Disease Control and Prevention, from 2007–2009. There were 2363 subjects aged 60 yr or older among those who participated in the survey between January and December 2009. To confine the study sample to non-obese adults, the data used in our study were limited to participants with body mass indexes (BMIs) between 18.5 and 25 kg/m² (BMI over 25 kg/m², n=751).

We excluded individuals without data for oral daily calcium intake (n=154) and those with a history of chronic kidney disease (n=10). After excluding the non-eligible subjects, the total number of participants for this analysis was 1339 (632 men and 707 women). All the participants in this survey signed an informed consent form.

Clinical and laboratory measurements

Dietary variables were assessed using a 24-hour recall method in the nutrition survey. Daily intakes of total energy, fat, fiber, and calcium were calculated based on the food items consumed.

Blood samples were collected from each participant during the survey after a 12-hour overnight fast, and were processed, immediately refrigerated, and transported in cold storage to the Central Testing Institution.

Serum levels of glucose, total cholesterol (TC), high-density lipoprotein (HDL) cholesterol, triglycerides (TG), creatinine, aspartate aminotransferase (AST), and alanine aminotransferase (ALT) were measured enzymatically using a Hitachi automatic analyzer 7600 (Tokyo, Japan). Serum 25(OH)D concentrations were measured by RIA (DiaSorin Inc., Stillwater, MN, USA) using a counter (1470 Wizard; PerkinElmer, Turku, Finland).

A parathyroid hormone (PTH) assay was performed in the same laboratory using a chemiluminescence assay (DiaSorin) for the measurement of intact PTH. Insulin concentrations were measured by immunoradiometry (INS-IRMA; Bio-Source, Nivelles, Belgium). The homeostasis model assessment estimate of insulin resistance (HOMA-IR) was calculated using the following formula: fasting plasma glucose (millimoles per liter)/fasting insulin (milli-IU per liter)/22.5 [14].

Body composition

Body mass index (BMI) was calculated as weight/height² (kg/m²) and waist circumference was measured at the midpoint between the lower border of the rib cage and the iliac crest. A whole body DXA scan was performed for each subject to measure total and regional lean mass (kg), total body fat (kg), and total body fat percentage (%) using fanbeam technology (Hologic; Bedford, MA, USA). Appendicular skeletal muscle mass (ASM (kg)) was defined as the sum of lean soft tissue masses for the arms and legs, following the method of Heymsfield *et al.* [15]. We used ASM as a percentage of body weight (Wt), as modified in studies by Janssen *et al.* [16] and Lim *et al.* [17].

Definition of sarcopenia

Sarcopenia was defined as an appendicular skeletal muscle mass divided by body weight (ASM/Wt) less than 2 SD below the sex-specific mean of a sample of 2392 healthy adults aged 20–40 yr (1054 men, 1338 women) [17, 18]. For men, the cutoff value for sarcopenia was 29.5% (ASM/Wt); for women, the corresponding cutoff value was 23.2% (ASM/Wt).

Statistical analysis

Continuous variables were reported as mean±SD and compared by independent *t* tests. Categorical variables were expressed as percentages and compared using a χ^2 test. Spearman correlation coefficients between daily calcium intake and various parameters of body compo-

sition were calculated. The participants' characteristics were compared according to sarcopenia status using independent-sample Student's *t* tests.

Multiple logistic regression analysis was conducted to evaluate associations between daily calcium intake and sarcopenia. The participants were classified into daily calcium intake tertiles (T1, T2, and T3). The odds ratios (OR) and 95% confidence intervals (CI) were calculated. We used multiple logistic regression analysis to determine the OR of sarcopenia in subjects stratified by tertiles of daily calcium intake. Adjustments were made for the following variables: age, sex, BMI, total energy intake, serum 25(OH)D level, PTH, HOMA-IR, regular exercise, occupation, region, smoking, alcohol drinking, and vitamin and mineral supplement use. For testing linear risk trends, we used the tertile of daily calcium intake as a continuous variable in the regression model. A value of $p < 0.05$ was accepted as significant. All data were analyzed using IBM SPSS Statistics 20.0 (IBM, Armonk, NY, USA).

Results

General characteristics of the study participants

The general characteristics of the study participants according to daily calcium intake tertiles are shown in Table 1. The cross-sectional analyses included data on 1339 participants (592 men and 707 women). The mean age of the study participants was 70.1 yrs. When we compared participant characteristics across daily calcium intake, sex, and age, we found that total body fat mass and total body fat percentage decreased with increasing daily calcium intake. There were no significant differences in lipid and glucose profiles according to daily calcium intake tertile. BMI, waist circumference, ASM, ASM/Wt (%), regular exercise, total energy intake, and protein (% of energy) were significantly different and increased with increasing daily calcium intake tertiles.

Table 2 presents metabolic and dietary characteristics according to sarcopenia status. The mean daily calcium intake was significantly lower in those with sarcopenia than in those without sarcopenia (316.37 ± 252.39 vs. 414.65 ± 316.10 mg/day, $p=0.005$; Table 2). The prevalence of known diabetes mellitus and hypertension was significantly higher in subjects with sarcopenia. Subjects with sarcopenia were older, more obese, and were less likely to exercise regularly than those without sarcopenia. Subjects with sarcopenia

had greater total body fat mass and lower ASM. There were no significant differences in lipid profiles, serum fasting glucose levels, and HOMA-IR values between the sarcopenia and non-sarcopenia groups (Table 2).

Spearman correlation analysis showed that daily calcium intake correlated negatively with total body fat percentage ($\rho = -0.140$, $p < 0.001$). Daily calcium intake correlated positively with truncal lean body mass ($\rho = 0.280$), ASM ($\rho = 0.276$), ASM/Wt ($\rho = 0.182$), and total body lean body mass ($\rho = 0.281$) (all $p < 0.001$). In addition, according to the Spearman correlation analysis, bone mineral density (BMD) of the femur neck correlated positively with ASM and ASM/Wt (ASM, $\rho = 0.693$, $p < 0.001$; ASM/Wt $\rho = 0.463$, $p < 0.001$).

Prevalence of sarcopenia according to daily calcium intake tertile

As seen in Fig. 1, the proportion of subjects with sarcopenia significantly decreased as daily calcium intake increased from the first to the third tertile (p for trend = 0.009). The point estimates for prevalence of sarcopenia were 6.3, 4.3, and 2.7% in T1, T2, and T3, respectively.

Risk of sarcopenia according to daily calcium intake tertile

When the odd ratios for sarcopenia according to daily calcium intake tertile were analyzed with logistic regression analyses, the risk for sarcopenia decreased as daily calcium intake increased from the first to the third tertile, after correction for confounding variables. After adjustment for age, sex, and BMI, the OR for having sarcopenia was 0.380 (95% CI = 0.183–0.790) in subjects in T3 for daily calcium intake (≥ 444.5 mg/day) compared with those in T1 (≤ 241.8 mg/day) (p for trend = 0.008; Model 2, Table 3). Controlling further for alcohol consumption, smoking, regular exercise, occupation, serum 25(OH)D levels, HOMA-IR, and lifestyle factors did not attenuate the association between daily calcium intake and sarcopenia (OR = 0.391; 95% CI = 0.163–0.940; p for trend = 0.033). The association remained significant after further adjustment for serum parathyroid hormone level and total fat mass; however, T2 did not show a significantly decreased risk for sarcopenia in all adjustment models. Thus, there appears to be a threshold effect in that sarcopenia was only decreased in the highest tertile (≥ 444.5 mg/day).

Table 1 Clinical characteristics of participants according to daily calcium intake

Variable	Daily oral calcium intake tertile			<i>p</i> for trend
	T1 (≤ 241.5 mg/dL) N =447	T2 (241.6-444.4 mg/dL) N =445	T3 (≥ 444.5 mg/dL) N =447	
Sarcopenia	28 (6.3%)	19 (4.3%)	12 (2.7%)	0.009
Age (yr)	72.0 $\pm$ 6.8 ^{a, b}	69.6 $\pm$ 6.6 ^{a, c}	68.6 $\pm$ 6.3 ^{b, c}	<0.001
Sex (Male)	155 (34.7%)	215 (48.3%)	262 (58.6%)	<0.001
BMI (kg/m ²)	21.82 $\pm$ 2.08 ^{a, b}	22.17 $\pm$ 2.09 ^{a, c}	22.30 $\pm$ 1.89 ^{b, c}	0.001
Waist circumference (cm)	78.67 $\pm$ 7.55 ^b	79.68 $\pm$ 7.38	80.32 $\pm$ 7.01 ^b	0.003
Total body fat mass (kg)	14.3 $\pm$ 4.2	14.4 $\pm$ 4.2	14.0 $\pm$ 4.0	0.492
Total body fat percentage (%)	27.1 $\pm$ 7.05 ^{a, b}	26.18 $\pm$ 7.35 ^{a, c}	25.02 $\pm$ 7.14 ^{b, c}	<0.001
ASM (kg)	15.5 $\pm$ 3.4 ^{a, b}	17.0 $\pm$ 3.9 ^{a, c}	17.9 $\pm$ 4.0 ^{b, c}	<0.001
ASM/Wt (%)	29.41 $\pm$ 3.89 ^{a, b}	30.40 $\pm$ 4.24 ^{a, c}	31.18 $\pm$ 4.11 ^{b, c}	<0.001
Total cholesterol (mg/dL)	193.47 $\pm$ 37.98 ^b	190.03 $\pm$ 35.67	186.86 $\pm$ 36.39 ^b	0.035
HDL-cholesterol (mg/dL)	49.63 $\pm$ 12.39	50.88 $\pm$ 12.45	50.22 $\pm$ 11.55	0.332
Triglycerides (mg/dL)	146.52 $\pm$ 108.49	135.20 $\pm$ 79.43	135.50 $\pm$ 86.47	0.133
Insulin (μ U/mL)	9.56 $\pm$ 11.7	8.64 $\pm$ 4.23	8.54 $\pm$ 3.34	0.096
HOMA-IR	2.62 $\pm$ 5.85	2.18 $\pm$ 1.55	2.29 $\pm$ 1.24	0.180
ALP (IU/L)	257.74 $\pm$ 73.76	250.97 $\pm$ 73.17	254.21 $\pm$ 87.52	0.463
AST (IU/L)	23.83 $\pm$ 12.40	24.19 $\pm$ 14.55	26.44 $\pm$ 25.57	0.088
ALT (IU/L)	19.03 $\pm$ 12.33 ^b	19.45 $\pm$ 12.02	21.52 $\pm$ 16.54 ^b	0.020
25(OH)D (ng/mL)	20.05 $\pm$ 7.59	20.23 $\pm$ 7.21	20.70 $\pm$ 7.28	0.420
PTH (ng/liter)	72.43 $\pm$ 36.64 ^b	70.46 $\pm$ 28.52	65.37 $\pm$ 28.29 ^b	0.004
Previous hypertension (%)	189 (42.4%)	165 (37.1%)	189 (42.4%)	0.176
Previous diabetes mellitus (%)	63 (14.1%)	45 (10.1%)	84 (18.8%)	0.045
Previous stroke (%)	23 (5.2%)	22 (4.9%)	19 (4.3%)	0.531
Regular exercise ^A (%)	32 (7.3%)	43 (9.7%)	66 (14.9%)	<0.001
Vitamin supplement use (%)	71 (15.9%)	98 (22.1%)	115 (25.8%)	<0.001
Region, urban area (%)	184 (41.2%)	241 (54.2%)	260 (58.2%)	<0.001
Occupation ^B				
Clerical work (%)	19 (4.3%)	25 (5.6%)	28 (6.3%)	0.037
Manual work (%)	134 (30.5%)	192 (43.3%)	154 (34.8%)	0.037
Unemployed (%)	287 (65.2%)	226 (51.0%)	260 (58.8%)	0.037
Dietary intake ^C				
Total energy (kcal/d)	1224.88 $\pm$ 434.79 ^{a, b}	1688.29 $\pm$ 534.61 ^{a, c}	2008.57 $\pm$ 764.13 ^{b, c}	<0.001
Protein (% of energy)	10.9 ^{a, b}	12.8 ^{a, c}	15.0 ^{b, c}	<0.001
Fat (% of energy)	8.7 ^{a, b}	11.4 ^{a, c}	14.7 ^{b, c}	<0.001
Carbohydrate (% of energy)	78.4 ^{a, b}	74.0 ^{a, c}	69.9 ^{b, c}	<0.001

Data are n (%) or mean $\pm$ standard deviation.

^a*P* < 0.05 vs. T1 and T2 of daily oral calcium intake by one-way ANOVA with Tukey multiple comparison post hoc analysis.

^b*P* < 0.05 vs. T1 and T3 of daily oral calcium intake by one-way ANOVA with Tukey multiple comparison post hoc analysis.

^c*P* < 0.05 vs. T2 and T3 of daily oral calcium intake by one-way ANOVA with Tukey multiple comparison post hoc analysis.

To convert 25(OH)D to nanomoles per liter, multiply by 2.496. To convert parathyroid hormone (PTH) to nanograms per liter, multiply by 1. F, Female; HDL, high-density lipoprotein; M, male; ALP, alkaline phosphatase; AST, aspartate aminotransferase; ALT, alanine aminotransferase.

^A Regular exercise is indicated as 'yes' when a subject performed vigorous exercise on a regular basis (for more than 20 min at a time and more than three times per week).

^B Clerical work included sales and service, clerical staff, administration, and specialists. Manual work included agriculture, forestry, fishery, manual labor, engineering, assembling, and technical work.

^C Daily energy and nutrient intakes were assessed using the 24-h recall method of the Nutrition Survey of KNHANES IV. Dietary information was available for 1339 participants (sarcopenia, n = 59; non-sarcopenia, n = 1280)

Table 2 Metabolic and dietary characteristics of participants with and without sarcopenia

Variable	With sarcopenia (n=59)	Without sarcopenia (n=1280)	p-value
Daily oral calcium intake (mg/dL)	316.37 ± 252.39	414.65 ± 316.10	0.005
Age (yr)	72.68 ± 6.18	69.96 ± 6.72	0.002
Sex (M/F)	33/26	559/681	0.169
BMI (kg/m ²)	23.2 ± 1.4	22.0 ± 2.0	<0.001
Waist circumference (cm)	85.7 ± 5.9	79.3 ± 7.3	<0.001
Total body fat mass (kg)	18.6 ± 2.8	14.0 ± 4.1	<0.001
Total body fat percentage (%)	33.7 ± 5.9	25.9 ± 7.1	<0.001
ASM (kg)	14.6 ± 3.2	16.9 ± 3.9	<0.001
ASM/Wt (%)	25.6 ± 3.1	30.5 ± 4.1	<0.001
Total cholesterol (mg/dL)	192.7 ± 40.0	189.9 ± 36.6	0.598
HDL-cholesterol (mg/dL)	48.4 ± 12.7	50.3 ± 12.1	0.258
Triglycerides (mg/dL)	149.0 ± 63.0	138.6 ± 93.4	0.412
Fasting glucose (mg/dL)	110.7 ± 40.3	102.8 ± 29.8	0.158
HOMA-IR	4.9 ± 15.2	2.2 ± 1.5	0.209
25(OH)D (ng/mL)	17.1 ± 6.8	20.5 ± 7.4	0.001
PTH (ng/liter)	74.5 ± 70.7	69.2 ± 28.4	0.580
Regular exercise ^a (%)	25.4%	21.1%	0.587
Vitamin supplement use (%)	21.1%	25.4%	0.424
Dietary intake ^b			
Total energy (kcal/d)	1434 ± 538.0	1650 ± 679.8	0.016
Protein (% of energy)	13	12	0.347
Fat (% of energy)	12	12	0.756
Carbohydrate (% of energy)	74	74	0.861

To convert 25(OH)D to nanomoles per liter, multiply by 2.496. To convert parathyroid hormone (PTH) to nanograms per liter, multiply by 1. F, Female; HDL, high-density lipoprotein; M, male; ALP, alkaline phosphatase; AST, aspartate aminotransferase; ALT, alanine aminotransferase; ASM, Appendicular skeletal muscle mass; HOMA-IR, homeostasis model assessment estimate of insulin resistance.

^a Regular exercise is indicated as 'yes' when a subject performed vigorous exercise on a regular basis (for more than 20 min at a time and more than three times per week).

^b Daily energy and nutrient intakes were assessed using the 24-h recall method of the Nutrition Survey of KNHANES IV. Dietary information was available for 1339 participants (sarcopenia, n = 59; non-sarcopenia, n = 1280)

Fig. 1 Unadjusted prevalence of sarcopenia by daily oral calcium intake tertile

Discussion

We found a strong inverse association between daily calcium intake and sarcopenia in non-obese, older Korean adults. This association was independent of age, sex, BMI, total energy intake, serum 25(OH)D status, lifestyle factors (alcohol consumption, smoking, and regular exercise), and occupation. This association was particularly strong in subjects in the highest tertile for daily calcium intake when compared to subjects in the lowest tertile for daily calcium intake. Therefore, our data suggest that a relatively lower dietary calcium intake (278 mg per day) is associated with an increased risk of sarcopenia in non-obese, older Korean adults.

This study has important clinical implications.

Table 3 Adjusted ORs and 95% CIs for sarcopenia according to daily oral calcium intake

	Daily oral calcium intake tertile			<i>p</i> for trend
	T1 (≤ 241.5 mg/dL) N = 447	T2 (241.6–444.4 mg/dL) N = 445	T3 (≥ 444.5 mg/dL) N = 447	
Unadjusted	1 (ref)	0.667 (0.367–1.214)	0.413 (0.207–0.823)	0.010
Model 1	1 (ref)	0.696 (0.377–1.285)	0.430 (0.210–0.880)	0.019
Model 2	1 (ref)	0.590 (0.316–1.104)	0.380 (0.183–0.790)	0.008
Model 3	1 (ref)	0.613 (0.296–1.270)	0.391 (0.163–0.940)	0.033
Model 4	1 (ref)	0.620 (0.280–1.374)	0.259 (0.087–0.768)	0.014

Model 1 adjusted for age and sex

Model 2 adjusted for age, sex, and BMI

Model 3 adjusted for age, sex, BMI, total energy intake, serum 25(OH)D, HOMA-IR, regular exercise, occupation, region, smoking, alcohol drinking, and vitamin/ mineral supplement use.

Model 4 adjusted for age, sex, BMI, total energy intake, serum 25(OH)D, HOMA-IR, regular exercise, occupation, region, smoking, alcohol drinking, and vitamin/ mineral supplement use, parathyroid hormone, and total fat mass.

Many reports have indicated that changes in body weight, and in particular fat mass, are associated with daily calcium intake [4–6]. Older adults have less muscle and bone mass, expanded extracellular fluid volumes, and reduced body cell mass compared to younger adults [19]. Non-fat components of body composition play critical roles in the health of elderly people [19]. In particular, skeletal muscle atrophy, or “sarcopenia,” is highly prevalent in the elderly population and is strongly associated with disability, independent of morbidity. To our knowledge, this is the first cross-sectional study to evaluate the relationship between skeletal muscle mass, separate from fat mass, and daily calcium intake.

This is the only study to report an association between daily calcium intake and sarcopenia, after correcting for total energy intake and serum 25(OH)D status. We can only hypothesize about the mechanisms by which calcium intake might alter the risk of developing sarcopenia in older Korean adults. First, lower dietary calcium intakes can lead to increased concentrations of 1,25(OH)₂D and parathyroid hormone, which in turn may increase intracellular calcium concentrations [4, 27]. Alteration in calcium signaling may play a role in regulating muscle contractile force in differentiated muscle fibers. More recently, altered calcium homeostasis was found to be associated with skeletal muscle weakness during the aging process [20].

Second, low calcium intakes may increase the rate of lipogenesis and inhibit lipolysis, consequently leading to increased adiposity. Increased fat infiltration and fatty degeneration in skeletal muscle may cause subsequent atrophy of skeletal muscle, resulting in

impaired muscular performance in older individuals. In our study, calcium intake was negatively correlated with total body fat mass and positively correlated with appendicular skeletal mass.

Previous studies have shown the significant role of serum 25(OH)D status and calcium intake in fat and muscle mass [21–23]. Recently, Kim *et al.* reported an inverse association between serum 25(OH)D levels and sarcopenia. Their data also support the putative role of serum 25(OH)D in preventing sarcopenia, which may contribute to a process by which serum 25(OH)D deficiency leads to physical disability [22]. In addition, high calcium diets have been found to regulate body weight and the accumulation of fat in adipocytes [7, 8]. Two possible mechanisms for an effect of dietary calcium on body weight have been suggested. First, calcium may combine with fatty acids in the intestine to form insoluble soaps that are therefore not absorbed [24]. Increased dietary calcium may decrease body fat stores by decreasing the absorption of fat. Second, some researchers have proposed that low dietary calcium intakes lead to increased adipocyte triglyceride deposition [25, 26].

The major strength of this study is that we used data from a large representative sample of older adults in the general population in Korea. Moreover, we evaluated body composition by dual-energy X-ray absorptiometry (DXA). DXA provides a higher degree of precision with a single measurement and can exactly locate where fat or muscle is distributed throughout the body. Because it produces reliable results, DXA is emerging as the new gold standard for body composition assessment [25, 26]. These data provide the

first assessment of the associations between sarcopenia and low calcium intake, body composition, and aging in an older population using DXA. Our study sample was confined to non-obese subjects. Numerous studies have demonstrated significant inverse associations between daily calcium intake and body weight and body fat, which is why we only included participants with a BMI between 18 and 25 kg/m². We demonstrated that daily calcium intake is associated with sarcopenia independent of body weight in a non-obese, elderly Korean sample.

There are several limitations to our study. First, the cross-sectional nature of this study makes it impossible to identify any cause-effect relationships. Second, data on vitamins or calcium supplements, prescribed medications, and comorbidities were not available. Third, we used a 24-hour recall method to assess dietary variables, but a single 24-hour recall may not be representative of habitual diet. Fourth, sarcopenia is an evolving concept and the current definition of sarcopenia includes both loss of muscle strength and of muscle mass. However,

we relied on muscle mass only to define sarcopenia in the current study, hence the risk of overestimating the prevalence of sarcopenia. Fifth, all participants were Korean, and there is the possibility of selection bias. The mean daily dietary calcium intake in the present study was only 386 mg/day: relatively low compared to other studies. Therefore, our study is limited in generalizing the results to the worldwide population.

In conclusion, the present study is the largest population-based study to examine the association between dietary calcium intake and sarcopenia. Daily calcium intake, corrected for total energy intake and serum 25 (OH)D status, is significantly lower in subjects with sarcopenia than in those without. Our results suggest that there is a strong inverse association between daily calcium intake and sarcopenia in non-obese, older Korean adults.

Disclosure Summary

The authors have nothing to disclose.

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