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How Many Older Koreans Are at Risk? National Estimates of Food Insecurity and Sarcopenia Risk Based on ESPEN Guidelines

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Purpose: Food insecurity and inadequate nutrient intake are major public health concerns in aging populations. Sarcopenia is influenced by nutrition and socioeconomic status. This study aimed to estimate the prevalence of food insecurity and sarcopenia risk among Korean older adults and examine associations with socioeconomic and lifestyle factors.

Methods: A cross-sectional analysis of the 2019 Korea National Health and Nutrition Examination Survey (KNHANES) was conducted using a complex sample design. A total of 1,365 adults aged ≥65 years were included. Food insecurity, nutrient adequacy per European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines, and sarcopenia risk (defined by low handgrip strength) were assessed. Logistic regression determined associations with socioeconomic status, diet, and exercise.

Results: Food insecurity affected 15.7% of older adults (weighted percentage). An estimated 40.9% had inadequate nutrient intake, and 24.6% were at risk of sarcopenia. Lower income was significantly associated with sarcopenia risk; compared to the lowest quintile, those in the second quintile had lower odds (OR = 0.61, 95% CI: 0.43–0.87). Lower education also increased risk, with high school graduates showing lower odds (OR = 0.45, 95% CI: 0.26–0.78) compared to those with elementary education or less. Notably, nutrient adequacy based on ESPEN guidelines was not significantly associated with sarcopenia risk. Resistance exercise ≥3 days/week was protective (OR = 0.48, 95% CI: 0.28–0.82).

Conclusions: Socioeconomic disadvantage and physical inactivity are primary determinants of sarcopenia risk in Korean older adults. The lack of association between ESPEN-based nutrient adequacy and sarcopenia risk highlights the need to address structural socioeconomic determinants beyond simple nutrient supplementation.

Keywords: Aged; Food insecurity; Nutritional status; Resistance training; Sarcopenia

Introduction

Korea is transitioning to an ultra-aged society, necessitating a focus on the health of older adults and sustainable healthcare policies. Older adults are typically defined as those aged ≥65 years. However, their health conditions vary widely due to various factors, including genetic predisposition, health behaviors, and available resources.

Frailty, sarcopenia, and dynapenia are emerging focal points in geriatric research and practice, emphasizing preventive management to preserve independent functioning in older adults before rapid health decline necessitates nursing home care [1-3]. Compared with normal aging process, frail older adults have decreased functional and intrinsic capacity reserves and increased vulnerability to stress. Frailty is not limited to physical functioning but also includes a decline in social and mental abilities. It is characterized by difficulties in maintaining independence in activities of daily living. Poor nutrition is a major contributing factor to frailty and is associated with negative health outcomes, such as falls, infections, loss of mobility, and delayed wound healing [4,5].

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Sarcopenia, characterized by progressive loss of skeletal muscle mass and function, is particularly influenced by nutritional factors. While the physiological mechanisms of sarcopenia are well-documented, the interplay between socioeconomic factors, food insecurity, and sarcopenia remains underexplored in the Korean context [3]. Food insecurity, characterized by the lack of access to a stable and balanced diet, is a nutrition-related health issue among older adults [6]. Food insecurity among older adults is influenced by various factors beyond financial constraints, including therapeutic dietary requirements for medical conditions, increased dependence on others for food preparation due to physical disabilities, social isolation, and transportation issues [6,7].

A recent study on the prevalence of malnutrition among older adults in Korea found that 75.8% of those in long-term care facilities were malnourished, and 40.9% had comorbid frailty [8]. Among community-dwelling older adults, 9.4% were at risk of undernutrition, and 0.2% were malnourished [9]. In old age, undernutrition can be exacerbated by decreased taste and smell, difficulty with mastication due to tooth loss, decreased energy expenditure, decreased digestive capacity, and psychosocial problems [4,10]. Undernutrition is reported to be more prevalent among older adults living alone, in older couple households, and those with low education and income levels [4,10,11]. In South Korea, where poverty rates are high, food insecurity is more prevalent among older adults than in any other age group [12]. In particular, low-income older adults lack food-purchasing power, which leads them to purchase less diverse and insufficient food, resulting in nutritional imbalances and ultimately contributing to declining physical function [7, 12]. In turn, decreased physical function leads to difficulties in preparing healthy meals, resulting in a pattern of poorly cooked snacks for frail older individuals living alone [11].

This study adopted the Social Determinants of Health (SDOH) framework to select associated factors. According to this framework, health outcomes like sarcopenia are not solely determined by biological factors but are significantly shaped by the conditions in which people are born, grow, and age [13]. Consequently, we selected socioeconomic status (income, education), physical environment (food insecurity), and health behaviors (nutrient intake, physical activity) as key independent variables. This approach allows for a comprehensive analysis of how structural disadvantages translate into physiological deficits in older age.

Two critical research gaps exist in the current literature. First, while previous studies have reported malnutrition rates as high as 75.8% in specific settings, such as long-term care facilities or local community cohorts [8,9], there is a lack of nationally representative data that accurately estimates the prevalence of sarcopenia risk and food insecurity across the entire Korean older adult population. Given Korea's rapid demographic changes and the need for precise policy targeting, accurate population-weighted estimates using national survey data are urgently needed to understand the true scale of these risks.

Second, the applicability of existing nutritional guidelines to the Korean population remains unclear. The European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines provide authoritative nutritional recommendations for older adults, including five nutrient intake guidelines and six nutrient management guidelines [14,15]. However, applying these Western dietary standards to the Asian population without validation may overlook cultural and physiological differences, particularly given that Korean older adults typically consume a carbohydrate-heavy diet. Most existing studies have focused on clinical nutritional interventions or individual health behaviors, but it remains unclear whether adherence to ESPEN guidelines effectively predicts sarcopenia risk in Korean older adults. Therefore, it is crucial to determine whether these global guidelines are applicable to the Korean context and to identify population-specific risk factors to inform public health policies.

Addressing these gaps, this cross-sectional study utilized 2019 data from the eighth National Health and Nutrition Examination Survey, a large-scale national survey. This study aimed to: (1) estimate the prevalence of food insecurity and assess nutrient intake adequacy based on ESPEN guidelines across household income quintiles among community-dwelling older adults in Korea; and (2) investigate the association between nutritional adequacy, physical activity, and the risk of low handgrip strength as an indicator of sarcopenia risk.

Methods

Study design

This cross-sectional study used secondary data to analyze the subjective dietary experiences and nutrient intake of community-dwelling older adults in Korea according to income groups. We also compared and analyzed the risk of frailty according to the adequacy of nutritional intake.

Research participants

Data from the 2019 Korea National Health and Nutrition Examination Survey (KNHANES VIII-1) were used for the analysis

[16]. This study was exempted from ethical review by the Institutional Review Board of Konkuk University (IRB No. 7001355-202401-E-731) as it utilized publicly available data. The KNHANES employs a stratified, multi-stage clustered probability sampling design to ensure representative estimates of the Korean population. For the eighth period, the sampling frame was stratified by province, district, and type of housing, and the proportion of residential area, age of the household head, and proportion of single-person households were used as implicit stratification criteria. From the initial 8,110 households, we identified 1,735 individuals aged ≥ 65 years. After excluding 370 individuals with missing data on key variables (handgrip strength, nutritional intake surveys, or socioeconomic surveys), a total of 1,365 participants were included in the final analysis. The 1,365 individuals represented 7,253,900 older Koreans.

Research tools

1. Demographics

To understand the basic socioeconomic and health status, we analyzed sex, age, average monthly household income (KRW), household income quintile (first to fifth), education, and marital status.

2. General health characteristics

A body mass index (BMI) of 25 kg/m^2 was considered normal for Asians; > 25 kg/m^2, obese; and < 18.5 kg/m^2, underweight [17], Subjective health status was analyzed on a 5-point scale ranging from very poor to excellent. Strength training was assessed as the number of days per week of strength training, and aerobic physical activity practice was assessed as practicing (1) or not practicing (0) an equivalent of 2 hours 30 minutes or more of moderate-intensity physical activity, 1 hour 15 minutes or more of vigorous-intensity physical activity, or a combination of moderate- and vigorous-intensity physical activity (1 minute of moderate intensity equal to 2 minutes of vigorous intensity) per week.

3. Objective nutrient intake variable

Dietary intake data were collected using the 24-hour recall method conducted by trained nutritionists. Participants were interviewed about all foods and beverages consumed during the previous day [16]. Nutrient intake was then calculated using the Standard Food Composition Table provided by the Rural Development Administration of Korea. A variable for adequate nutrient intake per body weight was created, and then a nominal variable to categorize adequate, inadequate, and poor nutrient intake was created and analyzed [14]. The total caloric intake was 30 kcal per body weight, with 1 g per body weight of protein, 25 g per day of fiber, and 1.6 L of fluids for women and 2.0 L for men. Of the five principles outlined in the ESPEN guidelines, micronutrient supplementation was not included in the analysis because relevant data were unavailable in the raw data. Therefore, adequacy was analyzed using the following four criteria: total energy, protein, fiber, and water intake. Adequacy was also scored by coding the nutrient intake as 0 for inadequate and 1 for adequate, with a minimum of 0–4 on a 5-point scale.

4. Food insecurity

Food insecurity was assessed using the following item from the KNHANES: 'Which of the following best describes your family's dietary habits over the past year?' Participants chose one of four responses: (1) 'We could eat enough food and a variety of foods,' (2) 'We could eat enough food but not a variety of foods,' (3) 'We sometimes could not eat enough food because of financial difficulties,' and (4) 'We often could not eat enough food because of financial difficulties'.

5. Sarcopenia risk

Grip strength of the dominant hand was used to screen for sarcopenia according to the Asian Working Group for Sarcopenia criteria. In general, sarcopenia is expected if the force is less than 28 kg in men and less than 18 kg in women [18,19].

Statistical analysis

STATA 17.0 was used to analyze the data. From the 8,110 households surveyed, we identified 1,735 individuals aged 65 years or older. After excluding 370 individuals with missing data on key variables, a total of 1,365 participants were included in the final analysis. Since the KNHANES employs a complex sample design, we did not delete the excluded individuals by listwise deletion but set conditions to define the data as 1 and recode the other individuals as 0. Additionally, to consider the composite sample design in the analysis, we used appropriate weights considering the strata, clusters, and corresponding survey sectors, areas, and items. In this study, we used a combination of health surveys, screenings, and nutritional variables and applied appropriate sample weights to account for the complex survey design, including stratification and clustering. First, we analyzed the concentration and scatter of nominal variables, such as demographic characteristics, socioeconomic status, and disease morbidity, by frequency and percentage and continuous variables by means and

standard deviations. For frequencies, we report unweighted sample counts, whereas for percentages, we report weighted values as percentages of the population. Second, the chi-squared test was conducted to determine food insecurity by income quintile and to test for differences between groups. Third, we analyzed the objective adequacy of nutritional intake by comparing it with the ESPEN guidelines according to income quintiles. Fourth, logistic regression analysis was performed on the effects of nutritional intake and exercise status using handgrip strength as an indicator of sarcopenia risk. Statistical significance was set at $p < 0.05$.

Results

General characteristics and health habits

General characteristics of the study population are summarized in Table 1. The final analysis included 1,365 participants, representing a weighted population of approximately 7.25 million Korean older adults. The average age was 72.68 years, with 42.56% male and 57.4% female participants. Household income was divided into quintiles: the mean income of the first quintile was 67.23 ± 1.80; third quintile, 303.92 ± 6.05; and fifth quintile, 877.28 ± 39.75. The highest number of participants were in the lowest income quintile, with 542 (36.7%) in the first quintile, 194 (15.4%) in the third, and 91 (7.3%) in the fifth. Regarding education level, 768 (52.9%) participants had less than an elementary school diploma. Additionally, 903 (68.4%) were married and living with a spouse, while 377 (25.3%) were widowed. Regarding BMI, 44 (3.2%) participants were underweight, 847 (63.0%) had a normal weight, and 478 (33.8%) were obese. Most participants (n = 1,112, 80.4%) did not perform strength training at all. In contrast, 929 (67.5%) participants adequately practiced aerobic exercises. Regarding muscle strength, 353 (24.6%) participants were at risk of sarcopenia according to sex.

Food insecurity by income quintile

Food insecurity status by income quintile is summarized in Table 2. In the first income quintile, 197 participants (36.5%) believed they have sufficient food and variety, a lower proportion than those in other income quintiles. In the third income quintile and above, no one felt that the amount of food, and not variety, was insufficient. However, 55 (8.1%) and 12 (3.2%) people in the first and second quintiles, respectively, said they sometimes lacked food, and 13 (2.5%) and 4 (0.9%) said they often lacked food. Since these data are representative of 7,253,900 older people, we can estimate that approximately 818,867 (11.3%) of older adults in South Korea are sometimes food insecure, and approximately 318,446 (4.4%) are often food insecure, based on the weighted percentages of the first and second quintiles combined.

Analysis of objective nutritional intake according to ESPEN guidelines by income quintile

Objective nutritional intake according to ESPEN guidelines by income quintile is summarized in Table 3. When each of the four components was scored for adequacy, 579 (40.9%) participants consumed below the standard for all four components, while 330 (24.8%), 195 (15.2%), 213 (15.3%), and 48 (3.8%) adequately consumed one, two, three, and all four components, respectively. Looking at each category separately, 385 (28.3%) participants adequately consumed total energy, with a high proportion of people consuming less energy than their body weight, and 459 (35.7%), 627 (46.2%), and 80 (6.0%) participants adequately consumed protein, fiber, and water, respectively.

When scoring adequate nutrition by income quintile, older adults in the first income quintile were particularly likely to score zero (51.1%). Regarding total energy intake, no statistically significant differences ($p > 0.05$) were observed across the income quintiles. However, when broken down by nutrient, protein intake was particularly inadequate among older adults in the first income quintile, with 70.7% having inadequate intake, compared to participants in other income quintiles. Fiber intake was also inadequate, with 64.9% of participants in the first quintile having inadequate intake. No statistically significant difference ($p > 0.05$) in fluid intake according to income quintile was observed.

How socioeconomic variables, nutrition, and exercise affect sarcopenia risk

Table 4 presents the results of logistic regression analysis examining the association between socioeconomic status, nutritional intake, exercise, and sarcopenia risk in Korean older adults. Age was a significant predictor of sarcopenia based on handgrip strength, with a 1.13-fold increase in the odds of sarcopenia per year ($p < .001$). Based on the first income quintile, those in the second quintile were 0.61 times less likely to experience significant sarcopenia risk than those in the first quintile, indicating a 38.7% less likelihood ($p < .01$). However, from the third quintile onwards, the odds of developing sarcopenia were not significantly different from those in the first quintile. When comparing the impact of nutritional adequacy according to the ESPEN guidelines on the odds of sarcopenia risk, no significant association was observed between total energy, fiber, protein, or fluid intake ($p > .05$). By education, high school graduates were 0.45 times

Table 1. General Characteristics of Study Participants (*N*=1,365)

Variables	Categories	n (%) or M ± S.E	95% CI	
			lb	ub
Age		72.68 ± 0.18	72.32	73.04
Gender	Male	581 (42.6)	43.11	48.67
	Female	784 (57.4)	51.33	56.89
Family member	One-person households	330 (19.1)	16.68	21.76
	married couple	661 (45.6)	41.66	49.56
	1st generation household - other	6 (0.6)	0.21	1.45
	Second-generation household - couple, unmarried children	120 (12.5)	9.92	15.70
	Two-generation household - single parent, unmarried children	61 (6.0)	4.54	7.96
	2nd Generation Household - Other	93 (6.8)	5.19	8.95
	Households of 3 or more generations	98 (9.4)	7.14	12.26
Household income (10,000 KRW/month)	1st quintile	67.23 ± 1.80	63.68	70.77
	2nd quintile	176.07 ± 3.99	168.18	183.95
	3rd quintile	303.92 ± 6.05	291.97	315.87
	4th quintile	481.49 ± 12.30	457.19	505.79
	5th quintile	877.28 ± 39.75	798.68	955.88
Household income quintile (n, %)	1st quintile	542 (36.7)	32.62	40.94
	2nd quintile	395 (28.7)	25.45	32.24
	3rd quintile	194 (15.4)	13.04	18.05
	4th quintile	143 (12.0)	9.40	15.13
	5th quintile	91 (7.3)	5.62	9.30
Education	Below elementary school	768 (52.9)	48.88	56.91
	Junior high school	224 (16.8)	14.54	19.39
	Highschool	248 (19.7)	17.25	22.49
	Above University or college	125 (10.5)	7.94	13.81
Marital status	Currently married or cohabiting	903 (68.4)	65.03	71.61
	Formerly married but currently separated	18 (1.7)	0.98	2.78
	Widowed	377 (25.3)	22.59	28.10
	Divorced	55 (3.8)	2.73	5.39
	Single (never married)	12 (0.8)	0.45	1.56
BMI	Underweight (< 18.5 kg/m)^2	44 (3.2)	2.26	4.45
	Normal (18.5–25 kg/m^2)	847 (63.0)	59.69	66.16
	Obese (> 25 kg/m^2)	478 (33.8)	30.68	37.16
Resistance exercise	None	1,112 (80.4)	77.66	82.83
	1–2 days	41 (3.0)	2.20	4.19
	Over 3 days	212 (16.6)	14.24	19.22
Aerobic exercise	No	929 (67.5)	64.26	70.58
	Yes	436 (32.5)	29.42	35.74
Handgrip strength	Normal	1,012 (75.4)	72.29	78.31
	At risk	353 (24.6)	21.69	27.71

Unweighted count (weighted %); lb=lower bound; ub=upper bound;10,000 KRW was approximately 7.19 USD as of June 2024

more likely to have sarcopenia than those with a primary school education or less, and those with a college degree or higher were 0.442 times more likely to have sarcopenia, a reduction of 54.9% and 55.8%, respectively ($p < .01$, $p < .05$). Marital status did not show a significant difference ($p > .05$) when compared to other forms of status such as separation and divorce. For BMI, no significant differences were observed between the normal-weight and underweight groups, whereas being overweight was associated with a 0.61-fold (39.2%) decrease in the odds of sarcopenia risk ($p < .01$).

Table 2. Food Insecurity Status by Income Quintile of Older Adults in Korea (*N*=1,365)

Household income	Enough & diversity	Enough but not diverse	Lack of food sometimes	Lack of food often	Total (Column %)
	(Row %)				
1st quintile	197 (36.5)	277 (52.9)	55 (8.1)	13(2.5)	36.7
2nd quintile	191 (50.7)	188 (45.1)	12 (3.2)	4 (0.9)	28.7
3rd quintile	102 (51.4)	92 (48.6)	0 (0.0)	0 (0.0)	15.4
4th quintile	85 (57.2)	58 (42.8)	0 (0.0)	0 (0.0)	12.0
5th quintile	65 (71.4)	26 (28.6)	0 (0.0)	0 (0.0)	7.3
Total	640 (47.9)	641 (47.0)	67 (3.9)	17 (1.2)	100.0

Unweighted count (weighted %); χ^2= 95.48, F=5.72, p<.001

Table 3. Proper Nutritional Intake According to ESPEN Guidelines by Income Quintile (*N*=1,365)

Variables	Categories	Household income quintile					Total	*p*
		1st	2nd	3rd	4th	5th		
Total score (0–4)	0	287 (51.1)	149 (36.8)	59 (30.9)	55 (38.7)	29 (30.6)	579 (40.9)	.011
	1	107 (20.7)	107 (27.0)	58 (29.8)	32 (22.9)	26 (29.9)	330 (24.8)	
	2	71 (14.5)	56 (16.0)	32 (15.9)	20 (13.6)	16 (17.2)	195 (15.2)	
	3	64 (11.1)	66 (15.6)	37 (20.2)	30 (19.2)	16 (18.7)	213 (15.3)	
	4	13 (2.7)	17 (4.7)	8 (3.3)	6 (5.7)	4 (3.6)	48 (3.8)	
Total energy (≥ 30 kcal/kg)	Poor	410 (75.4)	280 (71.2)	132 (68.3)	97 (68.1)	61 (67.8)	980 (71.7)	.339
	Good	132 (24.6)	115 (28.8)	62 (31.7)	46 (31.9)	30 (32.2)	385 (28.3)	
Protein (≥ 1 g/kg)	Poor	393 (70.7)	257 (62.4)	115 (58.2)	85 (59.4)	56 (60.3)	906 (64.3)	.023
	Good	149 (29.3)	138 (37.6)	79 (41.8)	58 (40.6)	35 (39.8)	459 (35.7)	
Fiber (≥ 25 g/day)	Poor	353 (64.9)	192 (49.0)	82 (43.5)	72 (52.4)	39 (41.6)	738 (53.9)	< .001
	Good	189 (35.2)	203 (51.0)	112 (56.5)	71 (47.6)	52 (58.4)	627 (46.2)	
Water (Male ≥ 2.0L, Female ≥ 1.6L)	Poor	519 (95.5)	366 (93.0)	182 (94.9)	132 (89.9)	86 (95.4)	1285 (94.0)	.219
	Good	23 (4.5)	29 (7.0)	12 (5.1)	11 (10.2)	5 (4.6)	80 (6.0)	

Unweighted count (weighted %)

Compared with those who did not receive strength training, the odds of sarcopenia risk were reduced by 0.48 times (52%) among those who trained three or more days per week (p < .01). For aerobic exercise, the odds of sarcopenia risk were not significantly different compared with no exercise (p > .05).

Discussion

Poverty and Food Insecurity in Korean Older Adults

The poverty rate among older adults is the percentage of the older population whose income is below the poverty line, defined as less than half of the median household income. Among the OECD countries, Korea's overall poverty rate was 15.1% in 2021, while the poverty rate among older adults was 39.3%, ranking second. The gap between the overall poverty rate and the poverty rate among older adults seems to be quite high [20]. Consistent with this demographic trend, 36.68% of the participants in this study belonged to the lowest income quintile. Our findings confirm that socioeconomic disadvantage is directly linked to nutritional vulnerability. We estimated that approximately 11.33% of older adults are 'sometimes' food insecure, and 4.39% are 'often' food insecure. Older adults in the lowest income quintile were significantly more likely to experience food insecurity, indicating that financial constraints remain a primary barrier to obtaining a sufficient and diverse diet [12]. While food insecurity is a known risk factor for undernutrition and subsequent frailty [4-7], our study sought to determine whether this nutritional vulnerability directly translates into sarcopenia risk.

ESPEN guidelines for the Korean Population

A pivotal finding of this study is that nutrient adequacy based on the ESPEN guidelines—specifically for total energy, protein, fiber, and water—was not significantly associated with sarcopenia risk. This null finding warrants a critical re-evaluation of applying Western-centric standards to Asian populations.

First, regarding protein intake, standard interventions for sarcopenia emphasize adequate protein consumption combined with resistance exercise [3,21]. While our participants' average

Table 4. Logistic Regression Analysis: Association Between Socioeconomic status, Nutritional Intake, Exercise, and Sarcopenia risk in Korean Older Adults (*N*=1,365)

Dependent variable: Sarcopenia risk (grip strength)		Odds ratio	Linearized S.E.	t	*p*	95% CI	
						lb	Ub
Age		1.13	0.02	7.52	< .001	1.10	1.17
Household Income Quintile (ref. 1 quintile)	2nd quintile	0.61	0.11	-2.79	.006	0.43	0.87
	3rd quintile	0.71	0.19	-1.31	.192	0.42	1.19
	4th quintile	0.71	0.22	-1.13	.261	0.38	1.30
	5th quintile	0.73	0.25	-0.94	.351	0.38	1.42
Sex (ref. male)		0.93	0.16	-0.41	.681	0.66	1.31
Proper energy intake (ref. poor)		1.34	0.31	1.27	.207	0.85	2.10
Proper fiber intake (ref. poor)		0.87	0.15	-0.85	.397	0.62	1.21
Proper protein intake (ref. poor)		0.89	0.17	-0.59	.557	0.61	1.31
Proper water intake (ref. poor)		0.68	0.28	-0.93	.352	0.30	1.54
Education (ref. elementary)	Junior high school	0.84	0.17	-0.89	.377	0.57	1.24
	Highschool	0.45	0.12	-2.89	.004	0.26	0.78
	Above University or college	0.44	0.17	-2.09	.038	0.21	0.96
Marital status (ref. married)	Formerly married but currently separated	1.58	1.02	0.71	.476	0.45	5.63
	Widowed	0.90	0.16	-0.59	.559	0.64	1.27
	Divorced	0.97	0.43	-0.06	.953	0.41	2.32
	Single (never married)	0.60	0.40	-0.76	.447	0.16	2.23
BMI (ref. normal)	Underweight	1.92	0.80	1.55	.124	0.84	4.39
	Obesity	0.61	0.10	-2.97	.003	0.44	0.85
Muscular exercise day/week (ref. none)	1-2 days	0.62	0.43	-0.69	.489	0.16	2.44
	Over 3 days	0.48	0.13	-2.73	.007	0.28	0.82
Aerobic exercise (ref. no)		0.70	0.13	-1.93	.055	0.48	1.01
Constant		0.00	0.00	-7.53	< .001***	0.00	0.00

lb=lower bound; ub=upper bound.
F=6.78, p<0.001; Strata with single sampling unit treated as certainty units.

intake met the ESPEN recommendation of 1 g/kg, this threshold may be insufficient to prevent muscle loss in older adults. Previous studies indicate that higher intakes (1.2–1.5 g/kg) are necessary to significantly increase lean body mass, although functional improvements such as gait speed are not always observed [21,22]. Hong et al. [23] also found that protein intake below 1.2 g/kg increased the odds of sarcopenia. Our results support the notion that the current 1 g/kg guideline may not adequately reflect the clinical requirements for maintaining muscle function in Korean older adults. Further research is needed to establish population-specific cut-offs.

Second, regarding dietary fiber and water, although fiber is known to aid muscle protein synthesis via gut microbial balance [24,25], and hydration is critical for muscle cell volume and function [26,27], we found no significant protective effects. It is notable that 93.99% of our participants had inadequate water intake based on ESPEN standards. However, the lack of association with handgrip strength suggests that dynapenia (loss of strength) may operate through mechanisms distinct from those governed solely by fluid volume or fiber intake [1]. These findings imply that nutritional quantity alone, as defined by European standards, may not be the sensitive predictor of sarcopenia risk in Koreans, who typically consume a carbohydrate-heavy, plant-based diet.

The Role of Body Composition and Exercise

Unlike nutritional intake, physical factors such as BMI and exercise habits were significant predictors of sarcopenia risk. Interestingly, we observed an "obesity paradox" where higher BMI (overweight/obesity) was associated with a lower risk of sarcopenia. While sarcopenic obesity is generally detrimental due to inflammatory and hormonal mechanisms [28,29], in older adults, higher body mass can sometimes reflect greater metabolic reserves and protection against wasting. However, this interpretation requires caution, as higher BMI does not necessarily equate to healthy muscle quality [29].

Conversely, physical inactivity remains a critical modifiable risk factor. Our study confirmed that resistance exercise performed three or more days per week significantly reduced the odds of sarcopenia, whereas aerobic exercise did not. Resistance training directly activates muscle protein synthesis and improves insulin sensitivity, which are crucial for counteracting age-related sarcopenia [30,31]. Despite these benefits, participation rates in strength training among Korean older adults remain critically low (19.6%). This highlights the need for targeted public health campaigns that prioritize resistance training over general physical activity.

Structural Determinants of Sarcopenia

Perhaps the most important insight from this study is the discrepancy between socioeconomic predictors and nutritional factors. While low income and education levels were robust predictors of sarcopenia risk, current nutrient adequacy was not. This suggests that the impact of socioeconomic status (SES) on sarcopenia is not mediated solely through the quantity of nutrient intake in old age. Instead, structural social determinants of health likely play a more pivotal role.

Older adults with lower SES may face cumulative physiological burdens, often referred to as 'allostatic load,' resulting from lifelong exposure to stress, limited access to safe environments for physical activity, and barriers to quality healthcare management for chronic diseases [32]. These structural disadvantages can accelerate muscle decline independently of current dietary intake. Therefore, public health interventions restricted to improving food access may be insufficient to mitigate sarcopenia risk in vulnerable populations. Policies should instead focus on addressing the root causes of health inequities by creating supportive environments that facilitate resistance exercise and integrated chronic disease management for low-income older adults, rather than relying exclusively on nutritional supplementation [13].

Limitations

This study has limitations. First, its cross-sectional design utilizing KNHANES data prevents establishing causal relationships between variables. Second, the potential effects of unmeasured confounders, such as genetic factors or specific medication use, were not considered. Third, dietary data were derived from a 24-hour recall, which may be subject to memory bias. Nevertheless, the use of a complex sample design with weighted estimates ensures that our findings regarding sarcopenia risk and food insecurity are highly representative of the Korean older adult population.

Conclusions

In conclusion, this study identified that socioeconomic disadvantage and physical inactivity are the primary determinants of sarcopenia risk among Korean older adults, whereas nutritional adequacy based on ESPEN guidelines showed no significant association. This discrepancy highlights that the impact of low socioeconomic status on muscle health is likely mediated by broader structural determinants—such as limited access to health resources or exercise environments—rather than by dietary deficits alone.

Therefore, public health strategies must evolve beyond simple nutritional supplementation or food support programs. To effectively prevent sarcopenia in an aging society, policies should prioritize addressing health inequities and creating accessible environments that facilitate resistance training, particularly for vulnerable low-income populations. Future research is needed to establish population-specific nutritional standards that accurately reflect the physiological needs of Korean older adults.

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Conflict of interest

The authors declared no conflict of interest.

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Authors contributions

Dasom Kim contributed to conceptualization, data curation, formal analysis, methodology, project administration, writing - original draft, review & editing, investigation, resources, validation, supervision, funding acquisition, and software.

Data availability

Please contact the corresponding author for data availability.

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References

1. Manini TM, Clark BC. Dynapenia and aging: an update. The Journals of Gerontology: Series A. 2012;67(1):28–40. https://doi.org/10.1093/gerona/glr010
2. Shen Y, Shi Q, Nong K, Li S, Yue J, Huang J, et al. Exercise for sarcopenia in older people: a systematic review and network meta-analysis. Journal of Cachexia, Sarcopenia and Muscle. 2023;14(3):1199–1211. https://doi.org/10.1002/jcsm.13225
3. Rolland Y, Dupuy C, Abellan van Kan GA, Gillette S, Vellas B. Treatment strategies for sarcopenia and frailty. Medical Clinics of North America. 2011;95(3):427–438. https://doi.org/10.1016/j.mcna.2011.02.008
4. Nazri NS, Vanoh D, Leng SK. Malnutrition, low diet quality and its risk factors among older adults with low socio-economic status: a scoping review. Nutrition Research Reviews. 2021;34(1):107–116. https://doi.org/10.1017/S0954422420000189
5. Chang SF. Frailty is a major related factor for at risk of malnutrition in community-dwelling older adults. Journal of Nursing Scholarship. 2017;49(1):63–72. https://doi.org/10.1111/jnu.12258
6. Leroux J, Cox J, Rosenberg M. Food insecurity and aging: a scoping study of the literature. Canadian Journal on Aging. 2020;39(4):662–696. https://doi.org/10.1017/S071498081900059X
7. Lee JS, Frongillo EA Jr. Nutritional and health consequences are associated with food insecurity among US elderly persons. The Journal of Nutrition. 2001;131(5):1503–1509. https://doi.org/10.1093/jn/131.5.1503
8. Moon S, Oh E, Chung D, Choi R, Hong GS. Malnutrition as a major related factor of frailty among older adults residing in long-term care facilities in Korea. PLoS ONE. 2023;18(4):e0283596. https://doi.org/10.1371/journal.pone.0283596
9. Kim N, Kim GS, Won CW, Lee JJ, Park MK, Shin J, et al. Two-year longitudinal associations between nutritional status and frailty in community-dwelling older adults: Korean Frailty and Aging Cohort Study. BMC Geriatrics. 2023;23(1):216. https://doi.org/10.1186/s12877-023-03903-4
10. Leslie W, Hankey C. Aging, nutritional status and health. Healthcare. 2015;3(3):648–658. https://doi.org/10.3390/healthcare3030648
11. Han GS, Yang EJ. Evaluation of dietary habit and nutritional intake of Korean elderly: data from Korea National Health and Nutrition Examination Survey 2013-2015. Journal of East Asian Society of Dietary Life. 2018;28(4):258–271. https://doi.org/10.17495/easdl.2018.8.28.4.258
12. Han E, Chung S. Prevalence of and factors associated with food insecurity among the mid and old age householders by age group in South Korea. Korean Journal of Gerontological Social Welfare. 2018;73(2):141–170. https://doi.org/10.21194/kjgsw.73.2.201806.141
13. Commission on Social Determinants of Health. Closing the gap in a generation: health equity through action on the social determinants of health [Internet]. Geneva: World Health Organization; 2008 [cited 2024 Jun 4]. Available from: https://www.who.int/publications/i/item/WHO-IER-CSDH-08.1
14. Volkert D, Beck AM, Cederholm T, Cruz-Jentoft A, Goisser S, Hooper L, et al. ESPEN guideline on clinical nutrition and hydration in geriatrics. Clinical Nutrition. 2019;38(1):10–47. https://doi.org/10.1016/j.clnu.2018.05.024
15. Volkert D, Beck AM, Cederholm T, Cereda E, Cruz-Jentoft A, Goisser S, et al. Management of malnutrition in older patients-current approaches, evidence and open questions. Journal of Clinical Medicine. 2019;8(7):974. https://doi.org/10.3390/jcm8070974
16. Korea Disease Control and Prevention Agency. Korea Health Statistics 2019: Korea National Health and Nutrition Examination Survey (KNHANES VIII-1) [Internet]. Cheongju: Korea Disease Control and Prevention Agency; 2020 Dec 31 [cited 2024 Jun 4]. Available from: https://knhanes.kdca.go.kr/knhanes/main.do
17. Li Z, Daniel S, Fujioka K, Umashanker D. Obesity among Asian American people in the United States: A review. Obesity. 2023;31(2):316–328. https://doi.org/10.1002/oby.23639
18. Won CW. Diagnosis of sarcopenia in primary health care. Journal of the Korean Medical Association. 2020;63(10):633–641. https://doi.org/10.5124/jkma.2020.63.10.633
19. Chen LK, Liu LK, Woo J, Assantachai P, Auyeung TW, Bahyah KS, et al. Sarcopenia in Asia: consensus report of the Asian Working Group for Sarcopenia. Journal of the American Medical Directors Association. 2014;15(2):95–101. https://doi.org/10.1016/j.jamda.2013.11.025
20. OECD. Poverty rate 2021 [Internet]. Paris: OECD; c2024 [cited 2024 Jun 4]. Available from: https://data.oecd.org/inequality/poverty-rate.htm
21. Lin CC, Shih MH, Chen CD, Yeh SL. Effects of adequate dietary protein with whey protein, leucine, and vitamin D supplementation on sarcopenia in older adults: an open-label, parallel-group study. Clinical Nutrition. 2021;40(3):1323–

1329. https://doi.org/10.1016/j.clnu.2020.08.017
22. Bauer JM, Verlaan S, Bautmans I, Brandt K, Donini LM, Maggio M, et al. Effects of a vitamin D and leucine-enriched whey protein nutritional supplement on measures of sarcopenia in older adults, the PROVIDE study: a randomized, double-blind, placebo-controlled trial. Journal of the American Medical Directors Association. 2015;16(9):740–747. https://doi.org/10.1016/j.jamda.2015.05.021
23. Hong J, Shin WK, Lee JW, Kim Y. Relationship between protein intake and sarcopenia in the elderly with nonalcoholic fatty liver disease based on the fourth and fifth Korea National Health and Nutrition Examination Survey. Metabolic Syndrome and Related Disorders. 2021;19(8):452–459. https://doi.org/10.1089/met.2021.0011
24. Prokopidis K, Cervo MM, Gandham A, Scott D. Impact of protein intake in older adults with sarcopenia and obesity: A gut microbiota perspective. Nutrients. 2020;12(8):2285. https://doi.org/10.3390/nu12082285
25. Montiel-Rojas D, Nilsson A, Santoro A, Franceschi C, Bazzocchi A, Battista G, et al. Dietary fibre may mitigate sarcopenia risk: findings from the NU-AGE cohort of older European adults. Nutrients. 2020;12(4):1075. https://doi.org/10.3390/nu12041075
26. Lorenzo I, Serra-Prat M, Yébenes JC. The role of water homeostasis in muscle function and frailty: a review. Nutrients. 2019;11(8):1857. https://doi.org/10.3390/nu11081857
27. Li S, Xiao X, Zhang X. Hydration status in older adults: current knowledge and future challenges. Nutrients. 2023;15(11):2609. https://doi.org/10.3390/nu15112609
28. Benz E, Pinel A, Guillet C, Capel F, Pereira B, De Antonio M, et al. Sarcopenia and sarcopenic obesity and mortality among older people. JAMA Network Open. 2024;7(3):e243604. https://doi.org/10.1001/jamanetworkopen.2024.3604
29. Axelrod CL, Dantas WS, Kirwan JP. Sarcopenic obesity: emerging mechanisms and therapeutic potential. Metabolism: Clinical and Experimental. 2023;146:155639. https://doi.org/10.1016/j.metabol.2023.155639
30. Hurst C, Robinson SM, Witham MD, Dodds RM, Granic A, Buckland C, et al. Resistance exercise as a treatment for sarcopenia: prescription and delivery. Age and Ageing. 2022;51(2):afac003. https://doi.org/10.1093/ageing/afac003
31. Martín Del Campo Cervantes J, Habacuc Macías Cervantes M, Monroy Torres R. Effect of a resistance training program on sarcopenia and functionality of the older adults living in a nursing home. The Journal of Nutrition, Health and Aging. 2019;23(9):829–836. https://doi.org/10.1007/s12603-019-1253-1
32. Gruenewald TL, Seeman TE, Ryff CD, Karlamangla AS, Singer BH. Allostatic load and frailty in older adults. Journal of the American Geriatrics Society. 2012;60(9):1697–1704. https://doi.org/10.1111/j.1532-5415.2012.04115.x