



Feature Article

Sarcopenia influences fall-related injuries in community-dwelling older adults



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ABSTRACT

This study aimed to determine the relationship between sarcopenia and fall-related injuries in community-dwelling older adults in Korea. The study population comprised 2848 subjects aged 65 years or older who participated in the Korea National Health and Nutrition Examination Surveys during 2010–2011. Sarcopenia was considered to be present if the subject's appendicular skeletal muscle mass divided by his or her weight was less than 29.9% in men, or less than 25.1% in women. The incidence of fall-related injuries during the past year among all the respondents was 4.3%, and the prevalence of sarcopenia was 32.2%. After controlling for sociodemographic variables and morbidity due to chronic diseases, the incidence of fall-related injuries remained significantly elevated among older adults with sarcopenia (odds ratio = 1.61, 95% confidence interval = 1.01–2.54). Sarcopenia should be considered when investigating means of preventing of fall-related injuries in community-dwelling older adults. To prevent falls among these persons, it is vital to implement intervention programs that increase muscle mass.

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Introduction

Among older adults, falls are one of the most common accidents that can cause disability or impairment.^{1,2} Approximately 28%–35% of older adults are reported to fall each year, worldwide.³ Further, it has been reported that 21%–48% of older adults in Korea experience falls each year.^{4,5} Of these individuals who experienced falls, 80% developed an injury and 63% received treatment at a hospital.⁵ In the United States, falls are the second largest contributor to the economic burden of injuries (in terms of lifetime costs).² Similarly, health care expenditure associated with fall-related injuries is expected to rise in Korea, accompanying rapid increases in the size of the elderly population.

Accidental falls among community-dwelling older adults have been shown to contribute to hospital visits, nursing home placements, and functional decline.^{6,7} Therefore, it is critical to identify risk factors for accidental falls in the community.^{8–10} In a systematic review, muscle strength, gait, and balance impairments were found to be the strongest risk factors for falls among community-dwelling older adults.¹ In particular, lower or upper extremity muscle weakness significantly increased the odds ratio (OR) for

injurious falls.¹¹ However, limited information is available regarding the independent effect of loss of skeletal muscle mass with aging and its association with muscle strength and falls.¹²

The loss of skeletal muscle mass that occurs with aging is known as sarcopenia. Previous investigations have shown that sarcopenia is closely associated with declining muscle quality¹³ and muscle strength in the older population.¹⁴ Sarcopenia is considered to play a crucial role in the frailty process, leading to poor outcomes, including falls, multiple trauma, functional decline, disability, poor quality of life, nursing home placement, and mortality.¹² Nonetheless, findings regarding the relationship between sarcopenia and falls have been inconsistent.^{15–17} Thus, it is essential to clarify the independent relationship between sarcopenia and falls. Indeed, doing so may lay the groundwork for interventions that successfully prevent falls among community-dwelling older adults.

Therefore, the aim of the current study was to assess the influence of sarcopenia on fall-related injuries in community-dwelling older adults in Korea. To increase the validity of our findings, we used the Korea National Health and Nutrition Examination Survey (KNHANES), which is nationally representative.

Methods

Study population and data collection

Data on subjects were obtained from KNHANES V-1 and V-2. KNHANES is a nationwide survey on health and nutrition status,

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conducted by the Korea Centers for Disease Control and Prevention. It provides baseline data for developing health promotion programs and health-related policies. Study subjects in the KNHANES were randomly sampled according to stratified regions, gender, age composition, and average size and price of housing. Data were collected throughout the year 2010 for KNHANES V-1 and 2011 for KNHANES V-2. In total, the survey was completed by 81.9% of the interviewed subjects in KNHANES V-1 and 80.4% of those in KNHANES V-2. Of the 17,476 subjects in both surveys, 3076 who were 65 years or older were selected for the current study. After excluding 228 subjects who did not respond to the questionnaire on falls, a total of 2848 participants were included for analysis in this study.

Assessment of fall-related injuries and sarcopenia

We defined fall-related injuries as unintentional injuries due to falls or sliding accidents during the past year. Fall-related injuries were assessed using the following questions. First, participants were asked, "Have you ever experienced accidents that required treatment at a hospital or emergency room?" Respondents who answered, "Yes," were additionally asked, "How did the accident occur?" Older adults were considered to have experience with fall-related injuries if they reported accidental falls from high locations or had accidentally slipped onto the ground and been treated by health care providers.¹⁸

To measure sarcopenia, we adopted a formula in which the appendicular skeletal muscle mass (ASM) is divided by total weight.^{19,20} Appendicular muscle mass was measured using dual-energy X-ray absorptiometry (Discovery-W; Hologic Inc., Waltham, MA, USA) by determining differences in the transmittance of each subject's body composition. As a component of KNHANES, a dual-energy X-ray absorptiometry was performed on all study subjects at a mobile examination center. According to a previous study in an older Korean population, members of the sarcopenic group were more likely to have cardiometabolic risk factors than were members of the normal community-based elderly cohort.²¹ In that study, the sarcopenic group included subjects who met the defined criteria for sarcopenia (ASM/weight, <29.9% in men and <25.1% in women).

Data analysis

Descriptive statistics were used to analyze subjects' socio-demographic characteristics. In light of the inherent statistical complications involved in multistage, complex survey designs, the investigators followed the guidelines of KNHANES for the analysis of sample weights. By using these weights appropriately, the stratification and clustering of the design were incorporated into the analyses to ensure appropriate estimates and standard errors.²² *t*-tests and chi-square tests were employed to test differences between subjects who had and had not experienced fall-related injuries.

To assess whether sarcopenia had an independent influence on fall-related injury (above and beyond the influences of potential confounders), we applied a hierarchical multiple logistic regression analysis. The regression analysis was used to estimate the relationship between sarcopenia and the risk of fall-related injuries after adjusting for covariates.²³ In model 1, we included demographic variables that may be associated with falls or sarcopenia^{3,4,24}: age, gender, educational difference, income, and marital status. In model 2, we additionally incorporated covariates related to disease morbidity: stroke, arthritis, diabetes, and depression.^{1,25} Finally, model 3 included each covariate in model 2, as well as sarcopenia status, which was thereby adjusted for demographic

variables and disease morbidity. In the multiple logistic regression analyses, education and income were treated as continuous variables. Multicollinearity was ruled out using Spearman's rho for correlation analyses, the results of which demonstrated low correlations between predictors ($\rho < 0.45$ for all variables).²³ Additionally, the absence of multicollinearity was supported by multiple linear and logistic regression analyses, in which the low percentage of variance for each predictor was accounted for by the other predictors (R^2 or pseudo- $R^2 < 0.12$ for all predictors). An alpha level of 0.05 was selected for assessments of statistical significance. Data were analyzed using SPSS 19.0 (SPSS, Inc., Chicago, IL, USA) complex samples procedures.

Results

Table 1 shows the characteristics of the participants according to history of fall-related injuries. Of the 2848 participants, 120 (4.3%) had experienced one or more fall-related injuries in the past year. The mean (standard deviation) age was 73.17 (0.14) years, and 58.8% of the participants were women.

In univariate analyses, the incidence of fall-related injuries differed significantly according to gender. Women accounted for 71.2% of the respondents who had experienced fall-related injuries, and men accounted for 28.8% ($\chi^2 = 7.97, p = 0.022$). The incidence of falls however did not differ according to age, education, income, living arrangement, or body mass index. Older adults who had experienced fall-related injuries had higher rates of morbidity in terms of stroke (7.9% vs. 3.4%, $\chi^2 = 7.04, p = 0.013$) and depression (4.7% vs. 2.1%, $\chi^2 = 3.82, p = 0.049$). However, no significant differences were observed for arthritis or diabetes mellitus. Of the total respondents, 1404 (49.3%) had sarcopenia. Subjects with sarcopenia were significantly more likely to have experienced fall-related injuries (63.3% vs. 48.7%, $\chi^2 = 5.96, p = 0.008$).

Table 1
Characteristics of participants ($N = 2848$).

Variables	Total ($n = 2848$)	Fallers ($n = 120$)	Non fallers ($n = 2728$)	χ^2/t	p
	n (%)				
Age, year (mean (SE))	73.17 (0.14)	73.41 (0.49)	72.93 (0.13)	0.97	0.335
Gender					
Women	1675 (58.8)	85 (71.2)	1590 (58.3)	7.97	0.022
Men	1173 (41.2)	35 (28.8)	1138 (41.7)		
Education					
Less than elementary school graduate	2047 (71.9)	89 (73.9)	1958 (71.8)		
Middle school graduate	313 (11.0)	14 (11.7)	301 (11.0)	2.05	0.574
High school graduate	327 (11.5)	14 (11.6)	313 (11.5)		
More than a college graduate	159 (5.6)	3 (2.7)	156 (5.8)		
Income quartile					
Low	772 (27.1)	37 (31.2)	735 (27.0)		
Middle-low	722 (25.3)	27 (22.3)	695 (25.5)	1.33	0.764
Middle-high	702 (24.7)	28 (23.1)	674 (24.7)		
High	652 (22.9)	28 (23.4)	624 (22.9)		
Living arrangement					
Living alone	478 (16.8)	25 (21.0)	453 (16.6)	1.66	0.287
Living with others	2370 (83.2)	95 (79.0)	2275 (83.4)		
Morbidity of disease					
Stroke	103 (3.6)	9 (7.9)	94 (3.4)	7.04	0.013
Arthritis	803 (28.2)	41 (33.8)	762 (28.0)	1.95	0.307
Diabetes	501 (17.6)	24 (19.9)	477 (17.5)	0.46	0.499
Depression	63 (2.2)	6 (4.7)	57 (2.1)	3.82	0.049
Sarcopenia	1404 (49.3)	76 (63.3)	1328 (48.7)	5.97	0.008
Body mass index (mean (SE))	23.72 (0.10)	24.08 (0.33)	23.71 (0.10)	1.16	0.237

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