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Evaluation of SARC-F and SARC-CalF for sarcopenia screening in patients with chronic musculoskeletal pain

A prospective cross-sectional study

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Abstract

Objectives: Early sarcopenia detection using screening tools, such as SARC-F and SARC-CalF, has been proven reliable. However, the relationship between chronic musculoskeletal pain with sarcopenia is unknown. This study assessed sarcopenia morbidity as well as the reliability of sarcopenia screening with SARC-F and SARC-CalF in patients with chronic musculoskeletal pain.

Methods: Overall, 172 patients with chronic musculoskeletal pain were included in this cross-sectional study. All participants completed the SARC-F, SARC-CalF, numeric rating scale (NRS), and pain disability assessment scale (PDAS) assessments. Sarcopenia was diagnosed using the Asian Working Group for Sarcopenia criteria 2019. Correlations between SARC-F and SARC-CalF scores and each measured variable were evaluated using univariate and multiple linear regression analyses. A receiver operating characteristic curve analysis was conducted, and reliabilities of SARC-F and SARC-CalF scores for diagnosing sarcopenia were compared.

Results: Thirty-nine patients were diagnosed with sarcopenia. Among these, 10 patients were <65 years old, and 29 were >65 years old. Both SARC-F and SARC-CalF scores significantly correlated with grip power, gait speed, skeletal mass index, numeric rating scale score, and PDAS score. In multiple linear regression analysis, SALC-F and SALC-CalF scores significantly correlated with PDAS score, skeletal mass index, and gait speed. The area under the curve were 0.70 for SARC-F and 0.88 for SARC-CalF; SARC-CalF had a significantly higher area under the curve than SARC-F.

Discussion: Sarcopenia was diagnosed in patients aged <65 years with chronic musculoskeletal pain. SALC-F and SARC-CalF scores showed a significant correlation with disability due to pain and were reliable sarcopenia screening tools for chronic musculoskeletal pain. SARC-CalF was more reliable than SARC-F.

Abbreviations: ADL = activities of daily living, AUC = area under the curve, AWGS = Asian Working Group for Sarcopenia, CC = calf circumference, LR = likelihood ratio, NPV = negative predictive value, NRS = Numeric Rating Scale, PDAS = pain disability assessment scale, PPV = positive predictive value, ROC = receiver operating characteristic, SMI = skeletal muscle index.

Keywords: chronic musculoskeletal pain, SARC-CalF, SARC-F, Sarcopenia, screening

1. Introduction

As the population of older adults in developed countries rises, so does the number of people requiring nursing care services, with approximately 21.5% of these people requiring nursing care for musculoskeletal disorders.[1] Thus, early detection, prevention, and treatment of musculoskeletal disorders are important objectives for reducing the number of older people who require nursing care and extending healthy life expectancy. From this perspective, sarcopenia is a rising concern.[2–8] Sarcopenia is defined as a progressive and generalized skeletal muscle disorder that involves accelerated loss of muscle mass and function.[9,10] It is associated with increased adverse outcomes, including functional decline, falls, fractures, and even mortality.[5,11–13] Although sarcopenia is

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common among older adults, it can also occur earlier in life, making early detection essential for the prevention and treatment of this condition.[5] Among the existing screening tools, SARC-F and SARC-CalF are commonly recommended instruments, with the evidence available to support their use.[14,15]

Chronic pain is another problem that decreases activities of daily living (ADL), affecting 20% of the general population.[16,17] The International Association for the Study of Pain and the World Health Organization have included chronic musculoskeletal pain in the International Statistical Classification of Diseases-11.[18,19] Chronic musculoskeletal pain causes decreased physical function due to prolonged pain, whose onset can be in patients as young as 40 years of age.[20] While both chronic pain and sarcopenia decrease physical function and activity, the relationship between them is not well-defined. Moreover, from the perspective of prevention, screening for sarcopenia in patients with chronic musculoskeletal pain is important. Therefore, this study aimed to assess the morbidity of sarcopenia and evaluate the reliability of screening sarcopenia using SARC-F and SARC-CalF in patients with chronic musculoskeletal pain.

2. Methods

2.1. Study participants

This cross-sectional study was conducted at Okayama University Hospital. We included 172 patients (43 men, 129 women) with chronic musculoskeletal pain who presented to our outpatient pain clinic between December 2019 and February 2021. The inclusion criteria for this study were age over 40 years, pain for >3 months, and consent to complete written self-report questionnaires and a physical examination. The exclusion criteria were as follows: ongoing litigation, dementia, delirium, or other conditions that would make completion of questionnaires and physical examinations difficult. Participants were requested to complete questionnaires and undergo a physical examination and body composition assessment at the outpatient clinic. Ethical approval was obtained from the Board of Ethics of Okayama University Hospital. This study was conducted in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

2.2. Assessment of sarcopenia-related factors

2.2.1. Diagnosis of Sarcopenia. Diagnosis of sarcopenia was performed according to the Asian Working Group for Sarcopenia (AWGS) criteria 2019.[6] Gait speed, grip strength, and muscle mass were assessed and used in this study. The criterion for low muscle strength was handgrip strength <28 kg for men and <18 kg for women and the criterion for low physical performance was 6-m walking speed <1.0 m/s. The skeletal muscle index (SMI) was assessed using Inbody 770 and S10 (InBody Japan, Tokyo, Japan), and low muscle mass was defined by an SMI <7.0 kg/m^2 in men and <5.7 kg/m^2 in women in this study. Sarcopenia was defined by the presence of low muscle mass and either low muscle strength or low physical performance.

2.2.2. SARC-F and SARC-CalF as Screening Tools for Sarcopenia. SARC-F and SARC-CalF were used to screen for sarcopenia in this study.[21–24] The SARC-F comprises five items, assessing participant strength, assistance in walking, rising from a chair, climbing stairs, and falls. Each item is scored between 0 and 2.[23] SARC-CalF comprises the items from SARC-F and one additional calf circumference (CC) item. The first five items are scored the same as in the standard SARC-F. The CC item is scored 0 if the CC is >34 cm for men and >33 cm for women and 10 points if the CC is ≤34 cm for men and ≤33 cm for women.[15] A total SARC-F score ≥4 and SARC-CalF score ≥11 indicate a positive result for sarcopenia.

2.3. Evaluation of pain-related factors

2.3.1. Pain intensity assessment. The numeric rating scale (NRS) was used to assess pain intensity. The NRS score ranges from 0 to 10, with 0 representing no pain and 10 representing the worst pain imaginable.[25] The average pain intensity in the past 1 week was used in this study.

2.3.2. Disability due to pain. The pain disability assessment scale (PDAS) was used to assess the extent to which pain interfered with patients' ADL during the previous week.[26] The PDAS comprises 20 items; each item is rated from 0 to 3, with 0 representing "pain did not interfere with this activity" and 3 representing "pain interfered with this activity." The PDAS scores range from 0 to 60, and a higher score indicates a greater pain-related interference.

2.4. Statistical analyses

Descriptive statistics are presented as mean ± standard deviations (SDs) for continuous variables and as numbers and percentages for categorical variables.

The Kolmogorov–Smirnov test was used to assess normality for continuous variables. Next, we performed the Mann–Whitney *U* test to compare the measured parameters in patients with and without sarcopenia. We subsequently analyzed correlations of SARC-F and SARC-CalF scores with each measured variable using Spearman's rank correlation coefficient. We then performed multiple linear regression to determine the factors associated with SARC-F and SARD-CalF scores. The explanatory variables included grip power, gait speed, SMI, and NRS and PDAS scores, while the covariates were age, sex (male = 1 and female = 0), and BMI. The standardized partial regression coefficient of each variable was calculated. Next, to evaluate the diagnostic value of SARC-F and SARC-CalF scores, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+), and negative likelihood ratio (LR–) were evaluated. Subsequently, a receiver operating characteristic curve (ROC) analysis was performed, and the results were compared between SARC-F and SARC-CalF. For the statistical analyses, we used EZR software (Saitama

Table 1

Patient characteristics.

Variables	All (n = 172)	<65 years (n = 75)	>65 years (n = 97)
Patient background			
Age (years)	66.6 ± 13.9	52.9 ± 6.8	77.2 ± 6.9
Sex (men/women)	43/ 129	20/ 55	23/ 74
BMI (kg/m^2)	23.8 ± 4.5	24.0 ± 5.4	23.6 ± 3.7
Sarcopenia-related factor			
Sarcopenia	36 (20.9)	7 (9.3)	29 (29.9)
SARC-F (points)	2.7 ± 2.5	1.6 ± 2.0	3.5 ± 2.5
SARC-CalF (points)	7.0 ± 5.8	4.6 ± 4.9	9.0 ± 5.7
Grip power (kg)	20.2 ± 10.5	23.8 ± 10.9	17.5 ± 9.4
Gait speed (m/s)	1.1 ± 0.4	1.3 ± 0.4	1.0 ± 0.4
SMI (kg/m^2)	6.7 ± 1.3	7.1 ± 1.3	6.3 ± 1.1
Pain-related factor			
NRS (points)	5.0 ± 2.5	4.9 ± 2.5	5.1 ± 2.4
PDAS (points)	17.0 ± 14.4	13.5 ± 12.0	19.4 ± 15.6
Pain site			
Cranio-cervical	26 (15.0)	14 (18.7)	12 (12.4)
Upper limb	34 (19.8)	15 (20.0)	19 (19.6)
Trunk	96 (55.8)	41 (54.7)	55 (56.7)
Lower limb	84 (48.8)	30 (40.0)	54 (55.7)

Data are expressed as mean ± standard deviation for continuous variables and as number (%) for categorical variables.

BMI = body mass index, NRS = numeric rating scale, PDAS = pain disability assessment scale, SMI = skeletal mass index.

Table 2

Participant characteristics with and without sarcopenia.

Variables	With sarcopenia (n = 36)	Without sarcopenia (n = 137)	*P* value
Patient background			
Age (years)	75.1 ± 12.4	64.4 ± 13.4	<.001
Gender (men/women)	3/33	40/ 96	.009
BMI (kg/m^2)	21.2 ± 3.3	24.5 ± 4.6	<.001
Sarcopenia-related factor			
SARC-F (points)	4.0 ± 2.5	2.3 ± 2.4	<.001
SARC-CalF (points)	13.2 ± 3.2	5.4 ± 5.2	<.001
Grip power (kg)	12.5 ± 5.3	22.3 ± 10.6	<.001
Gait speed (m/s)	0.9 ± 0.4	1.2 ± 0.4	<.001
SMI (kg/m^2)	5.3 ± 0.5	7.0 ± 1.1	<.001
Pain-related factor			
NRS (points)	5.1 ± 2.1	4.9 ± 2.6	.667
PDAS (points)	21.8 ± 16.2	15.5 ± 13.7	.034

Data are expressed as mean ± standard deviation for continuous variables.
BMI = body mass index, NRS = numeric rating scale, PDAS = pain disability assessment scale, SMI = skeletal mass index.

Table 3

Correlation of SARC-F and SARC-CalF scores with the other measured parameters.

	SARC-F		SARC-CalF	
Variables	*r*	*P*	*r*	*P*
Age	0.440	<.001	0.441	<.001
BMI	0.134	.079	−0.409	<.001
Grip power	-0.501	<.001	−0.454	<.001
Gait speed	-0.675	<.001	−0.467	<.001
SMI	-0.312	<.001	−0.557	<.001
NRS	0.319	<.001	0.255	<.001
PDAS	0.681	<.001	0.441	<.001

BMI = body mass index, NRS = numeric rating scale, PDAS = pain disability assessment scale, SMI = skeletal mass index.

Medical Center Jichi Medical University, Tochigi, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). Results were considered significant at a level of $P < .05$. To determine the number of test samples for multiple linear regression analysis, a prior sample size calculation was performed with effect size of 0.15, α error of 0.05, and (1-β) of 0.95 using G*power software version 3.1.9.7.[27] This resulted in a required sample size of 160.

3. Results

3.1. participant characteristics

The characteristics of the patients are shown in Table 1. The mean age was 66.6 years (SD: 13.9 years), mean SARC-F score was 2.7 (SD: 2.5), and mean SARC-CalF score was 7.0 (SD: 5.8). Among all patients, 75 patients were aged <65 years and 97 were aged >65 years; 36 (20.9%), 7 (9.3%), and 29 (29.9%) patients, respectively, were diagnosed with sarcopenia. Data for the other sarcopenia-related factors (grip power, gait speed, and SMI) and pain-related factors (NRS score, PDAS score, and pain site) are also shown in Table 1, and Table 2 shows the characteristics of patients with and without sarcopenia. All sarcopenia-related factors and the PDAS score differed significantly in patients with and without sarcopenia.

3.2. Variables associated with SARC-F and SARC-CalF scores

Table 3 shows the results for the correlation between SARC-F and SARC-CalF scores and each variable. Both SARC-F and SARC-CalF scores were significantly correlated with grip power ($r = -0.501$ and -0.454), gait speed ($r = -0.675$ and -0.467), SMI ($r = -0.312$ and -0.557), NRS score ($r = 0.319$ and 0.255), and PDAS score ($r = 0.681$ and 0.441), and all P values were <.001. In multiple linear regression analysis, SARC-F score was significantly correlated with PDAS score ($\beta = 0.49$, $P < .001$), SMI ($\beta = -0.28$, $P = .006$), and gait speed ($\beta = -0.29$, $P < .001$) (Table 4); SARC-CalF score was also significantly correlated with PDAS score ($\beta = 0.28$, $P < .001$), SMI ($\beta = -0.25$, $P = .038$), and gait speed ($\beta = -0.19$, $P = .020$) (Table 5).

Table 4

Multiple linear regression analysis examining factors associated with the SARC-F score.

Variables	Standardized partial regression coefficient	95% CI		*P* value
		Lower	Upper	
PDAS	0.49	0.37	0.60	<.001
SMI	−0.28	−0.49	−0.08	.006
Gait speed	−0.29	−0.42	−0.16	<.001
BMI	0.17	0.03	0.30	.014
Sex	0.16	0.02	0.30	.030
Constant term	0.00	-0.09	0.09	1.000

BMI = body mass index, CI = confidence interval, PDAS = pain disability assessment scale, SMI = skeletal mass index.

Table 5

Multiple linear regression analysis examining factors associated with the SARC-CalF score.

Variables	Standardized partial regression coefficient	95% CI		*P* value
		Lower	Upper	
PDAS	0.28	0.14	0.41	<.001
SMI	−0.25	−0.49	−0.01	.038
Gait speed	−0.19	−0.34	−0.03	.020
BMI	−0.34	−0.50	−0.19	<.001
Constant term	0.00	−0.11	0.11	1.000

BMI = body mass index, CI = confidence interval, PDAS = pain disability assessment scale, SMI = skeletal mass index.

3.3. Diagnostic power and comparison of SARC-F and SARC-CalF scores

The diagnostic value of SARC-F and SARC-CalF scores for sarcopenia was assessed by determining the sensitivity, specificity, PPV, NPV, LR+, LR−, and area under the curve (AUC) (Table 6) as well as the ROC curves for SARC-F and SARC-CalF scores, shown in Fig. 1. The AUCs were 0.70 for SARC-F and 0.88 for SARC-CalF, with SARC-CalF showing a significantly higher AUC than SARC-F ($P < .001$).

4. Discussion

Our findings showed that 20.9% of the overall study population with chronic musculoskeletal pain, and 9.3% of the participants aged <65 years, had sarcopenia. The SARC-F and SARC-CalF scores were significantly correlated with not only sarcopenia-related factors but also NRS and PDAS scores in univariate analysis and with the PDAS score, SMI, and gait speed in multivariate analysis. In assessments of the sarcopenia screening capacity in chronic pain patients, both SALC-F and SARC-CalF showed moderate diagnostic power in the ROC curve analysis, with SARC-CALF showing a higher diagnostic power than SARC-F.

Table 6

Correlations of SARC-F and SARC-CalF scores with the other measured parameters.

	Sensitivity, %	Specificity, %	PPV %	NPV, %	+LR	−LR	AUC	*P* value
All ages								
SARC-F	55.6 (38.1–72.1)	71.3 (62.9–78.7)	33.9 (22.1–47.4)	85.8 (78.0–91.7)	1.94 (1.31–2.87)	0.62 (0.43–0.91)	0.70 (0.60–0.79)	<.001
SARC-CalF	80.6 (64.0–91.8)	77.9 (70.0–84.6)	49.2 (35.9–62.5)	93.8 (87.7–97.5)	3.65 (2.56–5.21)	0.25 (0.13–0.49)	0.88 (0.83–0.93)	
>65 years								
SARC-F	62.1 (42.3–79.3)	57.4 (44.8–69.3)	38.3 (24.5–53.6)	78.0 (64.0–88.5)	1.46 (0.98–2.16)	0.67 (0.40–1.10)	0.66 (0.54–0.77)	<.001
SARC-CalF	89.7 (72.6–97.8)	70.6 (58.3–81.0)	56.5 (41.1–71.1)	94.1 (83.8–98.8)	3.05 (2.07–4.50)	0.15 (0.05–0.43)	0.87 (0.81–0.94)	
≤65 years								
SARC-F	28.6 (3.7–71.0)	85.3 (74.6–92.7)	16.7 (2.1–48.4)	92.1 (82.4–97.4)	1.94 (0.53–7.16)	0.84 (0.52–1.35)	0.62 (0.37–0.86)	.139
SARC-CalF	42.9 (9.9–81.6)	85.3 (74.6–92.7)	23.1 (5.0–53.8)	93.5 (84.3–98.2)	2.91 (1.04–8.16)	0.67 (0.35–1.28)	0.82 (0.72–0.92)	

Values within parenthesis show 95 % confidential intervals. *P* value represents the difference of the AUC between SARC-F and SARC-CalF in each group.
+LR = positive likelihood ratio, −LR = negative likelihood ratio, AUC = area under the curve, NPV, negative predictive value, PPV = positive predictive value.

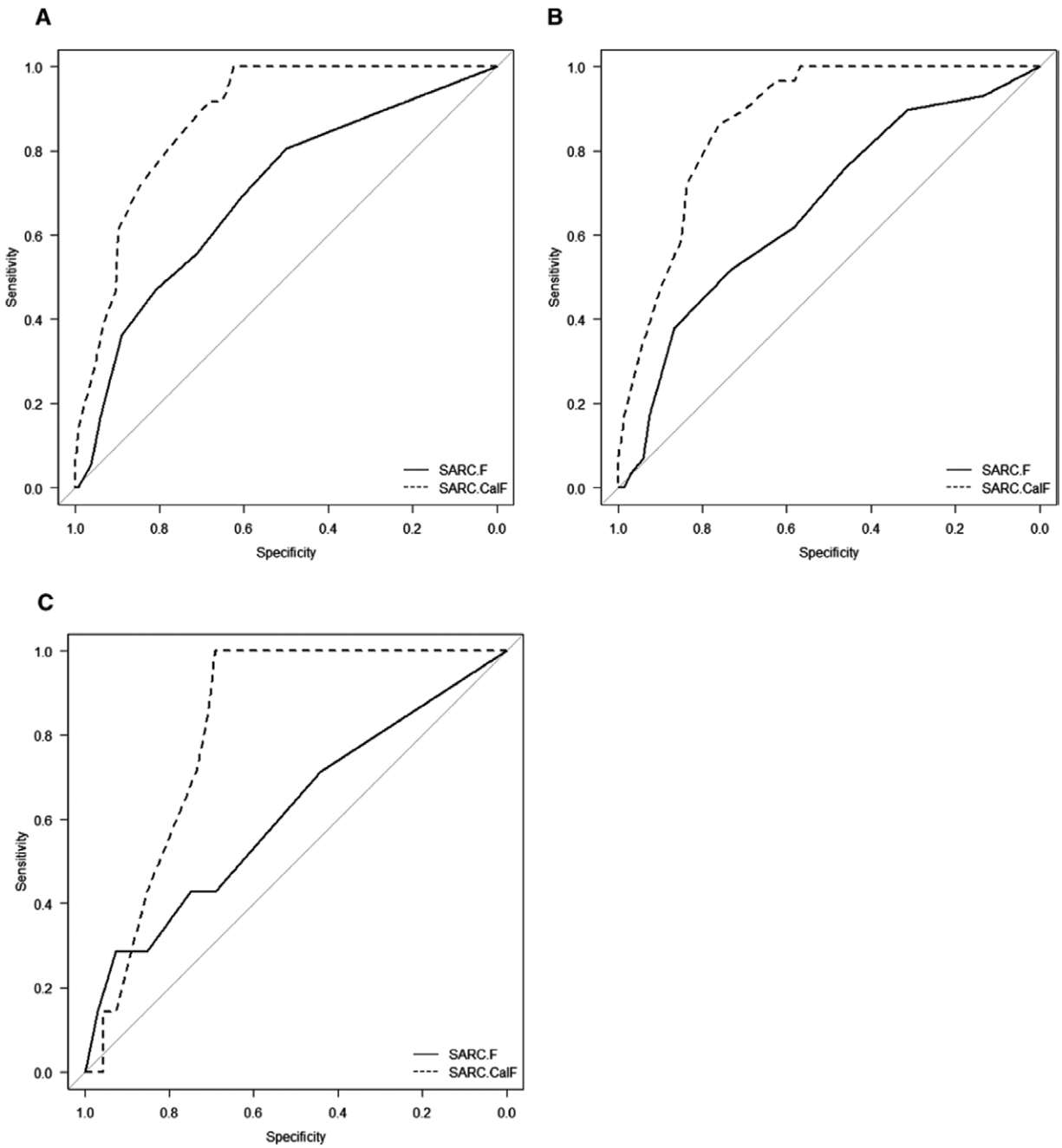

Figure 1. The receiver operating characteristic (ROC) curves of SARC-F and SARC-CalF for diagnosing sarcopenia against age: (A) all ages, (B) >65 years, and (C) <65 years.

In patients with chronic musculoskeletal pain, physical function and activity are impaired from a relatively early age.[20] Sarcopenia may result in similar impairments; in this study, approximately 10% of the patients <65 years of age were diagnosed with sarcopenia, and for the same degree of pain, patients with sarcopenia showed a significantly greater pain-induced reduction in activity. This result may represent a vicious cycle: prolonged pain decreases physical activity, thereby reducing muscle mass, causing greater prolonged pain, and causing further reductions in activity. However, since the time course of pain-induced loss of physical activity and muscle loss could not be evaluated from this study, further studies are warranted on this topic.

For screening sarcopenia in patients with chronic musculoskeletal pain, both SARC-F and SARC-CalF showed moderate diagnostic power. A previous study in community-dwelling older adults revealed that the AUC of SARC-F ranged from 0.79 to 0.89 using various diagnostic criteria.[28] In our study, the AUC of SARC-F was 0.72, which was thought to be similar to the previously reported findings. SARC-CalF was originally developed to enhance the SARC-F sensitivity by incorporating CC as a muscle mass surrogate into the SARC-F,[15] and SARC-CalF has indeed been shown to have significantly better sensitivity (66.7%) in comparison with SARC-F (33.3%) for all studied age groups. Similar results have been reported for community-dwelling older adults,[28] patients with cancer,[29] and patients with chronic pain who have participated in our study. In assessments of their reliability as screening tools, both SARC-F and SARC-CalF scores were correlated with PDAS scores, which indicated pain-related disability. In other words, SARC-F and SARC-CalF are not only screening tools for sarcopenia but also simple tools to assess disability in patients with chronic musculoskeletal pain.

This study has several limitations. First, since sarcopenia is a concept primarily applicable in older patients, its use in people <65 years is controversial. However, a previous longitudinal study revealed that leg skeletal muscle mass starts to decrease in the 40s,[30] and chronic musculoskeletal pain can exacerbate muscle mass and physical function reduction. Although the use of the term sarcopenia in younger ages is controversial, clinical attention should be paid to muscle mass and physical function maintenance in patients with chronic musculoskeletal pain, even at a younger age. Second, since this study was conducted in Japanese participants and we used the AWGS criteria for sarcopenia diagnosis, the results may differ in studies involving other populations and using other sarcopenia criteria, such as those proposed by the European Working Group on Sarcopenia in Older People[5] or the International Working Group on Sarcopenia.[22] Third, in this study, patients with chronic pain were evaluated mainly from the viewpoint of physical function and activity, although pain chronicity is related to a complex interplay of psychological and social factors, and such factors were not considered in this study. Fourth, since this was a cross-sectional study, it was difficult to evaluate the chronological order between sarcopenia and chronic pain. Fifth, while musculoskeletal pain includes rest and motion pain, we used average pain intensity in the past 1 week of NRS as a comprehensive and representative concept including exercise and resting pain. Based on these limitations, further prospective studies are needed to explore the relationships of sarcopenia with pain-related factors and outcomes after treatment in patients with chronic musculoskeletal pain.

This study demonstrated that, among patients with chronic musculoskeletal pain, sarcopenia was present in patients <65 years of age. While both SARC-F and SARC-CalF were shown to be reliable screening methods, SARC-CalF was the more reliable tool for detecting sarcopenia. Further studies are needed to assess the chronological relationship between sarcopenia and chronic musculoskeletal pain.

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Author contributions

Conceptualization: HT and Tomoko T. Methodology: HT and Tomonori T. Formal analysis and investigation: HT and Tomonori T. Writing – original draft preparation: HT, Tomoko T and Tomonori T. Writing – review and editing: YO and HM. Funding acquisition: TT. Resources: TT and ST. Supervision: KN and TO.

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