ORIGINAL

How common is sarcopenia associated with frailty? Diagnosis using the Kihon Checklist

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Abstract : Purpose : We aimed to determine the association between sarcopenia and frailty in Japan's hyper-aged society. Methods : We investigated the incidence of sarcopenia and frailty among 423 community-dwelling older adults (304 women and 119 men ; mean age : 77.0 years). Interviews, Kihon Checklist (KCL) assessments, physical function tests, and anthropometric measurements were performed at baseline. Sarcopenia was defined according to the Asian Working Group for Sarcopenia 2019 criteria, with a KCL score of ≥7 indicating frailty. Results : Eight patients (1.9%) had sarcopenia alone, 113 (26.7%) had frailty alone, and 26 (6.1%) had both sarcopenia and frailty. The instrumental activities of daily living (IADL) scores were significantly higher in all groups. Logistic regression analysis showed the association of sarcopenia and frailty with IADL. The receiver operating characteristic curves of the total KCL and IADL scores were analyzed to determine the cutoff value for assessing sarcopenia with frailty. The cutoff value for the total KCL score was 7.000, while that for the KCL-IADL score was 2.000. Conclusion : Approximately 6.1% of patients were diagnosed with sarcopenia with frailty using the KCL. These conditions were found to impair IADL. Hence, interventions addressing both frailty and sarcopenia may help prevent the decline in IADL. J. Med. Invest. 72 : 139-147, February, 2025

Keywords **:** *Kihon Checklist, frailty, sarcopenia, instrumental activities of daily living, body composition*

INTRODUCTION

The proportion of older adults is increasing worldwide, with Japan experiencing rapid population aging (1). In addition, frailty and other geriatric syndromes have become significant challenges in Japan's efforts to reduce the medical and nursing care costs (2). Frailty is characterized by a loss of physiological reserve function due to the disruption of homeostasis in response to various stressors and is considered a risk factor for increased mortality, falls, and functional disability (3, 4). One contributing factor to frailty is sarcopenia, which results in the age-related loss of skeletal muscle mass, strength, and physical function (5). Sarcopenia and frailty are associated with geriatric syndromes caused by functional and physical decline. Previous studies have shown that sarcopenia is a risk factor for frailty (6). Although sarcopenia and frailty have been implicated as comorbidities, their prevalence and characteristics remain largely unknown.

The Cardiovascular Health Study (CHS) criteria are widely used to assess frailty. By contrast, the Kihon Checklist (KCL) can also be employed to identify frailty ; it is commonly used by the Japanese government as a screening tool for older adults at high risk of requiring nursing care, particularly those eligible for secondary prevention projects (7). Based on a cutoff value of ≥7 points, the KCL can determine frailty with a level of accuracy comparable to that of the CHS (8). The CHS criteria are specifically designed to assess physical frailty and require the measurement of grip strength, while the KCL can comprehensively assess frailty using only self-administered questions (8). However, the prevalence of sarcopenia with frailty, determined using the KCL, and its underlying factors and characteristics remain unknown.

Mori *et al*. reported the distribution of sarcopenia with frailty, determined based on the CHS criteria, in older adults aged ≥60 years, and found that 3.6% of the population had sarcopenia with frailty. Furthermore, older age, falls, quality of life, and dietary intakes of energy, protein, and vitamin D were associated with sarcopenia and frailty (9). However, the prevalence of sarcopenia with frailty, assessed using the KCL and the characteristics of the KCL domains remain unknown. We aimed to diagnose frailty using the KCL and investigate the prevalence of sarcopenia with frailty and the characteristics of the KCL domains in residents of Wakasa-cho, Mikata-Kaminaka-gun, Fukui Prefecture. Considering that the prevalence of frailty and sarcopenia vary depending on the diagnostic criteria, age, and race, we conducted a literature search to explore the prevalence of sarcopenia with frailty across different criteria and populations.

MATERIALS AND METHODS

Participants

This retrospective study included 550 older adults living in the area who participated in a sarcopenia screening conducted in Wakasa Town, Mikata-Kaminaka County, Fukui Prefecture, from 2020 to 2022. Recruitment was announced by Wakasa town officials through flyers and telephone calls. Medical examinations were performed at 30 community centers. Of the 550 participants, 16 had missing KCL data, 84 had missing gait speed data, eight had no anthropometric data owing to the use of a pacemaker, 18 had missing phase angle data, and one had missing data on all anthropometric measurements. After excluding one person with missing data, the final sample consisted of 423 participants.

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Ethical statement

This study was approved by the University of Fukui Medical Research Ethics Review Committee (approval no. : 20190014). All researchers involved in this study adhered to the Ethical Guidelines for Medical and Biological Research Involving Human Subjects (MEXT/MHLW/METI notification no. : March 1 23, 2021).

Measurements

After written consent was obtained from all recruited older adults, an examination consisting of the following components was conducted : 1) a basic interview, 2) measurement of physical function (gait speed, grip strength, and height), 3) measurement of body composition (weight, body mass index [BMI], basal metabolic rate, lean body mass, muscle mass, skeletal muscle mass index [SMI], appendicular lean mass, bone mass, body fat percentage, and phase angle), KCL-based assessments, and an explanation of the results. The results are as follows.

1) A basic interview was conducted to confirm age, sex, medical history (diabetes, hypertension, dyslipidemia, stroke, chronic kidney disease, and heart disease), lifestyle factors (smoking status and alcohol consumption), and history of hospitalization.

2) Grip strength in both hands was measured using a Smedley-type digital grip strength meter (Tsutsumi Corporation, Tokyo, Japan), and the maximum value was recorded. The reference grip strength values were set at 28.0 kg for men and 18.0 kg for women. Gait speed was determined by asking participants to walk in a straight line for 8 m. A normal gait speed was defined as completing 5 m within a distance of 1.5 and 6.5 m.

3) Body composition was measured using a body composition analyzer (MC-780A-N and MC-780A ; Tanita Corporation, Tokyo, Japan), and the phase angle was calculated as the average of the limbs.

KCL

The KCL comprises 25 self-reported yes/no questions, covering various domains : instrumental activities of daily living (IADL) (five questions), physical function (five questions), nutritional status (two questions), oral function (three questions), socialization (two questions), cognitive function (three questions), and depressed mood (five questions). Higher scores indicated a higher risk of requiring long-term care (7, 10). Based on previous studies, frailty was defined as a KCL score of $\geq$7 points (8).

Sarcopenia

Sarcopenia was diagnosed using the Asian Working Group for Sarcopenia 2019 (AWGS 2019) criteria. Individuals with reduced muscle strength, physical function, and muscle mass were defined as having sarcopenia (11). Muscle mass loss was defined as an SMI of $<$7.0 kg/m^2 in men and $<$5.7 kg/m^2 in women. Muscle weakness was defined as a maximum grip strength of 28 kg or less in men and 18 kg or less in women.

Literature search

A systematic literature review was conducted to identify studies evaluating the prevalence of sarcopenia and frailty in community-dwelling older adults in Asia. The systematic search was conducted on November 15, 2024, using the electronic databases PubMed (100 hits), Scopus (76 hits), and Web of Science (159 hits). The following search terms were used : ("sarcopenia" OR "sarcopenic") AND ("frailty" OR "frail") AND ("prevalence" OR "co-prevalence" OR "incidence" OR "concurrence" OR "co-occurrence" OR "comorbidity" OR "combination" OR "combined" OR "overlap" OR "duplication") AND ("older adults" OR "elderly" OR "aging population" OR "aged") AND ("community dwelling" OR "community based") AND ("Asia" OR "Asian" OR "East Asia" OR "South Asia" OR "Southeast Asia" OR "Japan" OR "China" OR "India" OR "Korea" OR "Singapore" OR "Thailand" OR "Malaysia"). Studies that [1] provided data on the prevalence of sarcopenia with frailty, [2] had clear diagnostic criteria for frailty, [3] had clear diagnostic criteria for sarcopenia, [4] identified the overall population, including the robust population, and [5] involved an Asian population with a mean or median age of 60 years or older were analyzed. By contrast, [1] conference abstracts, letters, experimental studies, and review articles ; [2] studies with incomplete data and duplicate publications ; [3] studies involving non-Asian populations ; [4] studies published in languages other than English ; and [5] studies without available full text were excluded. A flowchart was created to visualize the detailed process of selecting relevant literature in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (Fig. 1). To ensure data accuracy, duplicate articles were identified and removed from the process of extracting studies from the electronic databases using Microsoft Excel (Microsoft, Redmond, WA, USA). The full texts of the selected papers were then thoroughly reviewed according to the predefined eligibility criteria. All included studies were then classified based on their characteristics, and data extraction was performed. The authors independently extracted the data and verified their accuracy. From these studies, we manually extracted data on first author, year of publication, country of study, number of participants, average age, prevalence of sarcopenia with frailty in the overall population, prevalence by diagnostic criteria of frailty in the overall population, and prevalence by diagnostic criteria of sarcopenia in the overall population. Graphs were created based on the extracted data.

Statistical analysis

All statistical data were analyzed using the EZR ver. 1.61 (Saitama Medical Center, Jichi Medical University, Japan) (12). Continuous variables were expressed as the mean ± standard deviation. Nominal variables were expressed as the number of cases and frequency (%) of each item. For comparisons across the three groups, Fisher's exact test was used for nominal variables, while Kruskal–Wallis test was used for continuous variables.

Multiple comparisons were conducted using Holm's test. Table 4 shows the association between KCL-IADL and sarcopenia, frailty, and sarcopenia with frailty using ordinal logistic regression analysis to estimate the odds ratios (ORs) and corresponding 95% confidence intervals (CIs). The KCL-IADL (points, ordinal) was used as the objective variable, while robustness (continuous/people), sarcopenia (continuous/people), frailty (continuous/people), and sarcopenia with frailty (continuous/people) were used as explanatory variables. The following parameters were used. The association between frailty, sarcopenia with frailty, and KCL-IADL scores was assessed using a binomial logistic regression analysis to estimate the OR and 95% CI (Table 5). The objective variables were frailty and sarcopenia with frailty (binomial, frailty/sarcopenia with frailty), while the explanatory variables were age (continuous/years), sex (binomial, male/female), and KCL-IADL (continuous/points).

The cutoff values for the total KCL and KCL-IADL scores in the presence or absence of sarcopenia with frailty were confirmed using receiver operating characteristic (ROC) analysis. The sensitivity and specificity at each cutoff value were calculated, and ROC curves were generated based on these values. The ROC curve illustrates the relationship between sensitivity and 1-specificity (false-positive rate), which is useful for visually evaluating diagnostic performance. The area spread under the ROC curve (AUC) was subsequently calculated to assess discrimination accuracy. The AUC ranged from 0.5 to 1.0, with values closer to

1.0 indicating better discrimination performance. In this study, the AUC range was classified as follows : $0.5 \leq AUC < 0.7$ as low, $0.7 \leq AUC < 0.9$ as moderate, and $0.9 \leq AUC \leq 1.0$ as high. Furthermore, the reliability of the ROC curve analysis results was confirmed by calculating the 95% confidence interval of the AUC to indicate the accuracy of the estimation. The significance of the test was determined at a risk rate of less than 5%.

RESULTS

Overlap between sarcopenia and frailty in community-dwelling older adults

Of the 423 participants, 147 (34.8%) were diagnosed with sarcopenia or frailty, eight (1.9%) with sarcopenia alone, 113 (26.7%) with frailty alone, and 26 (6.1%) with both sarcopenia and frailty (Fig. 2).

Baseline characteristics, physical function, and body composition of patients with sarcopenia and frailty

Table 1 presents the participants' baseline characteristics. Significant differences were observed in age and BMI between sarcopenia with frailty group and healthy individuals. Additionally, significant differences were observed in age between male and female participants with sarcopenia and frailty. Table 2 shows the physical function and body composition data. Significant differences were found in maximum grip strength, gait speed, basal metabolic rate, lean body mass, muscle mass, appendicular lean mass, SMI, phase angle, and bone mass between male and female with sarcopenia with frailty.

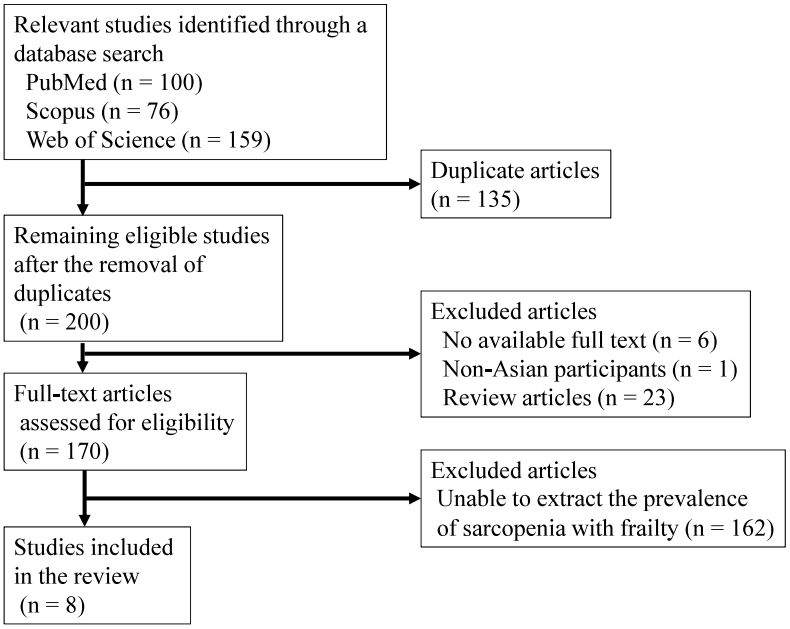

Figure 1. Systematic literature review process

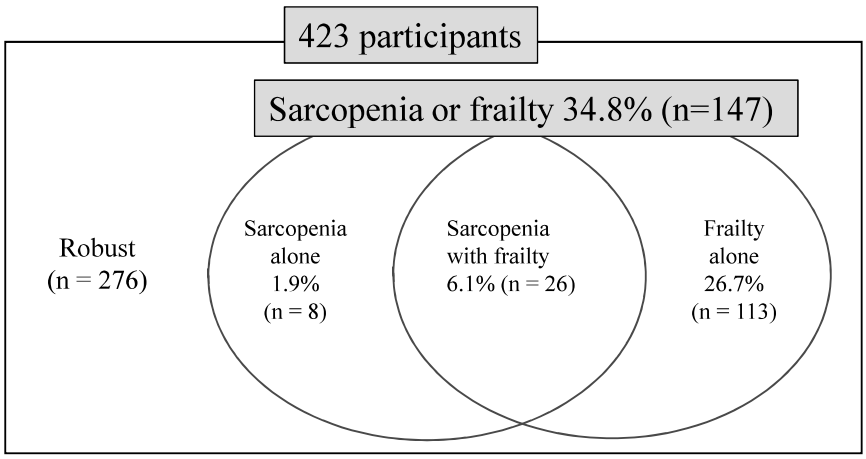

Figure 2. Coexistence between sarcopenia and frailty in community-dwelling Japanese individuals

Table 1. Baseline characteristics of patients with sarcopenia and frailty

		Overall				Male				Female			
		Robust	Sarcopenia	Frailty	Sarcopenia with frailty	Robust	Sarcopenia	Frailty	Sarcopenia with frailty	Robust	Sarcopenia	Frailty	Sarcopenia with frailty
		276	8	113	26	74	2	35	8	202	6	78	18
Age (years)		75.28 ± 7.22	86.38 ± 5.34*	78.43 ± 7.51*§	86.88 ± 3.63*¶	74.54 ± 7.11	86.00 ± 4.24	76.74 ± 8.63	86.50 ± 2.51*¶	75.55 ± 7.26	86.50 ± 6.02	79.19 ± 6.88*	87.06 ± 4.08*
Sex	Female	202 (73.2)	6 (75.0)	78 (69.0)	18 (69.2)								
	Male	74 (26.8)	2 (25.0)	35 (31.0)	8 (30.8)								
Body mass index (kg/m^2)		22.4 ± 2.8	22.6 ± 4.0	22.9 ± 3.3	21.0 ± 3.5*¶	23.2 ± 2.7	21.0 ± 0.1	23.2 ± 2.9	20.6 ± 2.3	22.1 ± 2.8	23.2 ± 4.6	22.7 ± 3.5	21.8 ± 3.9
Alcohol consumption		72 (26.1)	2 (25.0)	32 (28.3)	4 (15.4)	46 (62.2)	2 (100.0)	22 (62.9)	4 (50.0)	26 (12.9)	0 (0.0)	10 (12.8)	0 (0.0)
Smoking		24 (8.7)	0 (0.0)	8 (7.1)	2 (7.7)	20 (27.0)	0 (0.0)	5 (14.3)	2 (25.0)	4 (2.0)	0 (0.0)	3 (3.8)	0 (0.0)
Disease	Diabetes	28 (10.1)	1 (12.5)	11 (9.7)	4 (15.4)	7 (9.5)	0 (0.0)	7 (20.0)	4 (50.0)*	21 (10.4)	1 (16.7)	4 (5.1)	0 (0.0)
	Hypertension	134 (48.6)	6 (75.0)	69 (61.1)	12 (46.2)	38 (51.4)	2 (100.0)	23 (65.7)	2 (25.0)	96 (47.5)	4 (66.7)	46 (59.0)	10 (55.6)
	Dyslipidemia	101 (36.6)	2 (25.0)	37 (32.7)	6 (23.1)	25 (33.8)	0 (0.0)	9 (25.7)	3 (37.5)	76 (37.6)	2 (33.3)	28 (35.9)	3 (16.7)
	Stroke	6 (2.2)	0 (0.0)	4 (3.5)	0 (0.0)	3 (4.1)	0 (0.0)	1 (2.9)	0 (0.0)	3 (1.5)	0 (0.0)	3 (3.8)	0 (0.0)
	Chronic kidney disease	34 (12.3)	1 (12.5)	23 (20.4)	4 (15.4)	0 (0.0)	0 (0.0)	2 (5.7)	1 (12.5)	34 (16.8)	1 (16.7)	21 (26.9)	3 (16.7)
	Cardiac disease	12 (4.3)	0 (0.0)*	15 (13.3)	2 (7.7)	5 (6.8)	0 (0.0)	9 (25.7)*	1 (12.5)	7 (3.5)	0 (0.0)	6 (7.7)	1 (5.6)
Hospital history		31 (11.2)	2 (25.0)	19 (16.8)	4 (15.4)	10 (13.5)	1 (50.0)	5 (14.3)	0 (0.0)	21 (10.4)	1 (16.7)	14 (17.9)	4 (22.2)

Data are presented as the mean ± standard deviation and number (%). *p < 0.05, compared with robustness. §p < 0.05 compared with sarcopenia. ¶ p < 0.05 compared with frailty

Table 2. Physical function and body composition of patients with sarcopenia and frailty

	Overall				Male				Female			
	Robust	Sarcopenia	Frailty	Sarcopenia with frailty	Robust	Sarcopenia	Frailty	Sarcopenia with frailty	Robust	Sarcopenia	Frailty	Sarcopenia with frailty
	276	8	113	26	74	2	35	8	202	6	78	18
Physical function												
Maximum grip strength (kg)	28.62 ± 8.09	19.61 ± 2.69*	27.37 ± 8.64§	19.67 ± 4.75*¶	39.12 ± 6.06	21.50 ± 0.99	37.04 ± 7.33	23.94 ± 3.59*¶	24.78 ± 4.55	18.97 ± 2.83*	23.04 ± 4.82*§	17.78 ± 3.95*¶
Gait speed (s/m)	1.56 ± 0.35	0.83 ± 0.27*	1.32 ± 0.44*§	0.85 ± 0.24*¶	1.65 ± 0.36	0.96 ± 0.52	1.53 ± 0.49	0.90 ± 0.34*¶	1.53 ± 0.35	0.79 ± 0.20*	1.23 ± 0.39*§	0.83 ± 0.19*¶
Body composition												
Basic metabolic rate (kcal)	1,074.4 ± 185.1	857.4 ± 163.7*	1,080.6 ± 198.9§	886.3 ± 126.5*§	1,311.2 ± 157.7	1,090.0 ± 43.8	1,307.9 ± 183.5	1,034.9 ± 88.5*¶	987.7 ± 98.1	779.8 ± 90.8*	978.6 ± 92.9§	820.2 ± 72.8*¶
Lean body mass (kg)	38.41 ± 7.40	30.16 ± 7.50*	38.66 ± 7.93§	31.95 ± 5.72*¶	48.77 ± 5.40	41.15 ± 1.48	48.67 ± 6.23	39.24 ± 3.18*¶	34.61 ± 3.21	26.50 ± 3.72*	34.17 ± 2.90§	28.71 ± 2.79*¶
Body fat mass (kg)	14.53 ± 5.48	14.64 ± 5.18	15.12 ± 6.23	12.01 ± 5.85	13.56 ± 5.19	12.45 ± 1.06	13.69 ± 5.52	10.03 ± 5.02	14.89 ± 5.55	15.37 ± 5.90	15.77 ± 6.46	12.89 ± 6.11
Body fat percent (%)	27.14 ± 7.94	32.71 ± 10.45	27.64 ± 8.77	26.74 ± 9.69	21.26 ± 6.24	23.25 ± 0.92	21.17 ± 6.48	19.56 ± 7.34	29.29 ± 7.40	35.87 ± 10.24	30.54 ± 8.11	29.93 ± 8.99
Muscle mass (kg)	36.35 ± 7.00	28.74 ± 6.98*	36.61 ± 7.52§	30.37 ± 5.32*¶	46.22 ± 5.13	39.00 ± 1.41	46.13 ± 5.92	37.17 ± 3.01*¶	32.74 ± 2.93	25.32 ± 3.40*	32.33 ± 2.65§	27.35 ± 2.54*¶
Appendicular lean mass (kg)	16.16 ± 3.82	10.73 ± 4.67*	16.49 ± 4.30§	11.97 ± 2.87*¶	20.74 ± 3.50	16.10 ± 1.41	21.56 ± 3.63	15.64 ± 1.11*¶	14.44 ± 2.15	8.05 ± 2.61*	14.21 ± 2.03§	10.30 ± 1.44*¶
Skeletal muscle mass index (kg/m^2)	6.67 ± 0.92	5.26 ± 1.00*	6.82 ± 1.01§	5.58 ± 0.62*¶	7.70 ± 0.85	6.30 ± 0.22	7.75 ± 0.96	6.24 ± 0.66*¶	6.29 ± 0.61	4.92 ± 0.90*	6.40 ± 0.71§	5.28 ± 0.31*¶
Phase angle (°)	4.81 ± 0.64	3.98 ± 0.46*	4.59 ± 0.71*§	3.92 ± 0.53*¶	5.29 ± 0.53	4.21 ± 0.51	5.04 ± 0.64	4.20 ± 0.53*¶	4.64 ± 0.59	3.91 ± 0.46*	4.39 ± 0.65*	3.80 ± 0.50*¶
Bone mass (kg)	2.06 ± 0.41	1.43 ± 0.53*	2.06 ± 0.42§	1.57 ± 0.40*¶	2.55 ± 0.27	2.15 ± 0.07	2.54 ± 0.31	2.06 ± 0.18*¶	1.87 ± 0.28	1.18 ± 0.33*	1.84 ± 0.25§	1.36 ± 0.25*¶

Data are presented as mean ± standard deviation. *p < 0.05, compared with robustness. §p < 0.05 compared with sarcopenia. ¶ p < 0.05 compared with frailty

KCL domains in participants with sarcopenia with frailty

Table 3 presents the results of the KCL assessments. The sarcopenia with frailty and frailty groups obtained significantly higher scores on all KCL domains compared with the robust group. Moreover, the IADL, cognitive function, and depression scores were significantly higher in patients with sarcopenia and frailty than in those with sarcopenia alone. Only the IADL scores were significantly higher in patients with sarcopenia and frailty than in other groups.

Logistic regression analysis of KCL domain IADL scores associated with sarcopenia and frailty

The IADL of the KCL domain associated with sarcopenia and frailty, which showed higher scores in all study groups, was analyzed using ordinal logistic regression analysis. Table 4 shows the results of the logistic regression analysis. In the analysis, the IADL scores in the KCL domain were associated with frailty (odds ration [OR] : 4.83, 95% confidence interval [CI] : 3.02–7.77, $p < 0.001$) and sarcopenia with frailty (OR : 28.90, 95% CI : 12. 60–68.20, $p < 0.001$). Analyses also showed a larger OR for sarcopenia with frailty compared with frailty alone. However, sarcopenia was not associated with the IADL scores in the KCL domain.

As shown in Table 5, frailty and sarcopenia with frailty, which were associated with the IADL scores in the KCL domain, were further analyzed. Binomial logistic regression analysis was performed, with frailty as the objective variable and IADL scores in the KCL domain as the explanatory variable. In the unadjusted analysis, sarcopenia with frailty was associated with IADL scores in the KCL domain (OR : 1.66, 95% CI : 1.28–2.16, $p < 0.001$). The age- and sex-adjusted analysis also showed an association between sarcopenia with frailty and IADL scores in the KCL domain (OR : 1.50, 95% CI : 1.14–1.98, $p < 0.001$). Thus, IADL scores in the KCL domain were more strongly associated with sarcopenia and frailty than with frailty alone.

ROC curve of KCL in sarcopenia with frailty

Next, the ROC curve of the KCL-IADL score, which was associated with the total KCL score using logistic regression analysis, was analyzed to discriminate between sarcopenia and frailty (Fig. 3). The cutoff value for sarcopenia with frailty based on the total KCL score was 7.000 scores (cutoff value : 7.000, sensitivity : 100.0%, specificity : 71.5%, area under the ROC curve (AUC) = 0.901, 95% CI : 0.866–0.937). The cutoff value for sarcopenia with frailty based on the KCL-IADL score was 2.000 (cutoff value : 2.000 ; sensitivity : 65.4% ; specificity : 85.4% ; AUC : 0.807 ; 95% CI : 0. 708–0.906).

Table 3. Kihon Checklist domains of sarcopenia with frailty

	Overall				Male				Female			
	Robust	Sarcopenia	Frailty	Sarcopenia with frailty	Robust	Sarcopenia	Frailty	Sarcopenia with frailty	Robust	Sarcopenia	Frailty	Sarcopenia with frailty
	276	8	113	26	74	2	35	8	202	6	78	18
IADL	0.26 ± 0.63	0.62 ± 1.06	1.12 ± 1.44*	2.58 ± 1.90*§¶	0.36 ± 0.79	0.50 ± 0.71	1.26 ± 1.54*	2.12 ± 2.23*	0.22 ± 0.56	0.67 ± 1.21	1.05 ± 1.40*	2.78 ± 1.77*¶
Physical function	0.99 ± 0.99	2.00 ± 1.31	2.61 ± 1.33*	2.81 ± 1.39*	0.85 ± 0.93	3.50 ± 0.71	2.34 ± 1.41*	3.00 ± 1.60*	1.04 ± 1.01	1.50 ± 1.05	2.73 ± 1.29*	2.72 ± 1.32*
Nutritional status	0.14 ± 0.36	0.12 ± 0.35	0.33 ± 0.53*	0.38 ± 0.57*	0.15 ± 0.39	0.00 ± 0.00	0.14 ± 0.43	0.38 ± 0.52	0.13 ± 0.34	0.17 ± 0.41	0.41 ± 0.55*	0.39 ± 0.61
Oral function	0.54 ± 0.70	0.50 ± 0.53	1.46 ± 0.88*§	1.38 ± 0.94*	0.51 ± 0.69	0.50 ± 0.71	1.34 ± 0.80*	1.62 ± 1.06*	0.54 ± 0.71	0.50 ± 0.55	1.51 ± 0.91*§	1.28 ± 0.89*
Socialization domain	0.30 ± 0.47	0.25 ± 0.46	0.88 ± 0.69*§	0.81 ± 0.80*	0.30 ± 0.49	0.00 ± 0.00	0.60 ± 0.65	0.88 ± 0.83	0.30 ± 0.47	0.33 ± 0.52	1.01 ± 0.67*	0.78 ± 0.81*
Cognitive function	0.25 ± 0.47	0.00 ± 0.00	0.72 ± 0.75*§	0.85 ± 0.92*§	0.23 ± 0.48	0.00 ± 0.00	0.66 ± 0.64*	1.50 ± 0.76*¶	0.26 ± 0.47	0.00 ± 0.00	0.74 ± 0.80*	0.56 ± 0.86
Depression	0.57 ± 0.82	0.62 ± 0.74	2.58 ± 1.46*§	2.42 ± 1.58*§	0.57 ± 0.86	0.50 ± 0.71	2.63 ± 1.37*	3.25 ± 1.91*	0.56 ± 0.80	0.67 ± 0.82	2.56 ± 1.51*§	2.06 ± 1.30*
Total KCL score	3.04 ± 1.86	4.12 ± 0.99	9.75 ± 2.89*§	11.27 ± 3.24*§¶	2.92 ± 1.98	5.00 ± 0.00	9.00 ± 2.29*	12.75 ± 3.69*¶	3.08 ± 1.82	3.83 ± 0.98	10.09 ± 3.08	10.61 ± 2.89

Data are presented as mean ± standard deviation. *$p < 0.05$, compared with robustness. §$p < 0.05$ compared with sarcopenia. ¶ $p < 0.05$ compared with frailty
KCL, Kihon Checklist ; IADL, instrumental activities of daily living

Table 4. Results of the logistic regression analysis of the Kihon Checklist-IADL scores related to sarcopenia and frailty

	OR (95% CI)	p-value
Robust	Reference	
Sarcopenia	2.59 (0.54–9.88)	0.186
Frailty	4.83 (3.02–7.77)	< 0.001
Sarcopenia with frailty	28.9 (12.6–68.2)	< 0.001

In the ordinal logistic regression analysis of sarcopenia with frailty and the KCL-IADL score, the objective variable was the KCL-IADL score, while the explanatory variables were, sarcopenia, frailty, and sarcopenia with frailty. IADL, instrumental activities of daily living ; OR, odds ratio ; CI, confidence interval

Table 5. Results of the logistic regression analysis of the association between sarcopenia with frailty and the Kihon Checklist-IADL scores

	Unadjusted		Adjusted	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Age	-	-	1.24 (1.11–1.37)	< 0.001
Sex	-	-	1.24 (0.41–3.76)	0.700
KCL-IADL	1.66 (1.28–2.16)	<0.001	1.50 (1.14–1.98)	< 0.001

In the binomial logistic regression analysis of sarcopenia with frailty and KCL-IADL score, the objective variables were frailty and sarcopenia with frailty, while the explanatory variables were age, sex, and KCL-IADL score. KCL, kihon checklist ; IADL, instrumental activities of daily living ; OR, odds ratio ; CI, confidence interval

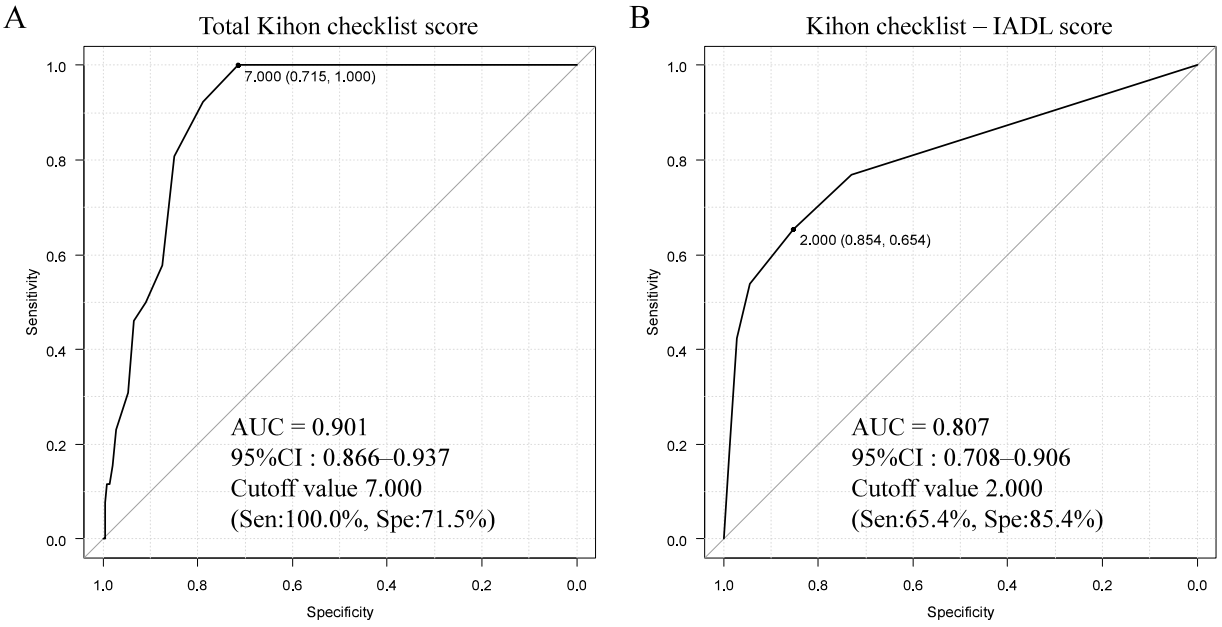

Figure 3. Receiver operating characteristic curve of the Kihon checklist for assessing sarcopenia with frailty
(A) Total Kihon checklist score, (B) Kihon checklist-IADL score. IADL : instrumental activities of daily living, AUC : area under the curve, CI : confidence interval, Sen : sensitivity, Spe ; specificity

DISCUSSION

This study examined the prevalence of sarcopenia and frailty among community-dwelling older adults and the characteristics of sarcopenia and frailty when they coexist. Frailty was assessed using the KCL, with domain-specific characteristics further evaluated. The results showed that 1.9%, 26.7%, and 6.1% of participants had sarcopenia alone, frailty alone, and sarcopenia with frailty, respectively. Additionally, higher IADL scores were observed in the sarcopenia with frailty and KCL domains.

The overall prevalence of sarcopenia with frailty in the present study was 6.1%. Sarcopenia and frailty result from the combined effects of age-related physiological changes. Therefore, these conditions are interrelated and often coexist. Their coexistence has been reported to be associated with the risk of all-cause mortality (13). Although in this retrospective cross-sectional study, we did not evaluate outcomes such as all-cause mortality, the findings of the study underscore the importance of early detection and intervention given the significant impact of sarcopenia with frailty on disease and life-threatening outcomes.

In the present study, the IADL domain of the KCL scored higher in patients with sarcopenia and frailty. IADL impairment has been previously reported in individuals with sarcopenia. Zhou *et al*. reported IADL impairment in older adults aged > 60 years in China (14). IADL impairment has been reported to be a marker of frailty (15). Sarcopenia is characterized by decreased muscle mass and strength and necessitates a minimum level of muscle strength to perform IADLs. In populations with frailty, even slight muscle weakness has been shown to significantly impact the performance of IADLs (16). The findings of this study suggest that IADL impairment in patients with sarcopenia and frailty is likely driven by muscle weakness.

In this study, the KCL score was used to determine the cutoff value for identifying sarcopenia with frailty. The cutoff value for the total KCL score was 7.000, with an AUC of 0.901. Similarly, the cutoff value for the KCL-IADL score, which was associated with sarcopenia and frailty in the logistic regression analysis, was 2.000, with an AUC of 0.807. The total KCL score was similar to the cutoff value previously reported for discriminating frailty (8). However, the present study highlights the utility of the KCL-IADL score in distinguishing between sarcopenia and frailty. As mentioned in previous studies, IADL impairment is linked to both sarcopenia and frailty (14, 15). Given its association with increased mortality, early intervention is essential (17).

Table 6 summarizes the prevalence of sarcopenia with frailty as reported in previous studies (9, 18-24). The prevalence of sarcopenia with frailty in this study was 6.1%. The prevalence of sarcopenia with frailty ranged from 0.0% to 12.5% depending on the target population, diagnostic criteria, and country. This variability is further influenced by the broad age range of 66.6–73.0 years observed in previous studies.

The prevalence of sarcopenia and frailty among community-dwelling older adults in Asia varies according to population, diagnostic criteria, and country. The mean age in this study was 76.5 years, which is higher than that in previous studies, while the prevalence of sarcopenia with frailty was relatively high at 6.1%. By contrast, studies by Lin *et al*. and Lee *et al*. reported lower prevalence rates of sarcopenia with frailty, with mean ages of 66.6 and 67.2 years, which were relatively low (22, 24). This trend indicates that the prevalence of sarcopenia and frailty increases with age, as both conditions are recognized as geriatric syndromes (25). In the country-by-country comparison, three studies were conducted in Japan, two in China, one in Korea, and three in Singapore. The prevalence in Japanese studies ranged from 3.6% to 4.0% (9, 18). Nishiguchi *et al*. and the present study reported a higher prevalence of frailty (20.9% and 32.9%, respectively) (18). Conversely, these studies reported a low prevalence of sarcopenia, ranging from 8.0% to 9.4%. In China, the prevalence ranged from 0.6% to 3.4% (20, 22). In South Korea, the prevalence rates increased by 2.3%, assessed based on the AWGS 2014 criteria, and 3.0%, based on the AWGS 2019 criteria. This difference reflects the impact of the revised diagnostic criteria. In Singapore, the prevalence varied from 0.0% to 12.5%, which may be dependent on the diagnostic criteria, sample size, and population. (19, 23, 24)

The CHS ; Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight (FRAIL) ; and KCL scores were used as diagnostic criteria for frailty. The prevalence of frailty varied widely,

Table 6. Previous studies reporting the prevalence of sarcopenia and frailty among community-dwelling older adults in Asia

No.	First author	Publication year	Sample size	Age	Country	Prevalence of sarcopenia with frailty (%)	Prevalence of frailty (%)			Prevalence of sarcopenia (%)		
							CHS	FRAIL	KCL	AWGS2014	AWGS2019	SARC-F
1	Nishiguchi *et al*.[18]	2015	273	73.0	Japan	4.0	20.9			8.0		
2	Mori *et al*.[9]	2019	331	71.5	Japan	3.6	6			9.4		
3	Lee *et al*.[19]	2021	200	67.9	Singapore	12.5		17.5				33.0
4	Yang *et al*.[20]	2022	2,372	67.6	China	3.4		6.2			29.6	
5	Lee *et al*.[21]	2022	2,028	75.9	Korea	2.3 (AWGS 2014) 3.0 (AWGS 2019)	5.5			9.1	17.5	
6	Lin *et al*.[22]	2024	1,042	66.6	China	0.6		1.9			8.3	
7	Piodena-Aportadera MRB *et al*.[23]	2024	187	66.8	Singapore	1.1	1.1				24.1	
8	Lee *et al*.[24]	2024	230	67.2	Singapore	0.0		0.0			27.0	
9	Our study	2024	423	76.5	Japan	6.1			32.9		8.0	

CHS : Cardiovascular Health Study ; FRAIL : Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight ; KCL, kihon checklist ; AWGS, Asian Working Group for Sarcopenia ; SARC-F, Strength, assistance with walking, rising from a chair, climbing stairs, and falling questionnaire

ranging from 0.0% to 32.9%, with considerable differences observed depending on the diagnostic criterion, population, and sample size. This study is the first to use the KCL to assess sarcopenia associated with frailty. Since CHS and FRAIL are specifically designed for evaluating physical frailty, future studies should consider using criteria that offer a more comprehensive assessment of frailty, including the KCL (26).

The AWGS 2014, AWGS 2019, and strength, assistance with walking, rising from a chair, climbing stairs, and falls (SARC-F) criteria were used to diagnose sarcopenia. Lee *et al*. noted that the prevalence of sarcopenia with frailty was higher when using the AWGS 2019 criteria compared with the AWGS 2014 criteria. This difference is likely due to the revised cutoff values based on the AWGS 2019 criteria (11, 21). In SARC-F, the prevalence of sarcopenia was notably high (33.0%). Consequently, the prevalence of sarcopenia with frailty was also higher (12.5%). (19) The sensitivity and specificity of SARC-F to the AWGS 2014 criteria were 86.05% and 40.28%, respectively, which may limit its ability to accurately capture the comorbidity of sarcopenia with frailty. (27)

The prevalence of sarcopenia and frailty among community-dwelling older adults in Asia varies widely according to diagnostic criteria, age, and population. Given the impact of sarcopenia and frailty on the quality of life and healthcare cost burden of older adults, adopting more standardized criteria and conducting studies that consider population-specific factors are essential.

This study has several limitations. First, only the KCL was used to diagnose frailty. Several criteria exist for diagnosing frailty, and using other criteria could provide a more accurate diagnosis. Second, this study was conducted only among residents of Wakasa Town (Mikata-Kaminaka Town, Fukui Prefecture), a geographically limited area, which may result in a biased population distribution and prevalence. In addition, the sample size was relatively small. Therefore, future large-scale studies are warranted. Third, IADL was assessed using only the KCL items, and no other assessment methods were employed for evaluation. Fourth, as this was a retrospective observational study, it was not possible to determine the reasons and trends behind the decreased IADL scores in participants with both sarcopenia and frailty. Future prospective studies should increase the number of participants and examine the longitudinal factors that contribute to the comorbidity of sarcopenia and frailty.

In this study, the prevalence of sarcopenia with frailty diagnosed using the KCL was 6.1%. Furthermore, sarcopenia with frailty can lead to IADL impairment. Hence, the improvement of IADL and early detection are important treatment strategies.

CONFLICT OF INTEREST

The authors declare that they have no proprietary interests regarding any aspect of this study.

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