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Factors Related to Hospital Readmission of Frail Older Adults in Korea

Ji Yeon Lee[1]*, Kwang Joon Kim[2]*, Ji Won Choi[3], Tae Hee Kim[3], and Chang Oh Kim[2]

[1]Yonsei University College of Nursing and Mo-Im Kim Nursing Research Institute, Seoul;
[2]Division of Geriatrics, Department of Internal Medicine, Yonsei University College of Medicine, Seoul;
[3]Division of Geriatrics, Yonsei University Health System, Seoul, Korea.

Purpose: Frail older adults have a higher risk of hospital readmission due to decline in physical, functional, and psychological health status. The impact of readmission on individuals, families, or the healthcare system is tremendously devastating. This study aimed to investigate factors associated with hospital readmission of frail older adults.

Materials and Methods: This was a retrospective descriptive study based on multi-professional health assessments found in electronic medical records of patients from a university-affiliated hospital in Seoul, Korea. The participants were 141 older adults who were admitted to the geriatric department with medical problems. Frailty, components of the comprehensive geriatric assessment including nutrition, physical functions, psychological and cognitive status, clinical data including length of hospital stay, and readmission within 30, 90, and 180 days were collected. Survival analysis was performed, and Cox proportional hazard regression model was used to investigate the risk factors for readmission.

Results: The statistically significant variables at each time point were slightly different. However, at most time points, disease-related problems (i.e., comorbidities and medications) and body functions (i.e., grip strength and physical activity) were included. The median duration until readmission was 27 days, and grip strength was found to be significantly related to readmission (p=0.020).

Conclusion: After discharge, both medical services to manage the medical condition and intervention to maintain physical function are needed to prevent frail older adults from being readmitted to the hospital.

Key Words: Aged, frailty, geriatric assessment, hand strength, patient readmission

INTRODUCTION

Frailty is a condition characterized by increased vulnerability to stressors (physical, physiological, psychological, or social), which is generally observed in older adults, and is associated with a reduced physiological function.[1] Complex health problems, such as sarcopenia, lack of strength and energy, decline of physical function, malnutrition, aging, and comorbidities, are intertwined with frailty.[2] The concept of frailty is clinically useful, especially in the geriatric field, as older adults often complain of geriatric symptoms (e.g. general weakness or loss of appetite) that are not limited to a specific disease. Abundant evidence has shown that frailty is associated with adverse outcomes, such as prolonged length of hospital stay (LOS), mortality, and readmission.[3-5]

Since hospitalized older adults are more vulnerable than other individuals of the same age due to their acute medical problems, hospitalization can have a significantly negative impact on frail older adults.[6,7] Indeed, hospitalization can result in further functional or cognitive decline, as well as emotional distress, in frail older adults.[8,9] Furthermore, hospital readmission increases medical costs and care burden, and may lead to further deterioration of health status. In 2018, the Korean government spent 3.8 billion won in medical costs related to hospital admission, which was 51% of the total costs of admission in Korea.[10,11]

Frailty is a risk factor for readmission in older patients. Emerg-

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Corresponding author: Chang Oh Kim, MD, PhD, Division of Geriatrics, Department of Internal Medicine, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.
E-mail: cokim@yuhs.ac

*Ji Yeon Lee and Kwang Joon Kim contributed equally to this work.
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ing evidence supports that, due to the presence of multiple health-related deficits, improving the health status of frail older patients remains challenging.[12,13] In the United States, the readmission rate of frail older adults was 27% and 33% for pneumonia and acute myocardial infarction, respectively in 2019.[14] In a systematic review of 12 studies, a high number of readmission was reported in frail older adults who were not on disease-specific pathways; specifically, 11% to 24% at 1 month and 38% to 52% between 6 and 12 months, respectively.[15] Frail older adults who have been recently discharged from the hospital may require comprehensive care to manage acute symptoms and exacerbation of chronic illnesses; however, it may be difficult for them to manage health-related problems on their own, due to their frail condition. Despite efforts to reduce unplanned readmission of frail older adults, the readmission rate remains high.[16] This may be due to the fact that frail older adults have problems in multiple domains, including physical, functional, or psychological health status. Research on frail older adults has not yet identified the risk factors for hospital readmission. Indeed, most studies have focused on a specific disease (e.g., pneumonia or cardiovascular diseases), and there has been a lack of studies regarding hospital readmission focusing on frailty itself. Therefore, this study aimed to investigate the factors associated with hospital readmission among frail older adults.

MATERIALS AND METHODS

This was a retrospective descriptive study using data collected from the electronic medical records of older patients who were admitted to the geriatric division of Yonsei University-affiliated tertiary hospital between October 2017 and October 2019. Among all of the patients who were admitted to the geriatric division during this period, comprehensive geriatric assessment (CGA) was performed on those who could benefit from CGA according to the judgement of geriatricians. From the complete samples of CGA over 2 years, we evaluated a total of 141 older adults who were categorized as frail based on the Korean version of the FRAIL scale,[17] who lived at home before admission and were discharged back home. CGA was performed and interpreted by the geriatric team (i.e., geriatricians, a gerontological nurse practitioner, and registered nurses with more than 3 years of experience in caring for older adults). All team members received CGA training to ensure quality of CGA performance. The reasons for admission included sepsis, cancer, impaired cognition or depression, heart failure, renal problems, uncontrolled diabetes mellitus, respiratory problems, including pneumonia and influenza, and gastrointestinal problems, including gastrointestinal bleeding.

Variables and measures

The primary outcomes were all-cause and unplanned readmissions within 30, 90, and 180 days. Readmissions were coded as "Yes" or "No" at each time point.

Frailty was assessed using the Korean version of the FRAIL scale,[17] which is developed from the original FRAIL scale.[18] It is a self-reported questionnaire consisting of items: fatigue, resistance, ambulation, illness, and weight loss. A score of 0 or 1 was given for each item, and a score between 3 and 5 indicated frailty.

The CGA, which is a multidimensional evaluation process, was applied by well-trained healthcare professionals and included various measurement tools. The components of the CGA consisted of basic items, nutrition, physical activity, mobility, functional status, depression, and cognition. Basic items included grip strength, self-rated health (SRH), fall incidence over the past year, smoking, alcohol consumption, unintentional weight loss, medications, and medical history. Nutrition was assessed using the short version of the Mini Nutritional Assessment (MNA), with a score ranging from 0 to 15, and a higher score denoting good nutritional status.[19] Physical activity and mobility were assessed by the Timed Up and Go test (TUG) and the Korean version of the International Physical Activity Questionnaire (IPAQ).[20] For the TUG test, each patient was asked to stand from a chair, walk 3 meters and return, and sit back down on the chair. The weekly metabolic equivalent (MET) was calculated from the IPAQ, and a higher MET score was associated with increased physical activity. To assess functional status, the Korean Activities of Daily Living (K-ADL) and Korean Instrumental Activities of Daily Living (K-IADL) were used, with a lower score on both the ADL and IADL, indicating greater independence in daily living.[21] The Korean version of the Mini-Mental Status Examination for Dementia Screening (MMSE-DS) was used for cognitive evaluation.[22] It consisted of 30 items, with a higher score being associated with normal cognitive capacity. Depression was screened using the Korean version of the Geriatric Depression Scale short form, scores ranging from 0 to 15, with a higher score indicating a greater risk for depression.[23] The SRH was rated from 1 ("I feel that I am not very healthy") to 5 ("I feel that I am very healthy"). Medical history was assessed based on the number of diseases of each patient and the Charlson Comorbidity Index (CCI), which assesses illness severity in 16 disease categories and provides a weighted score based on the severity of disease in each category.[24] Additionally, other clinical data were collected from the electronic medical records, and the length of hospital stay (LOS) was calculated based on the dates of admission and discharge. Results of laboratory blood testing, including white blood cell count, haemoglobin, platelet, calcium, phosphate, glucose, blood urea nitrogen, creatinine, albumin, C-reactive protein, and erythrocyte sedimentation rate, were included accordingly.

Statistical analysis

All analyses were performed using the STATA software (version 13.0; StataCorp, College Station, TX, USA). First, demo-

graphic, clinical, and CGA data were analyzed using descriptive statistics. Then, bivariate analysis was performed to explore the relationship between readmission and each variable using independent t-tests and Pearson's chi-square tests. Finally, logistic regression analysis at each point was conducted by including variables that were found to have an influence on readmission (e.g., age, sex, health habits, and physical activity) in previous studies as independent variables,[7,15] and considering the variables showing statistical significance in the bivariate analysis of the current study (e.g., MMSE score at 180-day) as covariates. Multicollinearity was identified in the regression analysis, and it was considered for variable selection (e.g., ADL and IADL) in the final analysis. In addition, survival analysis was performed. First, bivariate analysis was conducted to compare the readmission group to the no-readmission group for each variable. Then, a multivariate Cox proportional hazard regression model was used to find risk factors for readmission using variables that showed statistical significance in bivariate analysis. Multicollinearity was also considered for variable selection during this step. We plotted survival curves using the Kaplan-Meier method.

Ethics statement

This study was approved by Severance Hospital Institutional Review Board (approval No. 4-2019-0928).

RESULTS

As shown in Table 1, the mean age was 84.7±6.4 years, and 92 patients (65%) were female. The incidence of falls in the past year was 55 (39%). More than half of the patients reported their health status as unhealthy (64%) or average (23%), and only 13% rated their health as good. Grip strength was 10.5±5.0 kg in female patients and 19.0±6.0 kg in male patients. The number of diseases was 4.4±2.2, the number of medications taken was 9.9±6.5, and the CCI score was 3.9±2.8. The TUG test could be performed on only 36 older adults, and the mean duration of the 3-meter walking test was 17.2±7.8 sec. The mean score was 5.4±4.2 in ADL and 3.8±3.1 in IADL. The mean MNA score was 8.3±3.1, and only 18% had normal nutritional status. The MET was 194.6±455.8, indicating that most older adults had a sedentary lifestyle and only a few individuals maintained active or minimum physical activity levels. Due to refusal or health status, MMSE and GDS were assessed in 131 participants (16.7±9.6) and 114 participants (6.0±4.9), respectively. With respect to LOS, a wide range of results were observed, with an average of 13.9±18.6 days. Regarding readmission, there were 28 cases of 30-day readmission, 42 cases of 90-day readmission, and 50 cases of 180-day readmission (20%, 30%, and 36%, respectively).

Table 2 shows the variables that are significantly associated with readmission based on the three time points. Statistically significant variables differed according to each time point, but

Table 1. Characteristic of Study Participants (n=141)

Variables	Value
Age (yr)	84.7±6.4
Sex (female)	92 (65)
Frailty score	
3	69 (49)
4	57 (40)
5	15 (11)
Education level	
<Middle school (6 years of education)	58 (48)
≥Middle school	62 (52)
Smoking (never)	105 (75)
Alcohol drinking (yes)	6 (4)
Past fall incidence within 1 year (yes)	55 (39)
Self-rated health	4.2±1.8
Healthy	16 (13)
Average	29 (23)
Unhealthy	80 (64)
Grip strength (kg) (n=115)	13.5±6.7
Female (n=75)	10.5±5.0
Male (n=40)	19.0±6.0
Number of medications	9.9±6.5
Number of diseases	4.4±2.2
Charlson Comorbidity Index	3.9±2.8
Timed Up and Go test (sec) (n=36)	17.2±7.8
Activities of daily living	5.4±4.2
Instrumental activities of daily living	3.8±3.1
Mini Nutritional Assessment score	8.3±3.1
Normal	25 (18)
At risk of malnutrition	58 (41)
Malnourished	58 (41)
Physical activity (metabolic equivalent)	194.6±455.8
Mini-Mental State Examination score (n=131)	16.7±9.63
Normal	93 (71)
Impaired	38 (29)
Geriatric Depression Scale score (n=114)	6.0±4.9
Normal	50 (44)
Depression	64 (56)
Length of hospital stay (day)	13.9±18.6
Laboratory	
White blood cell ($\times 10^3$/μL)	7.7±3.1
Red blood cell ($\times 10^3$/μL)	3.4±0.6
Haemoglobin (g/dL)	10.6±1.9
Platelet ($\times 10^3$/μL)	228.8±103.0
Albumin (mg/dL)	3.1±0.6
Calcium (mg/dL)	8.4±0.8
Inorganic P (mg/dL)	3.8±6.3
Glucose (mg/dL)	135.9±65.5
Blood urea nitrogen (mg/dL)	26.0±18.9
Creatinine (mg/dL)	1.9±5.5
C-reactive protein (mg/L)	47.4±60.8
Erythrocyte sedimentation rate (mm/hr)	48.0±38.9
Readmission	
30 days	28 (20)
90 days	42 (30)
180 days	50 (36)

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

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Table 2. Differences in Demographic, Comprehensive Geriatric Assessment, and Clinical Data by Readmission Within 30, 90, and 180 Days

Variables	30 days			90 days			180 days		
	No (n=113)	Yes (n=28)	*p* value	No (n=99)	Yes (n=42)	*p* value	No (n=91)	Yes (n=50)	*p* value
Age (yr)	84.6±6.3	84.9±7.0	0.804	84.8±6.3	84.5±6.8	0.831	84.6±6.3	84.9±6.8	0.808
Sex			0.272			0.341			0.712
Male	42 (37)	7 (25)		37 (37)	12 (29)		33 (36)	16 (32)	
Female	71 (63)	21 (75)		62 (63)	30 (71)		58 (64)	34 (68)	
Frailty	3.6±0.1	3.5±0.1	0.477	3.6±0.1	3.6±0.1	0.982	3.6±0.1	3.4±0.1	0.739
Fall incidence			0.033			0.260			0.148
No	63 (56)	22 (79)		57 (58)	28 (68)		51 (56)	34 (69)	
Yes	49 (44)	6 (21)		42 (42)	13 (32)		40 (44)	15 (31)	
Self-rated health	4.3±1.8	4.0±1.5	0.547	4.3±1.7	4.4±1.9	0.563	4.2±1.7	4.3±1.8	0.711
Nutrition	8.2±3.1	8.5±2.9	0.639	8.3±3.2	8.1±2.9	0.603	8.3±3.2	8.1±2.8	0.742
CCI	3.6±2.7	5.0±0.6	0.018	3.6±2.7	4.6±3.0	0.040	3.5±2.7	4.6±3.0	0.016
Number of medications	9.2±6.2	12.9±7.1	0.007	9.1±6.4	11.9±6.3	0.018	9.3±6.3	11.1±5.9	0.016
Number of diseases	4.2±2.1	5.2±2.5	0.037	4.2±2.1	5.0±2.4	0.032	4.1±2.0	5.0±2.4	0.012
ADL	5.3±4.2	6.1±4.4	0.370	5.0±4.2	6.4±4.1	0.066	4.9±4.1	6.4±4.2	0.034
IADL	3.6±3.0	5.0±3.3	0.031	3.4±3.0	5.0±3.1	0.003	3.2±2.9	5.0±3.1	0.001
Grip strength	14.2±6.7	10.3±5.9	0.018	14.6±6.7	10.3±5.6	0.002	14.7±6.8	10.9±5.9	0.003
MET	210.8±478.8	129.2±348.0	0.399	221.1±475.6	131.9±404.0	0.289	235.4±491.4	120.4±376.1	0.153
MMSE	17.0±9.7	15.2±9.4	0.396	17.5±9.6	14.8±9.7	0.146	18.1±9.3	14.1±11.3	0.023
GDS	6.3±4.9	5.1±4.8	0.293	6.2±5.0	5.7±4.8	0.664	6.0±5.0	6.2±4.8	0.849
LOS (day)	12.4±8.9	19.5±37.7	0.071	11.9±8.7	18.4±31.2	0.061	12.0±10.1	17.3±9.2	0.101

ADL, activities of daily living; CCI, Charlson Comorbidity Index; GDS, geriatric depression scale; IADL, instrumental activities of daily living; LOS, length of hospital stay; MMSE, Mini-Mental State Examination; MET, metabolic equivalent.
Data are presented as mean±standard deviation or n (%).

Table 3. Logistic Regression for Readmission Within 30, 90, and 180 Days

Variables	30 days (n=114)		90 days (n=114)		180 days (n=104)	
	OR	95% CI	OR	95% CI	OR	95% CI
Age	0.92	0.81 to 1.05	0.94	0.85 to 1.04	1.06	0.96 to 1.14
Sex (ref: male)	0.56	0.07 to 4.50	0.49	0.08 to 2.84	0.15	0.02 to 1.09
Smoke (ref: never)	0.30	0.03 to 2.69	1.23	0.23 to 6.53	0.91	0.16 to 4.98
Alcohol (ref: no)	5.53	0.27 to 11.31	0.37	0.14 to 9.29	0.07	0.01 to 1.40
Fall incidence (ref: no)	0.25	0.06 to 1.04	0.60	0.21 to 1.75	0.39	0.13 to 1.19
CCI	1.34	1.06 to 1.68	1.24	1.03 to 1.51	1.21	0.99 to 1.48
Number of medications	1.09	1.01 to 1.18	1.08	1.01 to 1.15	1.10	1.01 to 1.19
IADL	1.09	0.80 to 1.47	1.04	0.81 to 1.32	0.99	0.78 to 1.26
Grip strength	0.89	0.77 to 1.03	0.85	0.74 to 0.97	0.81	0.71 to 0.93
Physical activity	1.00	0.99 to 1.00	1.00	0.99 to 1.00	0.99	0.99 to 1.00
MMSE	-		-		1.03	0.93 to 1.14

CCI, Charlson Comorbidity Index; CI, confidence interval; IADL, instrumental activities of daily living; MMSE, Mini-Mental State Examination; OR, odds ratio.

generally included fall incidence, CCI score, number of medications and diseases, ADL and IADL score, grip strength, and MMSE score.

Among the variables related to readmission at each point, the CCI score [odds ratio (OR)=1.34, 95% confidence interval (CI) = 1.06 to 1.68] and number of medications (OR=1.09, 95% CI= 1.01 to 1.18) showed a significant correlation with 30-day readmission; meanwhile, CCI score (OR=1.24, 95% CI=1.03 to 1.51; OR=1.21, 95% CI=0.99 to 1.48), number of medications (OR=1.08, 95% CI=1.01 to 1.15; OR=1.10, 95% CI=1.01 to 1.19), and grip strength (OR=0.85, 95% CI=0.74 to 0.97; OR=0.81, 95% CI=0.71 to 0.93) were associated with 90-day and 180-day readmission (Table 3). Although the *p*-value was not less than 0.05 in the statistical test, the grip strength (OR=0.89, 95% CI= 0.77 to 1.03) and fall incidence (OR=0.25, 95% CI=0.04 to 1.04) in the 30-day readmission model was also close to being statistically significant.

The survival analysis is shown in the Supplementary data. The readmission group had a higher CCI, a higher number of diseases and medications, decreased physical function and

grip strength, and a lower MMSE score (Supplementary Table 1, only online). The Kaplan-Meier curve demonstrated that the median duration until readmission was 27 days with a mean of 43 days (Supplementary Fig. 1, only online). Controlling covariates including variables such as fall incidence, multivariate Cox proportional hazard regression model showed that the hazard ratio of readmission was significantly affected by the grip strength (HR=0.84, 95% CI=0.73 to 0.97) (Supplementary Table 2, only online).

DISCUSSION

The present study was designed to determine the factors associated with readmission in frail older adults who were admitted to the geriatric department of a single tertiary hospital in Korea. The CCI score and number of medications were associated with 30-day readmission, and disease-related factors and grip strength were associated with 90-day and 180-day readmissions, respectively. Taken together, these results suggest that disease-related factors are important for short-term readmission. On the other hand, physical function is also important along with disease-related factors for mid-to-long-term readmissions. In line with previous reports,[15] this study found that the readmission rate was 20% at 30 days and increased to 35% at 180 days.

In literature, hospital readmission rates varied according to the disease groups; however, the rate was frequently high in the frail group.[5] In a previous study, the 30-day readmission rates of older adults with high risk of frailty were 33% (n=6919/23058), 32% (n=26240/87126), and 27% (n=7791/30966) in acute myocardial infarction, heart failure, and pneumonia, respectively.[14] Compared to subjects with low risk of frailty, the odds ratio was almost three-fold (3.0, 2.9, 2.8, respectively) higher in all three diseases. In another study, frailty was associated with 1-year readmission, with a 1.96-fold increase compared to non-frail patients with heart failure,[25] and 3-year readmission in geriatric patients (hazard ratio=1.40).[5]

Comorbidities and polypharmacy are representative indicators of disease status in older adults. Studies have shown that Korean older adults consume 6.4 medications on average[26] and have 2.6 chronic diseases.[27] Although this number may vary by country, older people generally tend to take more medications compared to other age groups. In the present study, comorbidities and medications were associated with short-term readmission. This result was in line with other studies that investigated the relationship between comorbidities, polypharmacy, and frailty.[16,28] The startling result from a previous study was that the readmission rate of frail older adults with polypharmacy was five times at 30 days and eight times at 90 days, compared to non-frail older patients without polypharmacy.[28] The main reason for readmission was acute medical conditions or exacerbation of pre-existing chronic illness in frail older adults[16]; therefore, attention to this group of patients with polypharmacy, specifically focusing on the medical conditions immediately after hospital discharge, is needed to reduce short-term readmission in this population.

One notable and important finding of the present study was that the physical function of frail older adults at baseline, with number of medications, was associated with mid-to-long-term readmission, which was consistent with the results of a previous systematic review in which morbidity and functional dependence were reported as risk factors.[15] Another study also reported that functional independence and hospital admission in the past year was associated with readmission at 60 days.[29] Notably, in previous studies, the readmission rate was similar in the frail and non-frail groups (15% and 17%; respectively) at 30 days; in addition, among several factors, only slow walking speed was associated with an increase adjusted risk of 12-month readmission.[25] Also, physical function and comorbidities were reported predictors of 90-day readmission.[16] In the present study, most frail older adults were not even able to undergo the TUG test, which requires getting up from the chair/bed and walking 3 meters round trip, due to their physical and psychological health status or environmental constraints that interfered with ambulation. In this regard, grip strength, could be a good option for frail older adults, as it is an objective measurement and easily obtained, even in bedridden frail patients.

In summary, the factors identified and associated with readmission in frail older adults were disease-related factors and physical function. Clinicians should pay more attention to frail older adults who have multiple comorbidities, polypharmacy, and declined physical function due to the risk of readmission. In-hospital care should focus on recognizing these populations with complex healthcare needs and provide the necessary medical/nursing services at the time of discharge (i.e., establishing discharge planning, scheduling a follow-up plan, making timely, effective handoffs to primary care providers, and referring them to transitional care and the community service).[30,31]

This study had some limitations. First, the study was conducted in a single urban tertiary university hospital, and illness severity was expected to be very high; therefore, generalization of the results may be compromised. Second, we only counted readmissions to the same hospital, and data on mortality after readmission was not acquired. Third, we included geriatric patients with various medical problems. This heterogeneity regarding the reason for hospital admission made it difficult to evaluate the readmission rate for a specific disease; however, since we focused on frailty rather than the diseases, it would be worth identifying the risk factors by disease, which have already been identified earlier in a substantial number of studies. This study still had several strengths. Although the prevalence of frailty varied depending on the tools used and the clinical setting, the frail older adults in the hospital, especially in medical wards or geriatric centres, constituted approximately 80%–90% of the population.[32] Additionally, and we hoped to bring atten-

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tion to the frail older adult population, especially those at higher risk, and to their medical and physical health status, among the sub-domains of frailty, as key factors related to readmission.

In conclusion, the results of the present study add to the findings in the rapidly expanding field of geriatrics regarding the risk factors for hospital readmission in frail older adults. The factors identified were disease-related problems at 30 days, as well as disease-related problems and physical function at 90 and 180 days. At the time of discharge, clinicians, patients, and caregivers should be aware that frail older adults who have multiple comorbidities, polypharmacy, and declined physical function are at higher risk of hospital readmission. Therefore, after discharge, care programs to manage medical condition and maintain physical function are needed to prevent frail older adults from being readmitted to the hospital.

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AUTHOR CONTRIBUTIONS

Conceptualization: Chang Oh Kim, Kwang Joon Kim, and Ji Yeon Lee. Data curation: Ji Yeon Lee, Ji Won Choi, and Tae Hee Kim. Formal analysis: Ji Yeon Lee. Funding acquisition: Chang Oh Kim. Investigation: Kwang Joon Kim and Ji Yeon Lee. Methodology: Chang Oh Kim, Kwang Joon Kim, and Ji Yeon Lee. Project administration: Chang Oh Kim and Kwang Joon Kim. Resources: Chang Oh Kim, Kwang Joon Kim, and Ji Yeon Lee. Software: Ji Yeon Lee. Supervision: Chang Oh Kim and Kwang Joon Kim. Validation: Kwang Joon Kim and Ji Yeon Lee. Visualization: Kwang Joon Kim and Ji Yeon Lee. Writing—original draft: Ji Yeon Lee and Kwang Joon Kim. Writing—review & editing: Chang Oh Kim, Kwang Joon Kim, and Ji Yeon Lee. Approval of final manuscript: all authors.

ORCID iDs

Ji Yeon Lee https://orcid.org/0000-0003-1159-6068
Kwang Joon Kim https://orcid.org/0000-0002-5554-8255
Ji Won Choi https://orcid.org/0000-0002-8813-7276
Tae Hee Kim https://orcid.org/0000-0002-1357-3110
Chang Oh Kim https://orcid.org/0000-0002-0773-5443

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