



Associations between Frailty in Older Adults and Malnutrition in Rural Areas: 2019 Updated Version of the Asian Working Group for Sarcopenia

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Purpose: The purpose of this study was to evaluate the prevalence of frailty among an older adult population living in rural communities and to determine if frailty is associated with nutritional status after adjusting for sarcopenia and depression.

Materials and Methods: This research used baseline data from the Namgaram-2 study. Frailty was evaluated using the Kaigo-Yobo checklist in an older Korean population. The nutritional statuses of older people were measured using the Korean version of the mini nutritional assessment (MNA). The recent criteria of the Asian Working Group for Sarcopenia were applied for diagnosis of sarcopenia, and depression was assessed using the Geriatric Depression Scale-Short Form.

Results: The prevalence of frailty was 18.8% (male: 9.6%; female: 23.4%) and was significantly higher in individuals in their 80s [male, 35.3% ($p<0.001$); female, 42.3% ($p<0.001$)], those of poor economic status [male, 18.2% ($p=0.012$); female, 34.9% ($p<0.001$)], those with hypertension [female, 27.7% ($p=0.008$)], those with sarcopenia [male, 34.1% ($p<0.001$); female, 37.2% ($p<0.001$)], those with depression [male, 46.4% ($p<0.001$); female, 51.7% ($p<0.001$)], and those at high risk of malnutrition [male, 44.4% ($p<0.001$); female, 51.7% ($p<0.001$)]. After adjusting for demographic variables, including hypertension, diabetes, sarcopenia and depression, frailty was significantly associated with nutritional status [male: odds ratio (OR)=6.73, 95% confidence interval (CI), 1.84–24.65; female: OR=4.83, 95% CI, 2.88–8.11].

Conclusion: For older adults, MNA is a suitable tool of use in assessing both nutritional status and frailty. Moreover, the nutritional status of older adults appears to be associated with frailty, even after corrections for physical and psychological function.

Key Words: Frailty, sarcopenia, malnutrition, depression, older adult

INTRODUCTION

From 1970 to 2017, the percentage of individuals aged 65 years

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and over increased from 3.1% to 13.8%.¹ In a 2017 study of life expectancy in 35 countries, Korea was predicted to become the most super-aged society in the world by 2030, with an average age of 86.7 years. Accordingly, studies on ageing have become increasingly relevant.²

Different from ageing, frailty is a pathological disorder that is very vulnerable to stress due to decreases in hormonal reserves that mediate organ functions inside the body. The reduction in physiological reserves inevitably inhibits the body's ability to sustain homeostasis, leaving people susceptible to various stresses.³ As consequences thereof, impaired performance of the body and an increased risk of falls, hospitalizations, and residential dwellings leads to a decline of health-related quality of life.⁴⁻⁷ Frailty assessment can help maintain a healthy state through appropriate intervention before progression to irre-

versible conditions, such as disability or death.

A number of risk factors for frailty have been reported and include disease factors, weakened muscle function, nutritional factors, and psychosocial factors. Interestingly, several studies have demonstrated an overlap in physical function impairment between frailty and sarcopenia.^{8,9} Also, among psychological factors, depression has been shown to be significantly associated with frailty.¹⁰

Optimal nutrition is important for not only disease prevention, but also facilitation of independence in life.¹¹ Recently, study results investigating the relationship between nutritional status and frailty in older adults have indicated that nutritional risk groups are highly associated with frailty. In fact, inadequate nutrient intake increases dependency among older individuals and the need for care, resulting in fatigue, reduced quality of life, and increased hospitalization rates.^{11,12} There are many studies showing that malnutrition is also related with sarcopenia and depression.^{13,14} However, few studies have simultaneously found links between frailty and sarcopenia, depression, malnutrition, and comorbidities.

The purpose of this study was to determine the prevalence of frailty in older adults in Korea and to determine whether malnutrition, which is also related to sarcopenia and depression, is related to frailty after correction for sarcopenia and depression.

MATERIALS AND METHODS

Participants

This research used the baseline data from the Namgaram-2 study, which was designed to examine the association between the incidence of musculoskeletal disorders and disabilities of activity in older adults in rural areas.¹⁵ A one-on-one conversation study was performed by a pre-trained investigator. Participants were excluded if they had cardiovascular disease, cognitive disorders, stroke, and/or malignancy. Evaluation of cognitive performance for participants with no cognitive function disorders was performed via an interview study utilizing the Korean version of the Mini-Mental State Examination for Dementia Screening. After participants completed a questionnaire, blood was collected from the participants, followed by physical function evaluation. All investigations were conducted after obtaining participant consent and after being reviewed by the Institutional Review Board of our institution (GIRB-A16-Y-0012).

Assessment tool

The survey used variables of sex, age, marital status, economic level, smoking history, hypertension, diabetes, nutritional risk, and nutritional risk. Economic level was subjectively considered as rich, middle, and poor, and smoking was investigated as current smoking and non-smoking. Hypertension and diabetes were used as comorbid diseases. Hypertension and diabe-

tes were investigated according to whether the study participants were currently being treated with drugs.

Frailty (Kaigo-Yobo checklist in older Korean adults)

The Kaigo-Yobo checklist¹⁶ was developed by researchers at the Tokyo Senior Research Institute, and the reliability and validity in Koreans have been confirmed.¹⁷ The checklist consists of 15 questions and focuses on social activities and evaluation of daily life. The Kaigo-Yobo checklist is a complex domain phenotype aging assessment tool and comprises questions only. For a total of 15 items, there are four items on nutritional status, three items on falls, two items on activity, two items on social relationships, and one item each on general health status, communication, mobility, and leisure activities. Further, the appropriate answer to each query was 'Yes' or 'No', and a score of one point was possible for each query, making a total of 15 points. Finally, cases with four or more points were classified as exhibiting frailty.

Nutritional status

Nutritional status was measured using the Korean edition of the mini nutritional assessment (MNA),¹⁸ which was downloaded from the Nestle Nutrition Institute (www.mna-elderly.com). The MNA consists of 18 questions [anthropometric measurements (four questions), global assessment (six questions), dietary assessment (six questions), and two questions related to subjective assessment of health and nutrition], with the total MNA score ranging from 0 to 30. The total score was used to classify patients into well nourished (MNA score ≥ 24.0), at risk of malnutrition (MNA score = 17.0–23.5), or malnourished (MNA score < 17). In the final analysis, there were 9 (1.0%) with less than 17 points, which were divided into well-nourished (24 points or more) and at-risk of malnutrition (23.5 points or less).

Sarcopenia

Although several criteria have been proposed to define sarcopenia, the recent criteria of the Asian Working Group for Sarcopenia were applied in this study.¹⁹

Dual energy X-ray absorptiometry was used to measure muscle mass. In addition, the measured total appendicular skeletal muscle mass (ASM), excluding bone and fat, divided by the square of the height (m^2) was calculated (ASM/Ht^2) and used as the skeletal muscle mass index (SMI). Low muscle mass was defined as SMI less than 7.0 kg/m^2 in male and less than 5.4 kg/m^2 in female.

Muscle strength was evaluated by grip strength, and the measurement was conducted using the Smedley-type dynamometer (TKK 5401; Takei Scientific Instruments Co., Tokyo, Japan), alternately evaluating both hands, twice each. Grip strength was recorded as the maximum value of four measured values. The criteria for low muscle mass strength were below 18 kg in female and below 28 kg in male. A short physical performance battery was applied to evaluate physical per-

formance, and when the total score totaled nine points or less, the physical performance was defined as reduced. Sarcopenia was defined as low muscle mass and strength, or reduced physical performance.¹⁷

Depression

To understand the symptoms of depression in the older adults, the Korean version of the Geriatric Depression Scale-Short Form-Korean (GDSSF-K), which has been adapted and developed for aged people in Korea, was used.²⁰ The GDSSF-K has the advantage of comprising items that are easy for older adults to understand relative to other current depression measurement tools. This scale of 15 items is graded from 0 to 15 points: a total score of 0–5 indicates normal, and a score of 6 and over indicates depression (mild and severe).

Statistical analysis

The general characteristics of the participants are described as statistics. The chi-square test was conducted for categorical variables, and the t-test was performed for continuous variables. Multiple logistic regression analysis was conducted to determine the association between nutritional status and frailty. After adjusting for sociodemographic variables, comorbidity, sarcopenia, and depression, multiple logistic regression analysis was performed for both male and female.

The SPSS 25.0 program (IBM Corp., Armonk, NY, USA) was used as the analysis tool, and the significance level was set to 0.05.

RESULTS

General characteristics

A total of 881 older people over 60 years old was evaluated, and 590 (67.0%) were female. The average participant age was 70.3±6.21 years, 560 (63.6%) participants had spouses, and 463 (52.6%) had higher than average economic status. The smoking rate was 7.5%, 444 (50.4%) were diagnosed with hypertension, 192 (21.8%) were diagnosed with diabetes, 286 had sarcopenia (32.5%), and 143 (16.2%) were at risk of malnutrition. The frailty prevalence was 18.8%. There were significant differences between male and female in age groups, smoking status, hypertension, depression, sarcopenia, and nutritional status (Table 1).

Prevalence of frailty according to general characteristics, sarcopenia, and nutritional status

Table 2 shows the prevalence of frailty according to general characteristics. The prevalence of frailty in male and female was significantly higher in participants in their 80s [male, 35.3% ($p<0.001$), female 42.3% ($p<0.001$)], those with poor economic status [male, 18.2% ($p=0.012$), female, 34.9% ($p<0.001$)], those with hypertension [female, 27.7% ($p=0.008$)], those with sarco-

Table 1. General Characteristics of the Participants

Variables	Total	Male	Female	<i>p</i> value
Age	70.3±6.21	69.1±5.79	70.9±6.33	<0.001
Spouse				<0.001
Yes	560 (63.6)	262 (90.0)	298 (50.5)	
No	321 (36.4)	29 (10.0)	292 (49.5)	
Economic status				0.005
Rich	152 (17.3)	67 (23.0)	85 (14.4)	
Middle	463 (52.6)	147 (50.5)	316 (53.6)	
Poor	266 (30.2)	77 (26.5)	189 (32.0)	
Smoking				<0.001
Yes	66 (7.5)	57 (19.6)	9 (1.5)	
No	815 (92.5)	234 (80.4)	581 (98.5)	
Hypertension				0.017
Yes	444 (50.4)	130 (44.7)	314 (53.2)	
No	437 (49.6)	161 (55.3)	276 (46.8)	
Diabetes mellitus				0.253
Yes	192 (21.8)	70 (24.1)	122 (20.7)	
No	689 (78.2)	221 (75.9)	468 (79.3)	
Sarcopenia				<0.001
Yes	286 (32.5)	44 (15.1)	242 (41.0)	
No	595 (67.5)	247 (84.9)	348 (59.0)	
Depression				<0.001
Yes	183 (20.8)	40 (13.7)	143 (24.2)	
No	698 (79.2)	251 (86.3)	447 (75.8)	
MNA				<0.001
≤23.5	143 (16.2)	27 (9.3)	116 (19.7)	
≥24.0	738 (83.8)	264 (90.7)	474 (80.3)	
Frailty				<0.001
Frailty	166 (18.8)	28 (9.6)	138 (23.4)	
Robust	715 (81.2)	263 (90.4)	452 (76.6)	

MNA, mini nutritional assessment.

Data are presented as mean±standard deviation or n (%).

penia [male, 46.4% ($p<0.001$), female, 51.7% ($p<0.001$)], those with depression [male, 34.5% ($p<0.001$), female, 49.0% ($p<0.001$)] and those at high risk of malnutrition [male, 44.4% ($p<0.001$), female, 51.7% ($p<0.001$)].

Factors associated with frailty

Table 3 shows the association between malnutrition and frailty. In male, nutritional status [odds ratio (OR)=6.73, 95% confidence interval (CI), 1.84–24.65] was statistically significant. Similarly, in female, there were statistically significant associations with malnutrition (OR=4.83, 95% CI, 2.88–8.11).

DISCUSSION

Health is an ever-changing state, and the process of aging may improve or worsen health status over time. There is increasing interest in two categories of health status in older adults, frail-

ty and sarcopenia.²¹ Moreover, nutrition is a key factor in the development of these two health states and can play a powerful role in prevention and treatment. Even when correcting for

Table 2. Prevalence of Frailty according to General Characteristics and Nutritional Status

	Male (%)	p value	Female (%)	p value
Age (yr)		<0.001		<0.001
60–69	5.9		14.7	
70–79	11.5		27.6	
>80	35.3		42.3	
Spouse		0.143		0.013
Yes	8.8		19.1	
No	17.2		27.7	
Economic status		0.012		<0.001
Rich	7.5		11.8	
Middle	6.1		19.6	
Poor	18.2		34.9	
Smoking		0.808		0.478
Yes	8.8		33.3	
No	9.8		23.2	
Hypertension		0.319		0.008
Yes	11.5		27.7	
No	8.1		18.5	
Diabetes		0.129		0.130
Yes	14.3		26.2	
No	8.1		22.6	
Sarcopenia		<0.001		<0.001
Yes	34.1		37.2	
No	5.3		13.8	
Depression		<0.001		<0.001
Yes	46.4		51.7	
No	5.2		16.5	
MNA		<0.001		<0.001
≤23.5	44.4		51.7	
≥24.0	6.1		16.5	
Total	9.6		23.4	

MNA, mini nutritional assessment.

sarcopenia and depression, which are closely associated with frailty, nutritional status was associated with frailty in both male and female.

In this study, the prevalence of frailty was 18.8%, with more female than male being affected. In a study of other rural areas²² frailty was noted in 17.4% of individuals when the criteria were based on Fried classification, and the prevalence of the frailty was 27.5% when the K-FRAIL tool was used. According to Murayama, et al.,²³ using a questionnaire similar to the same survey tool,²² the incidence of frailty in urban residents in Japan was 10.6%. They also reported that the prevalence of frailty varied based on the survey instrument used and characteristics of the population.

In a study conducted in other rural areas of Korea, 22 the overall prevalence of nutritional risk was 37.9% (male; 30.5%, female; 43.7%). However, the nutritional risk group in the present study comprised 16.2% of the population (male; 9.3%, female; 19.7%), lower than that of Jung, et al.²² It may be concluded that there is a discrepancy attributable to variations in participant characteristics (age difference, geographical discrepancies, etc.), but the gold standards for identifying frailty have not been defined. In the absence of a device to accurately determine the nutritional status of older adults, MNA may be a relatively simple but useful tool for assessing sarcopenia and frailty.

Recently, study results investigating the relationship between nutritional status and frailty in older adults have also reported that nutritional status measured by MNA was suitable as a tool for predicting frailty.^{24–26} The studies also indicated that nutritional risk groups were highly associated with frailty. Soysal, et al.²⁵ reported that the MNA-short form has high specificity in predicting frailty, as it consists of not only nutrition, but also body measurement questions, overall physical and psychological assessment questions, dietary assessment questions, and health and nutrition awareness questions.

Nutritional research on prevention and management of frailty, including sarcopenia, has indicated that healthier diets, Mediterranean diets, etc., mainly improve physical activity and

Table 3. Multiple Logistic Regression Results of Frailty according to General Characteristics, Depression, Sarcopenia, and Nutritional Status

	Male			Female		
	OR	95% CI	p value	OR	95% CI	p value
Age (yr)	1.06	0.97–1.15	0.175	1.02	0.98–1.07	0.308
Spouse (no vs. yes)	0.54	0.12–2.53	0.434	0.78	0.48–1.28	0.329
Economic (rich)	1.00			1.00		
Economic (poor)	1.18	0.31–4.54	0.805	3.25	1.41–7.50	0.006
Economic (middle)	0.25	0.06–1.10	0.067	1.90	0.85–4.25	0.119
Smoking (yes vs. no)	0.46	0.12–1.76	0.255	0.61	0.11–3.48	0.578
Hypertension (yes vs. no)	1.28	0.47–3.47	0.625	1.69	1.06–2.70	0.029
Diabetes (yes vs. no)	1.82	0.64–5.15	0.261	0.86	0.50–1.48	0.585
Depression (yes vs. no)	4.81	1.54–15.07	0.007	2.84	1.75–4.60	<0.001
Sarcopenia (yes vs. no)	6.19	1.98–19.31	0.002	3.20	1.93–5.31	<0.001
MNA (≤23.5 vs. ≥24.0)	6.73	1.84–24.65	0.004	4.83	2.88–8.11	<0.001

MNA, mini nutritional assessment; OR, odds ratio; CI, confidence interval.

gait speed, reducing the risk of falls.²⁷ In addition, high total protein intake can prevent aging regardless of protein source and amino acids constituting the protein.²⁸ Further, supplementing protein intake in older people may reduce progression of functional disability.²⁹ Therefore, it is important to educate older individuals on appropriate dietary requirements or to recommend diets comprising the required nutritional needs to successfully increase physical function therein. Regardless of whether frailty or malnutrition occurs more preferentially, there may be a cyclical link between these two during progression. This link is associated with a gradual increase in the prevalence of frailty between the well-nourished and malnourished groups, and the prevalence of malnutrition gradually increases with frailty. However, this result should be further investigated in prospective follow-up studies. In the absence of frailty, malnutrition was associated with low function decline and death, whereas in the presence of frailty, malnutrition was associated with a relatively greater increase in frailty.²⁴

This study has several limitations. First, since it was conducted as a cross-sectional study, the temporal relationship between frailty and malnutrition was unclear, and information on the physical activity of the participants was insufficient. Second, the relationship between cognitive function and nutritional status was not confirmed, because participants with cognitive function problems were excluded. Third, the definition of frailty was used only as a questionnaire, and pre-frail was not defined.

Nevertheless, our research has strengths, including that it was targeted at many population groups, and the criteria for sarcopenia were defined using the most recent guidelines and then adjusted for the relationship between frailty and nutritional status.

In conclusion, for older populations, MNA is suitable as a tool for assessing not only nutritional status, but also frailty. Also, the nutritional status of older adults is associated with frailty even after correcting for physical and psychological function.

AUTHOR CONTRIBUTIONS

Conceptualization: Ae-Rim Seo, Ki-Soo Park, and Jun-Il Yoo. **Data curation:** Ae-Rim Seo, Bokyoung Kim, Gyeong-Ye Lee, and Young-Mi Seo. **Formal analysis:** Ae-Rim Seo, Mi-Ji Kim, Bokyoung Kim, Gyeong-Ye Lee, and Young-Mi Seo. **Funding acquisition:** Ki-Soo Park. **Methodology:** Ae-Rim Seo, Mi-Ji Kim, Ki-Soo Park, and Jun-Il Yoo. **Project administration:** Ae-Rim Seo, Bokyoung Kim, Gyeong-Ye Lee, and Young-Mi Seo. **Writing—original draft:** Ae-Rim Seo, Ki-Soo Park, and Jun-Il Yoo. **Writing—review & editing:** Ae-Rim Seo, Ki-Soo Park, and Jun-Il Yoo. **Approval of final manuscript:** all authors.

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